Texas
Department
of Transportation

STANDARD SPECIFICATIONS FOR CONSTRUCTION AND MAINTENANCE OF HIGHWAYS, STREETS AND BRIDGES

Adopted by the
Texas Department of Transportation

March 1, 1995

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PART I, GENERAL PROVISIONS

DIVISION I
GENERAL REQUIREMENTS AND COVENANTS

ITEM 1

DEFINITION OF TERMS

1.1. Definitions. Wherever the following terms are used in these specifications or other contract documents, the intent and meaning shall be interpreted as shown below:

1.2. Abbreviations:

AANAmerican Association of Nurserymen.
AARAssociation of American Railroads.
AASHTOAmerican Association of State Highway and Transportation Officials.
AITCAmerican Institute of Timber Construction.
ANSIAmerican National Standards Institute.
APIAmerican Petroleum Institute.
AREAAmerican Railroad Engineers Association.
ASTMAmerican Society for Testing and Materials.
AWGAmerican Wire Gage.
AWPAAmerican Wood Preservers Association.
AWPBAmerican Wood Preservers Bureau.
AWPIAmerican Wood Preservers Institute.
AWSAmerican Welding Society.
DFPADouglas Fir Plywood Association.
IESIlluminating Engineering Society.
IMSAInternational Municipal Signal Association.
ITEInstitute of Transportation Engineers.
NBFUNational Board of Fire Underwriters.
NECNational Electrical Code (Published by NBFU).
NEMANational Electrical Manufacturers Association.
NFPANational Forest Products Association.

NIST National Institute of Standards and Technology
SFPA Southern Forest Products Association.
SPIB Southern Pine Inspection Bureau.
UL Underwriters Laboratory, Inc.
WWPA Western Wood Products Association.

1.3 to 1.13

1.3. **Arterial Highway.** A general term denoting a highway primarily for through traffic, usually on a continuous route.

1.4. **Bidder.** An individual, firm or corporation or any combination thereof submitting a proposal.

1.5. **Bridges.** Structures of over six (6) meter span measured from face to face of abutments, or in case of copings, from face to face of copings, and multiple span structures of over six (6) meter length, measured between inside of end walls along the centerline of the roadbed.

1.6. **Certificate of Insurance.** Texas Department of Transportation approved form covering insurance requirements stated in the contract.

1.7. **Commission.** The Texas Department of Transportation Commission.

1.8. **Construction Bulletin C-5.** Manual of procedures and requirements for manual welding and submerged arc welding for the fabrication of structural steel.

1.9. **Construction Bulletin C-6.** Manual of testing requirements for the qualification of welders for structural and reinforcing steel.

1.10. **Construction Bulletin C-8.** Manual of procedures for driving and test loading piling.

1.11. **Construction Bulletin C-9.** Manual of procedures for constructing and test loading drill shafts.

1.12. **Construction Bulletin C-11.** Manual of procedures to be followed in the design and control of portland cement concrete.

1.13. **Contract.** The agreement between the State and the Contractor

covering the furnishing of materials and performance of the work. The contract will include, but not be limited to the Plans, Standard Specifications incorporated by reference, Special Provisions, Special Specifications, Contract Bonds, Supplemental Agreements and Change Orders.

1.14. Contractor. The individual, firm or corporation or any combination thereof, Party of the Second Part, with which the contract is made by the State.

1.15. Controlled Access Highway. Any highway to or from which access is denied or controlled, in whole or in part, from or to abutting land or intersecting streets, roads, highways, alleys or other public or private ways.

1.16. Control of Access. The condition where the right to access of owners or occupants of abutting land or other persons in connection with a highway is fully or partially controlled by public authority.

(1) Full Control. Full control of access means that the authority to control access is exercised to give preference to through traffic by providing access connections with selected public roads only and by prohibiting crossings at grade or direct private driveway connections.

(2) Partial Control. Partial control of access means that the authority to control access is exercised to give preference to through traffic to a degree that, in addition to access connections with selected public roads, there may be some crossings at grade and some private driveway connections.

1.17. County. A political subdivision of the State.

1.18. Culvert. Any structure, other than a bridge, which provides an opening under a roadway for drainage or other purposes.

1.19. Department. The Texas Department of Transportation (TxDOT).

1.20. Departmental Material Specifications. Specifications for various materials published by the Materials and Tests Division.

1.21. Engineer. The Executive Director of the Department or his authorized representative.

1.22. Expressway. A divided arterial highway for through traffic with full or partial control of access and generally with grade separations at intersections.

1.23. Freeway. An expressway with full control of access.

1.24. Frontage Street or Frontage Road. A local street or road auxiliary to and located along an arterial highway for service to abutting property and adjacent areas and for control of access (sometimes known as a Service Road, Access Road or Insulator Road).

1.25. Hazardous Materials/Waste. Hazardous materials/waste include, but are not limited to, such materials as: explosives, compressed gas, flammable liquids, flammable solids, combustible liquids, oxidizers, poisons, radioactive materials, corrosives, etiologic agents and other material classified as hazardous by 40CFR261, or applicable state and federal regulations.

1.26. Highway, Divided. A highway with separate roadways intended to move traffic in opposite directions.

1.27. Highway, Street or Road. General terms denoting a public way for purposes of vehicular travel, including the entire area within the right of way. Recommended usage in urban areas is highway or street; in rural areas, highway or road.

1.28. Inspector. The person assigned by the Engineer to inspect any or all parts of the work and the materials to be used therein.

1.29. Intersection. The area embraced within the prolongation or connection of the lateral curb lines, or, if none, then the lateral boundary lines of the roadways, of two highways which join one another at, or approximately at, right angles; or the area within which vehicles traveling upon different highways joining at any other angle may come in conflict.

1.30. Island. An area within a roadway for which vehicular traffic is intended to be excluded, together with any area at the approach thereto occupied by protective deflecting or warning devices.

1.31. Laboratory. The testing laboratories of the Department or any other testing laboratory that may be designated or approved by the Engineer.

1.32. Letting Official. The Executive Director or any Department employee empowered by the Executive Director to officially close the receipt of bids at an advertised letting.

1.33. Local Street or Local Road. A street or road primarily for access to residence, business or other abutting property.

1.34. Major Street or Major Highway. An arterial highway with intersections at grade and direct access to abutting property, and on which geometric design and traffic control measures are used to expedite the safe movement of through traffic.

1.35. Manual of Testing Procedures. Texas Department of Transportation Materials and Tests Division manual outlining testing methods and procedures.

1.36. Materials. Definitions of materials and material properties are as found in Test Method Tex-100-E, Part I.

1.37. Median. The portion of a divided highway separating the traffic lane(s) in opposite directions.

1.38. Nonresident Bidder. A bidder whose principal place of business is not in Texas; includes a bidder whose ultimate parent company or majority owner does not have its principal place of business in Texas.

1.39. OSHA. Occupational Safety and Health Administration.

1.40. Pavement. That part of the roadway having a constructed surface for the facilitation of vehicular traffic.

1.41. Payment Bond. The security furnished by the Contractor solely for the protection of claimants, as defined by law, supplying labor and materials for the prosecution of the work in accordance with the terms of the contract.

1.42. Performance Bond. The security furnished by the Contractor to guarantee the completion of the work in accordance with the terms of the contract.

1.43. Plans. The drawings approved by the Engineer, or true reproductions thereof, which show the location, character, dimensions and details of the work and which are a part of the contract.

1.44. Power of Attorney for Surety Bonds. An instrument under corporate seal which appoints an attorney-in-fact to act in behalf of a Surety Company in signing bonds.

1.45. Project. The specific section or sections of the highway together with all appurtenances and construction to be performed thereon under the contract.

1.46. Proposal. The offer of the bidder, made out on the prescribed form, giving unit bid prices for performing the work described in the plans and specifications.

1.47. Proposal Guaranty. The security designated in the proposal and furnished by the bidder as a guaranty that the bidder will enter into a contract if awarded the work.

1.48. Ramp. A section of highway over which traffic passes for the primary purpose of making connections with other highways.

1.49. Registered Professional Engineer. A person who has been duly licensed and registered by the Texas State Board of Registration for Professional Engineers to engage in the practice of engineering in this state.

1.50. Rental Rate Blue Book for Construction Equipment. Equipment rental rates published by Dataquest (also known as the Rental Rate Blue Book or the Blue Book).

1.51. Right of Way. The land provided for a highway.

1.52. Roadbed. The graded portion of a highway which is prepared as foundation for the pavement structure and shoulders. On divided highways, the depressed median type and the raised median type highways will be considered to have two roadbeds. Highways with a continuous two-way left turn lane will be considered to have one roadbed.

1.53. Roadway. The portion of the highway within the limits of construction.

1.54. Screens and Sieves. As defined by the ASTM.

1.55. Shoulder. That portion of the roadway contiguous with the traffic lane(s) for accommodation of stopped vehicles for emergency use and/or for lateral support of base and surface courses.

1.56. Special Provisions. Additions and/or revisions to the Standard Specifications or Special Specifications.

1.57. Special Specifications. Supplemental Specifications applicable to the individual project, not covered by the Standard Specifications.

1.58. Specifications. The directions, provisions and requirements referenced or contained herein or in special specifications, supplemented by such special provisions as may be issued or made pertaining to the method and manner of performing the work or to quantities and qualities of materials to be furnished under the contract. Where the phrases such as "or directed by the Engineer", "or as approved by the Engineer" or "or to the satisfaction of the Engineer" occur, it is to be understood that the directions, orders or instructions to which they relate are within the limitations of and authorized by the contract. Special provisions and special specifications will cover work pertaining to a particular project and included in the proposal but not covered by the Standard Specifications. Where reference is made to Departmental Material Specifications, specifications of ASTM, AASHTO or Bulletins and Manuals of the Department, it shall be construed to mean the latest standard or tentative standard in effect on the date of the proposal. The metric versions will be used if available and in effect on date of the proposal. Incorporation of subsequent changes to the above documents will be considered by the Engineer in accordance with Item 4, "Scope of Work", as appropriate.

1.59. State. The State of Texas, Party of the First Part.

1.60. Subgrade. That portion of the roadbed upon which the subbase, base or pavement structure is to be placed.

1.61. Substructure. That part of the structure below the bridge seats or below the springing lines of arches. Parapets, backwalls and wingwalls of abutments shall be considered as parts of the substructure.

1.62. Superintendent. The representative of the Contractor authorized to receive and fulfill instructions from the Engineer, and who shall supervise and

direct the construction.

1.63. Superstructure. That part of the structure above the bridge seats or above the springing lines of arches.

1.64. Supplemental Agreements. Written agreements entered into between the Contractor and the State and approved by the Surety, covering alterations and changes in the contract.

A supplemental agreement is required whenever the modifications (1) significantly change the scope or character of the work (2) changes the project limits and/or (3) a change order amount or accumulation of change order amounts increases the original contract amount by 25 percent or $200,000, whichever is less.

1.65. Surety. The corporate body or bodies authorized to do business in Texas bound with and for the Contractor for the faithful performance of the work covered by the contract and for the payment for all labor and material supplied in the prosecution of the work.

1.66. Temporary Structures. All temporary bridges, culverts and structures required to maintain traffic during the construction of work.

1.67. TMUTCD. Texas Manual on Uniform Traffic Control Devices for Streets and Highways.

1.68. Traffic Lane. The strip of roadway intended to accommodate the forward movement of a single line of vehicles.

1.69. Traveled Way. The portion of the roadway for the movement of vehicles, exclusive of shoulders and auxiliary lanes.

1.70. The Work. The work shall include the furnishing of all labor, materials, equipment and other incidentals necessary or convenient to the successful completion of the project and the carrying out of all the duties and obligations imposed by the contract.

1.71. Working Day. A working day is defined as a calendar day, not including Saturdays, Sundays, or legal holidays authorized in the list prepared by the Department for contract purposes, in which weather or other conditions not under the control of the Contractor will permit the performance of the principal

unit of work underway for a continuous period of not less than 7 hours between 7 a.m. and 6 p.m. For every Saturday or legal holiday except the following holidays:

January 1st, the last Monday in May, July 4th, the first Monday in September, the fourth Thursday in November and December 25th

on which the Contractor chooses to work, one day will be charged against the contract working time when weather conditions will permit 7 hours of work as delineated above. The principal unit of work shall be that unit which controls the completion time of the contract. Nothing in this Item shall be construed as prohibiting the Contractor from working on Saturdays or legal holidays, except the six listed above, if he so desires. Work on Sunday and on the six legal holidays listed above will not be permitted except in cases of extreme emergency or when the safety of the Contractor's forces and/or the traveling public would be significantly improved, and then only with the written permission of the Engineer. If Sunday work or work on the six legal holidays listed above is permitted, working time will be charged on the same basis as week days.

The Engineer may suspend the work and the "Time Charge", in accordance with Article 8.4, on any holiday, on the day preceding the holiday or on the day following the holiday if the Engineer and the Contractor mutually agree the Contractor should not work. Such suspension shall be based upon (a) past experience as to the volume of holiday traffic that may be expected and (b) the hazard to the traveling public and/or Contractor's employees that project operations would present.

1.72. Work Order. Written notice to the Contractor to begin with the contract work; when applicable, includes the date of beginning of contract.

1.73. Mathematically Unbalanced Bid. A bid containing lump sum or unit bid items which do not reflect reasonable actual costs plus a reasonable proportionate share of the bidder's anticipated profit, overhead costs and other indirect costs.

1.74. Materially Unbalanced Bid. A bid which generates a reasonable doubt that award to the bidder submitting a mathematically unbalanced bid will result in the lowest ultimate cost to the State.

1.75. Written Notice. Notice shall be considered to have been duly given if delivered in person to the individual or member to whom it is intended, or if sent by registered or certified mail or delivered to the last known business address. The date of the letter will serve as the beginning day of notice. Unclaimed mail will not be cause for failure to receive written notice.
1.76 to 2.3

1.76. Debar (Debarment). To disqualify (the disqualification of) a Contractor from bidding on, or entering into a contractor, or from participating as a Contractor or subcontractor.

1.77. Subcontractor. An individual, partnership, firm, corporation or any combination thereof to which the Contractor sublets, or proposes to sublet, any portion of a contract.

1.78. Routine Maintenance Contract. A contract paid out of maintenance funds, for work performed to preserve and repair the roadways and right of way, with all its components, to its designed or accepted configuration. Components include travelway surfaces, shoulders, roadside, drainage facilities, bridges, tunnels, signs, markings, lighting fixtures, etc.

1.79. Change Order. A written description by the Department covering modifications to the original contract necessary to complete the contracted work.

ITEM 2

INSTRUCTIONS TO BIDDERS

2.1. Contents of Proposal Forms. Upon written request, bidders will be furnished with a proposal form which will state the location and description of the proposed work, an approximate estimate of the various quantities and kinds of work to be performed or materials to be furnished, a schedule of items for which unit prices are requested and the time within which the work is to be completed. The special provisions and special specifications will be bound in the proposal form.

2.2. Interpretation of Estimates of Quantities. The quantities listed in the proposal form will be considered as approximate and will be used for the comparison of bids. However, payments to the Contractor will be made for the work done in accordance with Item 4, "Scope of Work", and Item 9, "Measurement and Payment".

2.3. Examination of Plans, Specifications, Special Provisions and Site of Work. Before submitting a bid, the bidder shall examine carefully the proposal, plans, specifications, special provisions and the form of contract to be entered into for the work contemplated. The bidder shall examine the site of work and satisfy himself as to the conditions which will be encountered relating to the character, quality and quantity of work to be performed and materials to be furnished. The submission of a bid by the

bidder shall be conclusive evidence that he has complied with these requirements.

Any borings, soil profiles and water elevations shown on the plans were obtained for use of the Department in the preparation of plans and the bidder is hereby cautioned regarding the accuracy of these data. The bidder, in preparing his proposal, shall take cognizance of the difficulty of accurately classifying all material encountered in making foundation investigations, the possible erosion of stream channels and banks after survey data have been obtained, and the unreliability of water elevations other than for the date recorded.

2.4. Competency of Bidders. A proposal form for bidding will not be issued unless the bidder shall have filed with the Department, at least 15 days prior to the date upon which bids are to be submitted, an acceptable annual statement of his financial resources and of his experience on similar work. Each bidder must also furnish a statement listing the equipment available for the work being bid upon and such other information as may be called for on forms furnished by the Department.

2.5. Preparation of Proposal. The bidder shall submit his proposal on the form furnished to him by the Department except as provided below. The blank spaces for each item as required in the proposal shall be filled in by writing in words in ink except as provided below. The bidder shall submit a unit price for each item for which a bid is requested (including a zero if appropriate), except in the case of an alternate. In such case, prices must be submitted for the base bid or with the items of one or
more of the alternates. A bid item left blank, except in the case of an alternate, will constitute an incomplete bid. The proposal shall be executed with ink in the complete and correct name of the individual, firm, corporation or combination thereof making the proposal and be signed by the person or persons authorized to bind the individual, firm, corporation or combination

thereof.

Bidders, at their option, in lieu of handwriting in the unit prices in words in ink in the proposal, may submit an original computer printout sheet bearing certification by and signature for the bidding firm. The unit prices shown on acceptable printouts will be the unit prices used to tabulate the bid and used in the contract if awarded by the Commission. As a minimum, computer printouts must contain the information and in the arrangement shown on the "Example of Bid Prices Submitted by Computer

2.6

Printout" form in the proposal. Proposals with unit prices by computer printout will not be read if:

1. The proposal does not bear the certification verbatim, as shown on the example in the proposal.

2. The computer printout is not signed in the name of the firm to whom the proposal was issued.

3. The computer printout omits required bid items or includes items not shown in the proposal.

4. The proposal issued by the Department is not fully executed as provided above.

If the proposal submitted by the bidder contains both the form furnished by the Department, completed according to the instructions, and also a computer printout, completed according to the instructions, only one will be considered. In this situation the unit bid prices shown on the computer printout will be used to determine the bid.

2.6. Rejection of Proposals. Proposals may be rejected if they show any alteration of words or figures, additions not called for, conditional or uncalled for alternate bids, incomplete bids, any alteration of words or figures or erasures not initialed by the person or persons signing the proposal or irregularities of any kind.

Any proposal that has one or more of the deficiencies listed below will be

considered to be non-responsive and will not be read publicly.

1.The proposal certification is not signed.

2.Proposal guaranty is not a cashier's check or a bank money order on a State or National Bank, or a cashier's check or money order on a State or National Savings & Loan Association, or a cashier's check or money order on a State or Federally Chartered Credit Union payable to the order of the Texas Transportation Commission.

3.The guaranty check is not payable at or through the institution issuing the instrument or the guaranty instrument

2.7

did not state that the issuing institution is both the drawer and the drawee of the official obligation to pay the amount state.

4.Guaranty checks which are labeled "Officer's Check" or "Official Check".

5.Proposal guaranty is less than the amount prescribed by the proposal.

6.Proposal is submitted by an unqualified bidder.

7.The computer printout certification for unit bid prices is not signed and unit bid prices have not been entered in designated spaces on bid pages.

8.Bidder did not attend mandatory pre-bid conference.

9.The proposal submitted has too few or too many bid items due to bidder not submitted latest revised version of the proposal.

10.The proprietor, partner, majority shareholder or substantial owner is 30 or more days delinquent in providing child support under a court order or a written repayment agreement.

Any proposal found to be non-responsive for one or more of the above deficiencies, after having been read, will be tabulated as Non-responsive.

Any proposal found to be missing a unit price for one or more of the required

bid items, after having been read, will be tabulated as Incomplete.

2.7. Proposal Guaranty. The proposal shall be accompanied by a proposal guaranty of the character and in the amount as indicated in the proposal and described under Item 1, "Definition of Terms".

The State shall have no rights in and to the proposal guaranty unless the Contractor fails to execute the contract in accordance with Article 3.6. The proposal guaranty submitted with the proposal shall be returned to the Contractor in accordance with Article 3.3.

2.8 to 2.10

2.8. Delivery of Proposal. Each completed proposal shall be placed, together with the proposal guaranty, in a sealed envelope so marked as to indicate its contents. Proposals will be received, at the location described in the official advertisement of the project, on or before the hour and date set for the opening thereof and must be in the hands of the Letting Official by that time.

2.9. Revision of Proposal Unit Prices.

(1) A request by telephone or telegraph for a change in a unit bid price entered in a proposal will not be considered.

(2) Bid Price Changes Before Proposal is Submitted.

(a) Bid Prices Submitted in Writing in Words in Ink. When a proposal contains unit bid prices handwritten in words in ink for each bid item on the form furnished by the Department, a bidder may change a bid price entered in a proposal before it is submitted by changing the price and initialing the revision in ink.

(b) Bid Prices Submitted by Computer Printout Sheet. When a proposal provides a unit bid price for each item by a computer printout in accordance with Article 2.5, a bidder may change a bid price in the computer printout before the proposal is submitted by changing the price and initialing the revision in ink.

(3) Bid Price Changes After Proposal is Submitted.

(a) Bid Prices Submitted in Writing in Words in Ink. In cases where the proposal has been submitted, a bidder may change a bid price in his proposal by

withdrawing his proposal as provided in Article 2.10, changing the bid price and initialing the revision in ink, and resubmitting his proposal prior to the time set for the opening of proposals.

(b) Bid Prices Submitted By Computer Printout Sheet. In cases where the proposal has been submitted, a bidder may change a bid price in his proposal by withdrawing his proposal as provided in Article 2.10, changing the bid price in the computer printout and initialing the revision in ink, and resubmitting his proposal prior to the time set for the opening of proposals.

2.10. Withdrawal of Proposal. A bidder may withdraw his proposal provided his request in writing to do so is in the hands of the

Letting Official prior to the time set for opening of proposals. A request by telephone or telegraph for withdrawal of a proposal will not be considered.

2.11. Public Opening of Proposals. Proposals will be opened and read publicly at the time and place indicated in the official advertisement of the project.

2.12. Disqualification of Bidder. More than one proposal involving an individual, firm or corporation or any combination thereof under the same or different names for this work will not be considered. A bidder may, however, submit a proposal as contractor and as a material supplier, subcontractor or both to any one or all other bidders contemplating submitting a proposal for this work, and by so doing will not be liable to disqualification under this specification. The bidder must complete the "Certification of Interest in Other Bid Proposals for this Work" contained in the proposal.

Any or all proposals will be rejected if there is reason for believing that collusion exists among the bidders, and all participants in such collusion will not be considered in future proposals for the same work.

Following the opening of bids, the Department will examine the unit bid prices of the apparent low bid for reasonable conformance with the Engineer's estimated prices. A bid with extreme variations from the Engineer's estimate, or where obvious unbalancing of unit prices has occurred, shall be thoroughly evaluated. A bid found to be mathematically unbalanced, but not found to be materially unbalanced, may be awarded. When a low bid is determined to be both mathematically and materially unbalanced, the Department may reject all

bids. The bidder, whose low bid is found to be both mathematically and materially unbalanced, will not be considered in future proposals for the same work.

Contracts will be awarded only to responsible bidders.

2.13. Gratuities. Commission policy stipulates that Departmental employees cannot accept any benefits, gifts or favors from any person doing business or who reasonably speaking may do business with the Department under this contract. The only exceptions allowed are ordinary business lunches and items approved in advance and in writing by the Executive Director. Failure on the part of any Contractor or supplier to honor this policy may result in termination of the contract. In the event of termination

of the contract, the provisions of the second, third and fourth paragraphs of Article 8.8 shall govern.

2.14. Debarment. A Contractor and/or a Contractor's affiliate or successor may be debarred from bidding on, or entering into a contract, or participating as a subcontractor under a routine maintenance contract, as outlined in Title 43, Texas Administrative Code, Part 1.

2.15. Child Support Order Compliance. Senate Bill No. 84, 73rd Regular Legislative Session, provides that a sole proprietor, partner, majority shareholder, or substantial owner who is delinquent 30 or more days in providing child support under a court order or a written repayment agreement may not bid on or enter into a state contract.

For the purpose of this provision, majority shareholder shall be defined as any individual having more percentage of ownership in a firm than any other individual or group of individuals. Substantial owner shall be defined as any individual having five (5) percent or more interest in a firm.

By signing the contract, the Contractor, under penalty of perjury under the laws of the State of Texas, certifies that the proprietor, a majority shareholder, or any substantial owner of the firm is not 30 or more days delinquent in providing child support.

By signing the contract, the Contractor makes material representation of fact upon which reliance is placed as the Department enters into the contract. If it is

later determined that the Contractor knowingly rendered an erroneous representation, in addition to other remedies available, the Department may terminate the contract for cause or default.

The Contractor shall provide immediate written notice to the Department if at any time it learns that its representation was erroneous when submitted or has become erroneous by reason of changed circumstances.

ITEM 3

AWARD AND EXECUTION OF CONTRACT

3.1. Consideration of Bids. For the purpose of award, after the proposals are opened and read, the summation of the products of the approximate quantities shown in the proposal and the unit prices bid will be **3.2 to 3.4**

considered the amount of the bid. The summations will then be compared and the results made available to the public. Until the award of the contract is made, the State reserves the right to reject any or all proposals and to waive such technicalities as may be considered to be in the best interest of the State.

In determining the amount of the bid as well as computing the amount due for payment of each item under the contract, the State reserves the right to round off all unit bids involving fractional parts of a cent to the nearest one-tenth cent. Zero unit bids will be tabulated as one-tenth cent.

3.2. Award of Contract. The award of the contract, if awarded by the Commission, will be to the lowest bidder. The award, if made, will be within 30 days (60 days for routine maintenance contracts) after the opening of the proposal.

3.3. Return of Proposal Guaranty. The proposal guaranty of the lowest bidder may be retained until after the contract has been awarded, executed and bonds made.

3.4. Execution of Contract, Bonds, Filing Certificate of Insurance, and Furnishing DBE Information. Within 15 days after written notification of award of the contract the bidder shall execute and furnish to the Commission the contract, with (1) a performance bond and a payment bond, with powers of attorneys attached, each in the full amount of the contract price, executed by a surety company or surety companies authorized to execute surety bonds under

and in accordance with the laws of the State of Texas, and (2) the Certificate of Insurance showing coverages in accordance with contract requirements.

When Disadvantaged Business Enterprise (DBE) Goals are greater than 0.00%, the Contractor shall furnish to the Department within fifteen (15) days after conditional award of the contract either (1) the required DBE information naming the DBE firms that he plans to use to meet the DBE goal in this contract, or (2) acceptable documentation of the steps taken to obtain DBE participation. Disadvantaged Business Enterprise Goals are shown on Form DBE.

The performance bond and payment bond are to be furnished as a guarantee of the faithful performance of the work and for the protection of the claimants for labor and materials as outlined in Item 1, "Definition of Terms".

3.5 to 3.8

When the amount of the contract is $100,000 or less, a performance bond will not be required. When the amount of the contract is $25,000 or less, a payment bond will not be required.

3.5. Execution and Approval of Contract. The contract will be approved and signed under authority of the Commission.

3.6. Failure to Execute Contract and Bonds, File Certificate of Insurance or Furnish DBE Information.

(1) Should the bidder to whom the contract is awarded refuse or neglect to execute and file the contract, bonds and Certificate of Insurance within 15 days after written notification of the award of the contract, the proposal guaranty filed with the bid shall become the property of the State, not as a penalty, but as liquidated damages.

A bidder who forfeits his proposal guaranty in accordance with the preceding paragraph will not be considered in future proposals for the same work unless there has been a substantial change in the design of the project subsequent to the forfeiture of the proposal guaranty.

(2) When Disadvantaged Business Enterprise (DBE) Goals are greater than 0.00% and should the bidder to whom the contract is conditionally awarded refuse, neglect or fail to furnish to the Department (a) the required DBE information naming the DBE firms that he plans to use to meet the DBE goal in

this contract, or (b) acceptable documentation of the steps taken to obtain DBE participation, the proposal guaranty filed with the bid shall become the property of the State, not as a penalty, but as damages to the Department's DBE program.

A bidder who forfeits his proposal guaranty in accordance with the preceding paragraph will not be considered in future proposals for the same work.

3.7. Beginning of Work. The Contractor shall not begin work until authorized by the Engineer in writing to do so. Authorization notification will be by work order.

3.8. Antitrust. The successful bidder, by virtue of signing the contract, assigns to the State any and all claims for overcharges associated with the contract which arise under the antitrust laws of the United States, 15 U.S.C.A., Section 1, et seq. (1973).

ITEM 4

SCOPE OF WORK

4.1. Intent of Plans and Specifications. The intent of the plans and specifications is to describe the completed work to be performed under the contract. Unless otherwise provided, the Contractor shall furnish all materials, supplies, tools, equipment and labor necessary for the proper prosecution and completion of the work.

4.2. Significant Changes in the Character of Work. The Engineer reserves the right to make, in writing, at any time during the work, such changes in quantities and such alterations in the work as are necessary to satisfactorily complete the project. Such changes in quantities and alterations shall not invalidate the contract nor release the surety and the Contractor agrees to perform the work as altered.

If the alterations or changes in quantities significantly change the character of the work under the contract, whether such alterations or changes are in themselves significant changes to the character of the work or by affecting other work cause such other work to become significantly different in character, an adjustment, excluding anticipated profits, will be made to the contract. The basis for the adjustment shall be agreed upon prior to the performance of the

work. If a basis cannot be agreed upon, then an adjustment will be made either for or against the Contractor in such amount as the Engineer may determine to be fair and equitable.

If the alterations or changes in quantities do not significantly change the character of the work to be performed under the contract, the altered work will be paid for as provided elsewhere in the contract.

The term "significant change" shall be construed to apply only to the following circumstances:

(a) When the character of the work as altered differs materially in kind or nature from that involved or included in the original proposed construction; or

(b) When a major item of work, as defined below, is increased in excess of 125 percent or decreased below 75 percent of the original contract quantity. Any allowance for an increase in quantity shall apply only to that portion in excess of 125 percent of original contract item quantity, or in

case of a decrease below 75 percent, to the actual amount of work performed.

The Contractor shall perform the work as increased or decreased. Payment to the Contractor for contract items will be made for the actual quantities of work done or material furnished at the unit prices set forth in the contract, except as provided in specification items requiring plan quantity payment and except as provided for significant changes in the character of the work.

A major item is defined as any individual bid item included in the proposal that has a total cost equal to or greater than five (5) percent of the original contract or $100,000.00, whichever is less.

4.3. Extra Work. Before any extra work is begun, a "Change Order" shall be executed.

4.4. Claims and Disputes. In the event that the Contractor requests additional compensation for work not clearly covered in the contract, the Contractor shall notify the Engineer in writing of his intention to make a claim for additional compensation before beginning such work, once he has knowledge, or during the initial stages of such work. An assessment of damages

is not required to be a part of this notice but is
desirable. If such notice is not given and the Engineer is not provided an opportunity to keep an accurate account of the actual cost of the work in question, then the Contractor waives his right to file a claim for such work, unless the circumstances are such that the Contractor could not reasonably have knowledge of the additional cost prior to the performance of the work. Notice of claim by the Contractor and the documentation of the cost of the work by the Engineer shall not be construed as proof or substantiation of the validity of said claim. Every effort will be made to resolve this dispute at the project level; however, in the event that it is not resolved, the Contractor may file a formal claim with the Area Engineer to be forwarded to the proper officials in accordance with the Department's Administrative Procedures.

In the event that a claim for delay damages is filed by the Contractor, a notice of claim as stated above will be required as soon as the delay is evident. If the delay claim is substantiated by the Department, the Contractor's standby equipment costs will be limited as follows:

a. Standby costs will not be allowed during periods when the equipment would have otherwise been in an idle status;

b. No more than eight (8) hours of standby will be paid during a 24 hour day, nor more than 40 hours per week, nor more than 176 hours per month; and

c. Standby will be paid at 50 percent of the rental rates found in the Rental Rate Blue Book for Construction Equipment and calculated by dividing the monthly rate by 176 and multiplying by the regional adjustment factor and the rate adjustment factor. Operating costs will not be allowed.

4.5. Maintenance of Detours and Existing Facilities. The Contractor shall do such work as may be necessary to provide and maintain detours and facilities for safe public travel in accordance with the Traffic Control Plan and these specifications. There shall be provided and maintained in passable condition, as specified under Articles 7.7 and 7.8, such temporary roads and structures as may be necessary to accommodate public travel. Temporary approaches and crossings of intersecting highways shall be provided and maintained in a safe and passable condition by the Contractor at his expense. The Contractor will be responsible for the cost of normal maintenance of detours constructed under this contract. Any maintenance required to repair deterioration of the

pavement structure due to faulty design will be at the expense of the Department.

If, in the opinion of the Engineer, the above requirements are not complied with, the Engineer may do such work as he may consider necessary; however, this shall not change the legal responsibilities set forth in this Item. The expense for such work will be borne by the Contractor and the cost thereof shall be deducted from any moneys due the Contractor or to become due to the Contractor.

The State will be responsible for the cost of maintenance of existing streets, roadways or traffic control devices that are required to be used for detours or handling traffic, regardless of whether they are within or outside the project limits. Other existing streets, roadways or traffic control devices which are damaged by the Contractor's operations will be maintained and repaired by the Contractor at his expense.

4.6. Use of Materials Found on the Right of Way. The Contractor may use in the work any suitable stone, gravel or sand found in the "Excavation" and will be paid for the excavation of such materials at the contract price bid. He shall, however, at his own expense replace with other suitable materials the materials so removed and which were intended for use in embankments, backfills, approaches or elsewhere. No charge for **4.7 to 5.2**

materials so used will be made against the Contractor. The Contractor shall not excavate nor remove any material from within the highway which is not within the excavation, as indicated by the slope and grade lines, without written authorization from the Engineer.

4.7. Final Clean Up. Upon completion of the work and before acceptance and final payment is made, the Contractor shall clean, remove rubbish and temporary structures from the highway, restore in an acceptable manner all property which has been damaged during the prosecution of the work and leave the site of the work in a neat and presentable condition throughout.

Upon the completion of any structure, all excess materials, cofferdams, construction buildings, temporary structures and debris resulting from construction shall be removed. Where work is in a stream, all debris shall be removed to the ground line of the bed of the stream and the stream channels and highway left unobstructed and in a neat and presentable condition. All structures shall be cleaned to the flow line or the elevation of the outfall channel, whichever is higher. Materials cleared from the highway and deposited on

property adjacent thereto will not be considered as a satisfactory method of disposal, unless approved by the Engineer.

No direct compensation will be allowed for final clean up work, as such work is considered subsidiary to the various bid items of the contract.

ITEM *5*

CONTROL OF THE WORK

5.1. **Authority of Engineer.** The work will be observed, tested and inspected by the Engineer in accordance with the contract, plans and specifications. The Engineer will decide all questions which may arise as to the quality or acceptability of materials furnished and work performed; the manner of performance and rate of progress of the work; the interpretations of the plans and specifications and the acceptable fulfillment of the contract on the part of the Contractor. His decisions will be final and he will have executive authority to enforce and make effective such decisions and orders as the Contractor fails to carry out promptly.

5.2. **Engineer as Referee.** The Engineer will act as referee in all questions arising under the terms of the contract between the parties thereto and his decisions shall be final and binding.

5.3

5.3. **Plans and Working Drawings.** The plans will show in detail the work to be accomplished under the contract. When working drawings are required, they shall be furnished by the Contractor in a timely manner and approved by the Engineer prior to the beginning of the work involved. Working drawings shall be signed, sealed and dated by a Registered Professional Engineer as indicated below:

Working Drawings for	Requires Registered Professional Engineers' Signing Sealing & Dating	Requires Departmental Approval
1.Alternate or Optional Designs submitted by	Yes	Yes

Contractor		
2.Supplementary fabrication and shop drawings for structural items	No - unless required on the plans	See applicable item
3.Contractor proposed temporary facilities, that affect the public safety, not included on the plans	Yes	Yes

5.3

Working Drawings for	Requires Registered Professional Engineers' Signing Sealing & Dating	Requires Departmental Approval
4.Form details for a)Bridges, retaining walls and other major structures b)Minor Structures	Yes - unless otherwise shown on the plans No - unless otherwise shown on the plans	Yes No - unless otherwise shown on the plans
5.Erection Drawings	Yes	Yes
6.Contractor proposed major modifications to traffic control plan	Yes	Yes

These working drawings shall be in the International System of Units (SI) and shall be in the English language. Authorized alterations will be approved by endorsement on the plans or shown on supplementary sheets. The approval by the Engineer of the Contractor's working drawings will not relieve the Contractor of any responsibility under the contract.

Full compensation for furnishing all working drawings shall be considered as included in the price paid for the contract item of work to which such drawings relate and no additional compensation will be allowed.

It is the responsibility of the Contractor to verify all quantities of materials shown on the plans before ordering same, as payment is provided for acceptable materials complete in place. The Contractor will not be paid for material rejected due to improper fabrication, excess quantity or for any other reasons within his control.

5.4. **Conformity with Plans, Specifications and Special Provisions.** All work performed and all materials furnished shall be in reasonably close conformity with the lines, grades, cross sections, dimensions, details, gradations, physical and chemical characteristics of materials in accordance with tolerances shown on the plans or indicated in the specifications and special provisions. The limits establishing reasonably close conformity will be as defined in the respective items of the contract or if not defined, as determined by the Engineer.

In the event the Engineer finds that the work performed or the materials used are not within reasonably close conformity with the plans, specifications and special provisions, the affected material or product shall be removed and replaced or otherwise satisfactorily corrected by and at the expense of the Contractor.

Any deviations from the plans and approved working drawings will be made only with the approval of the Engineer.

5.5. **Coordination of Plans, Specifications and Special Provisions.** The specifications accompanying plans, special provisions and supplemental agreements or change orders are essential parts of the contract and a requirement occurring in one is as binding as though occurring in all. They are intended to be cooperative and to describe and provide for a complete work. In cases of disagreement, figured dimensions shall govern over scaled dimensions, plans shall govern over standard and special specifications, and special provisions shall govern over both standard and special specifications and plans.

5.6. **Cooperation of Contractor.** The Contractor will be supplied with four (4) copies of the plans, specifications and special provisions and he shall have one (1) copy of each available on the project at all times. He shall give the work his constant attention to facilitate the progress thereof and shall cooperate with the Engineer in every way possible. The Contractor shall designate, to the Engineer in writing, the name of a Superintendent, employed by the firm, regardless of how much of the work may be sublet. The Superintendent shall be cooperative, responsible and competent, English speaking, authorized to receive orders and to act for the Contractor. The Superintendent will be available at all times. In the event a competent superintendent is not available, the Engineer may suspend work until one is available.

5.7. **Construction Stakes.** Unless otherwise shown on the plans, Method A below shall be used.

5.7

(a) Method A. The Engineer will furnish the Contractor control points for determining lines and grades at intervals not to exceed 400 meters, near each major structure and at alignment changes throughout the project.

From the control points established by the Engineer, the Contractor shall establish and be responsible for the correctness of alignment, elevation and position of all construction required by the contract. As a minimum, construction stakes shall be placed at intervals of 20 meters. In the event that the Contractor's personnel are unable to construct an item of work to the tolerances allowed in the specifications with construction stakes at 20 meter intervals, then the stakes shall be placed at closer intervals as directed by the Engineer. The Contractor shall provide a qualified and experienced work force to perform this work. He shall keep the Engineer informed a reasonable time in advance of the time and place he intends to work, in order that measurements may be made as necessary for the record and for determination of pay quantities.

The Engineer may, at his option, make spot or complete checks on all construction alignment and grades to determine the accuracy of the Contractor's survey work. These checks, however, will not relieve the Contractor of his responsibility of constructing the work to the positions and elevations as shown on the plans or approved changes.

The Contractor shall furnish all stakes and other materials necessary to preserve control points for alignment and grade.

After the project is let to contract, the Department will furnish the Contractor, at no cost, with two (2) copies of the earthwork cross sections (when available) and two (2) copies of the computer printouts of the "Design Cross Section List" (when available).

Other computations, sketches and drawings used in the design and layout of this project will also be made available to the Contractor, but these items will not relieve the Contractor of his responsibility as set out above.

The Contractor will be held responsible for the preservation of all control points established by the Engineer and if, in the opinion of the Engineer, any of the stakes or bench marks have been carelessly or willfully destroyed or disturbed by the Contractor, they shall be replaced by the Contractor or the cost of replacement will be charged against the Contractor and deducted from any moneys due or to become due the Contractor.

No direct payment will be made for this work, but the cost of all labor, equipment and supplies necessary to perform the work shall be considered subsidiary to the various bid items of the contract.

(b) Method B. The Engineer shall be responsible for setting construction stakes necessary for establishing the correctness of alignment, elevation and position of all construction required by the contract. These stakes will be set sufficiently in advance of the work to avoid delay. The Contractor shall furnish, at his expense, additional stakes and other materials and templates necessary for marking and maintaining points and lines. The Contractor will be held responsible for the preservation of all stakes and marks, and if, in the opinion of the Engineer, any of the stakes or marks have been carelessly or willfully destroyed or disturbed by the Contractor, the cost of replacement will be deducted from any moneys due or to become due the Contractor.

5.8. **Authority and Duties of Inspectors.** Inspectors will be authorized to inspect all work done and all materials furnished. Such inspection may extend to all or to any part of the work and to the preparation or manufacture of the materials to be used. An Inspector will be assigned to the work by the Engineer and will report to the Engineer as to the progress of the work and the manner in which the work is being performed; also to report whenever it appears that the materials furnished and the work performed by the Contractor fail to fulfill the requirements of the specifications and contract and to call the attention of the Contractor to any such failure or other infringement. Such inspection will not relieve the Contractor from any obligation to perform the work in accordance with the requirements of the specifications. In case of any dispute arising between the Contractor and the Inspector as to materials furnished or the manner of performing the work, the Inspector will have the authority to reject materials or suspend work on the operation or materials in dispute until the question at issue can be referred to and decided by the Engineer. The Inspector will not be authorized to revoke, alter, enlarge or release any requirement of these specifications, nor to approve or accept any portion of work, nor to issue instructions contrary to the plans and specifications. The Inspector will in no case act as foreman or perform other duties for the Contractor nor interfere with the management of the work.

5.9. **Inspection.** The Contractor shall furnish the Engineer safe access to the work during construction and with every reasonable facility for ascertaining whether or not the work as performed is in accordance with the requirements of the contract. If the Engineer so requests, the Contractor shall, at any time before acceptance of the work, remove or uncover

portions of the finished work as may be directed. After examination, the Contractor shall restore said portion of the work to the standard required by the specifications. Should the work thus exposed or examined prove acceptable, the uncovering or removing and replacing of the covering or making good of the parts removed will be performed in accordance with Article 4.3; but should the work so exposed or examined prove unacceptable, the uncovering or removing and the replacing of the covering or making good of the parts removed shall be at the Contractor's expense. No work shall be done nor materials used without suitable supervision or inspection.

5.10. **Federal Inspection.** When the United States Government is to pay a portion of the cost of the work covered by the contract, the work will be subject to inspection by United States Government representatives. Such inspection will in no sense make the United States Government a party to the contract.

5.11. **Removal of Defective and Unauthorized Work.** All work which has been rejected as being in nonconformance with the plans and specifications shall be remedied or removed and replaced in an acceptable manner by the Contractor at his expense. Work done beyond the lines and grades given or as shown on the plans, except as herein provided, or any extra work done without written authority will be considered as unauthorized and done at the expense of the Contractor and will not be paid for. Work so done may be ordered removed at the Contractor's expense. Upon failure on the part of the Contractor to comply with any order of the Engineer made under the provisions of this paragraph, the Engineer will have authority to cause defective work to be remedied or removed and replaced and unauthorized work to be removed and the cost thereof may be deducted from any moneys due or to become due to the Contractor.

5.12. **Final Inspection.** Whenever the work provided for in, and contemplated under, the contract has been satisfactorily completed (with the exception of any performance periods) and the final clean up performed, the Engineer in charge of the work will notify the Engineer authorized to accept same to make the "Final Inspection". Such inspection will be made as soon as possible, but not longer than ten (10) days after such notification. After such final inspection, if the work is found to be satisfactory (with the exception of any performance periods), the Contractor will be notified in writing of the acceptance of same. No time charge will be made against the Contractor between said date of notification, by the Engineer in charge, and the date of final inspection of the work.

The "Final Acceptance" will not release the Contractor from responsibility for all items, materials or equipment requiring performance test periods or final measurements unless otherwise shown in the contract.

ITEM 6

CONTROL OF MATERIALS

6.1. Sources of Supply and Quality of Materials. The source of supply of each of the materials shall be approved by the Engineer before delivery is started and at the option of the Engineer, may be sampled and tested for determining compliance with the governing specifications by the Engineer before delivery is started. If it is found after trial that sources of supply previously approved do not produce uniform and satisfactory products, or if the product from any source proves unacceptable at any time, the Contractor shall furnish materials from other approved sources. Only materials conforming to the requirements of these specifications and approved by the Engineer shall be used in the work. All materials being used are subject to inspection or test at any time during preparation or use. Any material which has been tested and accepted at the source of supply may be subjected to a check test after delivery and all materials which, when retested, do not meet the requirements of the specifications, will be rejected. No material which, after approval, has in any way become unfit for use shall be used in the work. If, for any reason, the Contractor selects a material which is approved for use by the Engineer by sampling and testing or other means, and then decides to change to a different material requiring additional sampling and testing for approval, the expense for such sampling and testing may be deducted from any moneys due or to become due to the Contractor.

If the normal trade practice for manufacturers is to furnish warranties or guarantees for the materials and equipment specified herein, the Contractor shall turn the guarantees and warranties over to the Engineer for potential dealing with the manufacturers. The extent of such warranties or guarantees will not be a factor in selecting the successful bidder.

All manufacturing processes for steel or iron materials or for applying a coating to steel or iron materials (coating includes epoxy coating, galvanizing, painting and any other coating that protects or enhances the value of the steel or iron material) incorporated into the finished project must occur in the United States except:

(1) The requirements do not prevent a minimal use of foreign materials, if the cost of such materials used does not exceed one-tenth of one percent (0.1 percent) of the total contract cost or $2,500, whichever is greater.

(2) When shown on the plans, steel or iron products or application of a coating to steel or iron materials (coating includes epoxy coating, galvanizing, painting and any other coating that protects or enhances the value of the steel or iron material) will have alternate bid items for foreign materials. When alternate bid items are shown, the Bidder's attention is directed to Articles 2.5. and 3.2., of the Special Provisions to Items 2 and 3, respectively.

All manufacturing processes are defined as all processes required to change the raw ore or scrap metal into the finished, in-place steel product. The Contractor shall furnish, to the Engineer, certified mill test reports on the base metal and producer's certifications on all subsequent manufacturing processes stating compliance with the applicable specification(s) and that all manufacturing processes occurred in the United States. Producer's certifications shall bear the notarized signature of a responsible authorized representative of the producer.

6.2. Samples and Tests. All materials, before being incorporated in the work, shall be inspected, tested and approved by the Engineer, and any work in which materials are used without prior test and approval or written permission of the Engineer may be ordered removed and replaced at the Contractor's expense. Sampling and testing of all materials proposed to be used will be made by the Engineer. The selection of the method of test will be designated by the Department. Where tests are required, other than those made in the laboratory, for the purpose of control in the manufacture of a construction item, the Contractor shall be required to furnish such facilities and equipment as may be necessary to perform the tests and inspection and shall be responsible for calibration of all test equipment required. When requested, the Contractor shall furnish a complete written statement of the origin, composition and/or manufacture of any or all materials that are to be used in the work. If the Contractor chooses to use materials or products requiring inspection and approval at the point of manufacture or source, and such inspection will require abnormal expense, i.e., out of the contiguous forty-eight United States, the additional expense of such inspection over the normal cost of such services will be borne by the Contractor and will be deducted from any moneys due or to become due to the Contractor.

6.3. Plant Inspection. If the volume of the work, construction progress and other considerations warrant, the Engineer may undertake the inspection of materials at the source. It is understood, however, that no obligation is assumed to inspect materials in that manner.

Plant inspection will be undertaken only upon condition that:

(1) The cooperation and assistance of the Contractor and the producer with whom he has contracted for materials is assured;

(2) The representative of the Engineer shall have full entry at all times to such parts of the plant as may concern the manufacture or production of the materials ordered;

(3) When required by the Engineer, the material producer shall furnish an approved weatherproof building for the use of the Inspector. The building shall be constructed or furnished near the plant, at a location acceptable to the Engineer and may be either an independent structure or, if a portion of the structure is used by the material producer, the Department office or laboratory area shall not interconnect with material producer utilized rooms. Access to the office or laboratory shall be by direct outside entrance, controlled by the Engineer. The building shall be adequately lighted, heated, air conditioned and ventilated. Adequate rest room facilities shall be provided;

(4) The Contractor shall be responsible for furnishing and calibrating scales, measures and/or other equipment as may be required by the Engineer for the inspection of materials;

(5) In those cases where inspection of any item is requested for periods other than daylight hours, the inspection shall be provided under the following conditions:

(a) Continuous production of materials for Departmental use is necessary due to the production volume being handled by the plant;

(b) The lighting provided by the plant is approved by the Engineer to be adequate to allow satisfactory inspection of the material being produced; and

(6) Materials produced under Department inspection shall be for Department use only unless released in writing by the Engineer.

6.4 to 6.7

6.4. Pretested Materials. Subject to conditions established in a written agreement between a supplier and the Director of Materials and Tests, pretested and approved materials may be incorporated into the work.

6.5. Storage of Materials. Materials shall be so stored as to insure the preservation of quality and fitness for the work. When considered necessary by the Engineer, the materials shall be placed on wooden platforms or other hard, clean surfaces and not on the ground. The materials shall be placed under cover when so directed. Stored materials shall be so located as to facilitate prompt inspection.

When approved by the Director of Materials and Tests, selected materials or products may be pretested and approved for use, provided they are stored in an area meeting the requirements set forth by the Director of Materials and Tests.

6.6. Defective Materials. All materials not conforming to the requirements of these specifications will be rejected and shall be removed immediately from the site of the work unless permitted to remain by the Engineer. Rejected materials, the defects of which have been subsequently corrected, shall have the status of new material. Upon refusal on the part of the Contractor to comply with any order of the Engineer made under the provisions of this Item, the Engineer will have authority to remove and replace defective material and to deduct the cost of removal and replacement from any moneys due or to become due to the Contractor.

6.7. Hauling of Divisible Materials Paid for by Mass or Truck Measure. Any vehicle, truck, truck-tractor, trailer or semi-trailer or combination of such vehicles, when used to deliver materials to a project, shall comply with the State laws concerning the legal gross and axle mass. If the vehicle or combination has a valid yearly overweight tolerance permit which allows small percentages over legal gross and axle mass, such tolerance is also applicable to delivery of materials to a project. However, such tolerance is not applicable to the Interstate System of Highways.

The Contractor shall provide to the Engineer, upon demand, all copies of the yearly overweight tolerance permits for any vehicle to be used to deliver materials to a project.

The Contractor shall request, in writing to the Engineer, permission to haul overweight divisible loads within the limits of a project for hauling routes on which the traveling public is excluded. If, after evaluation by the Department, no damage or overstresses in excess of those normally allowed **6.7**

for overweight loads will result to roadbeds or structures which will continue in use after project completion, permission will be granted.

When hauling overweight divisible loads within the limits of a project which exceed the legal loads allowed by State law, including yearly overweight tolerance permit, the loads must be hauled such that only a single vehicle is on any span or continuous unit at one time. Barricades, fences, or other positive method shall be used to prevent other vehicles from access to any bridge at the time the overweight divisible load is on any span or continuous unit which is being used as part of a haul route.

When divisible loads are hauled such that the haul route is accessible to the traveling public, and haul tickets are issued and used for payment purposes, the net mass of the load for acceptance purposes under this Item shall be as follows:

(1) If the gross vehicle mass is less than the maximum allowed by State law, including any applicable yearly overweight tolerance permit, the net mass of the load shall be determined by deducting the tare mass of the vehicle from the gross mass.

(2) If the gross vehicle mass is more than the maximum allowed by State law, including any applicable yearly overweight tolerance permit, the net mass of the load shall be determined by deducting the tare mass of the vehicle from the maximum gross mass allowed.

When divisible loads are hauled such that the haul route is not accessible to the traveling public, advance permission is obtained in writing from the Engineer, and haul tickets are issued and used for payment purposes, then the net mass of the load for acceptance purposes under this Item shall be as follows:

(3) If the gross vehicle mass is less than the maximum overweight allowed by advance written permission from the Engineer, the net mass of the load shall be determined by deducting the tare mass of the vehicle from the gross mass.

(4) If the gross vehicle mass is more than the maximum overweight allowed by advance written permission from the Engineer, the net mass of the load shall be determined by

6.8

deducting the tare mass of the vehicle from the maximum overweight allowed.

Continued overloading in excess of the maximums described in (2) and (4) above will be grounds for rejection of such load and/or suspending hauling operations until the Engineer is satisfied that only loads not exceeding the maximums are hauled.

Any bridges which are load posted, which will remain in service by the traveling public during or after the completion of the project, that are proposed to be used as a portion of a haul route, will be evaluated by the Department for structural capability to handle the proposed hauling loads. These bridges will be subject to the same maximum stress limitations as would any non-load posted bridge.

The Contractor shall furnish a certified tabulation of measurements, tare mass and allowable legal gross mass calculations for all trucks, etc., prior to their use on the project. Each truck shall be identified by a permanent and plainly legible number located on the truck and on the bed of the truck and/or trailer.

When the specifications establish measurement of and payment for materials by truck measurement, the Engineer may require the weighing of the various types of loaded vehicles used by the Contractor to transport the material. This mass will be used to determine the maximum volume of the material being hauled that each type of vehicle may transport. The cost of such weighing shall be considered subsidiary to the pertinent bid item.

The above requirements are applicable to vehicles hauling materials over existing roadbeds and structures within the project limits where the roadbeds or structures will continue in use after project completion, except as controlled by specifications and special provisions in the contract. The requirements do not apply to the transportation of materials from a borrow or base source, concrete plant, asphalt plant, etc., where the haul route does not require travel over public roads outside the project limits or existing roadbeds or structures within the project limits that will continue in use after project completion.

6.8. Construction Traffic on Structures. Construction traffic on existing bridges and culverts outside the limits of a project shall be subject to the same maximum size and mass limitations as any other vehicle which has no connection to the project. Overweight permit requests shall be

handled through normal methods for all non-divisible loads delivering materials to the project.

Construction traffic on bridges and culverts within the limits of a project, including any structures under construction, which will remain in service by the traveling public during or after the completion of the project, shall be subject to the same size and mass limitations as structures outside the limits of the project.

Construction equipment and vehicles which exceed size and mass limitations, including applicable yearly overweight tolerance permits, may be authorized to cross structures provided the Contractor requests, in writing to the Engineer, permission to move such construction equipment across structures within the project limits. If, after evaluation by the Department, no damage or overstresses in excess of those normally allowed for overweight loads will result to roadbeds or structures which will continue in use after project completion, permission may be granted. These same provisions shall apply to any load posted highway or bridge.

Where a detour is not readily available or economically feasible to use, an occasional crossing of a structure outside the project limits with overweight equipment may be allowed for relocating equipment only, but not for hauling divisible material, provided a structural analysis of the structure using the exact equipment in question indicates that no damage or overstresses in excess of those normally allowed for overweight loads will result to roadbeds or structures which will continue in use after project completion. This structural analysis will be performed by the Department, or at the option of the Contractor, a structural analysis shall be prepared by a Registered Professional Engineer, using the exact equipment in question. When the Department performs the structural analysis, the Contractor shall notify the Department, in writing, sufficiently in advance of the anticipated crossing and the Contractor shall furnish the manufacturer's certificate of equipment mass, including the mass distribution on the various axles and including any additional parts such as counterweights. Temporary matting and/or other requirements may be imposed by the Engineer when an occasional crossing is allowed.

The Contractor shall be responsible for protection of existing bridges and other structures which will remain in use by the traveling public during and after the completion of the project. Any such structure damaged by the use of construction equipment shall be restored to its original condition or replaced by the Contractor. Additional temporary fill may be required by the Engineer for protection of certain structures.

6.9 to 7.2

6.9. Construction Loads on Structures. Construction loads on structures which will remain in service by the traveling public during or after completion of

the project, for the purpose of performing construction operations, such as cranes erecting beams in adjacent spans, may be allowed if necessary. Prior to any operation which may require placement of such equipment of a bridge, the Contractor shall prepare and submit for approval detailed erection analyses, prepared by a Registered Professional Engineer.

The erection analyses shall include all axle loads, tire loads, outrigger placements, center of gravity, equipment mass, and predicted loads on such tires and/or outrigger for all planned movements, swings, or boom reaches. The Department will make available to the Contractor any available plans and material reports for the existing structure. The analyses shall demonstrate that no overstresses will occur in excess of those normally allowed for occasional overweight loads.

ITEM 7

LEGAL RELATIONS AND RESPONSIBILITIES TO THE PUBLIC

7.1. Laws to be Observed. The Contractor shall be familiar with and at all times shall observe and comply with all Federal, State and local laws, ordinances and regulations which in any manner affect the conduct of the work and shall indemnify and save harmless the State and its representatives against any claim arising from the violation of any such law, ordinance or regulation, whether by himself or by his employees.

It is specifically agreed between the parties executing this contract that it is not intended by any of the provisions of any part of the contract to create the public or any member thereof a third party beneficiary hereunder, or to authorize anyone not a party to this contract to maintain a suit for personal injuries or property damage pursuant to the terms or provisions of this contract. The duties, obligations and responsibilities of the parties to this contract with respect to third parties shall remain as imposed by law.

7.2. Permits, Licenses and Taxes. Except as specified in Articles 7.18, 7.19 and 7.20, the Contractor shall procure all permits and licenses, pay all charges, fees and taxes and give all notices necessary and incident to the due and lawful prosecution of the work.

Contractors performing work in accordance with plans and specifications previously approved by a City will not be required to comply with the provisions and requirements of that City's Electrical Ordinance.

7.3. Patented Devices, Materials and Processes. If the Contractor is required or desires to use any design, device, material or process covered by letters of patent or copyright, he shall provide for such use by suitable agreement with the patentee or owner. The Contractor and the surety shall indemnify and save harmless the State from any and all claims for infringement by reason of the use of any patented design, device, materials or process, or any trademark or copyright used in connection with the work and they shall indemnify the State against any costs, expenses, or damages which it may be obliged to pay, by reason of such infringement, at any time during the prosecution or after the completion of the work.

7.4. Insurance. As specified in Article 3.4 and prior to the beginning of work, the Contractor shall provide the Department with the Department's Certificate of Insurance covering the below listed insurance coverages:

A. Workers' Compensation Insurance
Amount - Statutory

B. Comprehensive General Liability Insurance
Amounts - Bodily Injury $500,000 each occurrence Property Damage
$100,000 for aggregate
or

Commercial General Liability Insurance
Amount $600,000 combined single limit

C. Comprehensive Automobile Liability Insurance or
Texas Business Auto Policy
Amounts - Bodily Injury $250,000 each person
$500,000 each occurrence
Property Damage $100,000 each occurrence

This insurance shall be kept in force until the work described in this contract has been completed and accepted by the Department. If for any reason insurance coverage is not kept in force, all work will be stopped until an acceptable Certificate of Insurance is provided the Department.

The State shall be included as an "Additional Insured" by Endorsement to policies issued for coverages listed in B and C above. A "Waiver of Subrogation Endorsement" in favor of the State shall be a part of each policy for coverages listed in A, B and C above.

The Contractor shall be responsible for any deductions stated in the policy.

The Contractor also shall provide the Department a written certification that the Contractor is providing workers' compensation insurance coverage for all employees of the Contractor employed on the project.

A subcontractor shall provide a written certification to the Contractor that the subcontractor is providing workers' compensation insurance coverage for all employees of the subcontractor employed on the project, and the Contractor shall provide the Department written certification to this effect.

However, when the Contractor and the subcontractor agree in writing for the Contractor to provide workers' compensation insurance coverage for all employees of the Contractor and subcontractor employed on the project, the Contractor shall provide a copy of said agreement to the Contractor's workers' compensation insurance carrier within 10 days of execution, and provide a written certification of said agreement to the Department.

7.5. Restoration of Surfaces Opened by Permit. The Contractor shall not allow any party to make an opening in the highway unless a duly authorized permit signed by the Engineer is presented. Until the acceptance of the work, the Contractor shall make all necessary repairs in the roadway where openings have been made by due authority. Such repair work will be performed in accordance with Article 4.3.

7.6. Sanitary Provisions. The Contractor shall, at his entire expense, provide and maintain in a neat, sanitary condition such accommodations for the use of his employees as may be necessary to comply with the requirements and regulations of the Texas Department of Health or of other authorities having jurisdiction.

7.7. Public Safety and Convenience. The safety of the public and the convenience of traffic shall be regarded as of prime importance. Unless otherwise shown on plans or except as herein provided, all portions of the **7.8**

highway shall be kept open to traffic. It shall be the entire responsibility of the Contractor to provide for traffic along and across the highway, as well as for ingress and egress to adjacent property, in accordance with the traffic control plan and detours as shown on the plans and in the specifications for the project or as directed/approved by the Engineer.

The Contractor shall plan and execute his operations in a manner that will cause the minimum interference with traffic. The Contractor shall secure the Engineer's approval of his proposed plan of operation and sequence of work. If at any time during construction the approved plan does not accomplish the intended purpose due to weather or other conditions affecting the safe handling of traffic, the Contractor shall immediately make necessary changes as directed/approved by the Engineer therein to correct the unsatisfactory conditions.

During construction of proposed structures, unless otherwise shown on the plans, the Contractor will construct and maintain detours and temporary structures as designed by or directed by the Engineer. Unless otherwise provided on the plans, the cost of constructing such temporary detours will be paid for in accordance with Article 4.3.

At all times, all equipment not in use shall be stored in such manner and at such locations as not to interfere with the safe passage of traffic.

The Contractor shall provide and maintain flaggers at such points and for such periods of time as may be required to provide for the safety and convenience of public travel and Contractor's personnel, and as directed by the Engineer. Flaggers shall be English speaking, courteous, well informed, physically and mentally able to effectually perform their duties in safeguarding and directing traffic and protecting the work, and shall be neatly attired and groomed at all times when on duty. When directing traffic, flaggers shall use standard attire, flags and signals and shall follow the flagging procedures set forth in the TMUTCD.

If, in the opinion of the Engineer, any of the above requirements are not complied with, the Engineer may do such work as he may consider necessary; however, this shall not change the legal responsibilities set forth in this Item. The expense for such work will be borne by the Contractor and the cost thereof shall be deducted from any moneys due or to become due to the Contractor.

7.8. Barricades and Danger, Warning and Detour Signs and Traffic Handling. The Contractor shall have the sole responsibility for
7.9 to 7.10

providing, installing, moving, replacing, maintaining, cleaning and removing upon completion of work all barricades, warning signs, barriers, cones, lights, signals and other such type devices and of handling traffic as shown on the plans or as directed/approved by the Engineer. All barricades warning signs, barriers, cones, lights, signals and other such type devices shall conform to details shown on the plans or those indicated in the TMUTCD.

The Contractor may provide special signs not covered by the plans to protect the traveling public against special conditions or hazards, provided, however, that such signs are first approved by the Engineer.

Upon completion of the work, all barricades, warning signs, barriers, cones, lights, signals and other such type devices and evidence thereof shall be removed by the Contractor.

If, in the opinion of the Engineer, any of the above requirements are not complied with, the Engineer may do such work as he may consider necessary to fulfill these requirements; however, this shall not change the legal responsibilities set forth in this Item. The expense for such work will be borne by the Contractor and the cost thereof shall be deducted from any moneys due the Contractor or to become due to the Contractor.

7.9. Use of Explosives. When the use of explosives is necessary for the prosecution of the work, the Contractor shall use the utmost care not to endanger life or property. All explosives shall be stored in a secure manner and all storage places shall be marked clearly "DANGEROUS - EXPLOSIVES". The method of storing and handling explosives and highly flammable materials shall conform with Federal, State and local laws, ordinances and regulations.

In advance of doing any blasting work involving the use of electric blasting caps within 60 meters of any railroad track, the Contractor shall give at least 48 hours advance notice to the nearest Roadmaster.

7.10. Protection of Adjoining Property. The Contractor shall take proper measures to protect the adjacent or adjoining property which might be injured by any process of construction, and, in case of any injury or damage resulting from any act or omission on the part of or on behalf of the Contractor, he shall restore at his own expense the damaged property to a condition similar or equal to that existing before such injury or damage was done, or he shall make good such injury or damage in an acceptable manner.

7.11 to 7.12

7.11. Responsibility for Damage Claims. The Contractor agrees to indemnify and save harmless the State, its agents and employees from all suits, action or claims and from all liability and damages for any and all injuries or damages sustained by any person or property in consequence of any neglect in the performance of the contract by the Contractor and from any claims or amounts arising or recovered under the "Workers' Compensation Laws"; Chapter 101, Texas Civil Practice and Remedies Code (Texas Tort Claims Act) or any other laws. He shall further so indemnify and be responsible for all damages or injury to property of any character occurring during the prosecution of the work resulting from any act, omission, neglect or misconduct on his part in the manner or method of executing the work; or from failure to properly execute the work; or from defective work or materials.

The Contractor's attention is directed to the fact that pipelines and other underground installations as may or may not be shown on the plans may be located within the right of way. The locations shown on the plans have been taken from the best available information. The Contractor shall save the State harmless from any and all suits or claims resulting from damage by his operations to any pipeline or underground installation. In addition, the Contractor shall submit, at the pre-construction conference, his scheduled sequence of work to the respective utility owners so that any necessary adjustments of their utilities that conflict with the proposed work may be coordinated and scheduled.

7.12. Contractor's Responsibility for Work. Until final written acceptance of the project by the Engineer, the Contractor shall have the charge and care thereof and shall take every precaution against injury or damage to any part thereof by the action of the elements or from any other cause, whether arising from the execution or from the nonexecution of the work. The Contractor shall rebuild, repair, restore and make good all injuries or damages to any portion of the work occasioned by any of the above causes before final acceptance and shall bear the expense thereof except for damage to vehicle impact attenuators (crash cushions and guardrail end treatments) which are a portion of the work, not damaged by the Contractor or his operations, and except for damage to the work due to Acts of God such as earthquake, tidal wave, tornado, hurricane or other cataclysmic phenomena of nature or acts of governmental authorities. In case of suspension of work for any cause, the Contractor shall be responsible for the preservation of all materials. He shall provide suitable drainage of the roadway and shall erect temporary structures where required. The Contractor shall maintain the roadway in good and passable

7.12

condition until final acceptance, except as outlined below for opening the roadway to traffic.

Except in cases of damage by the Contractor or that caused by the Contractor's operations, all work required for the repair and/or replacement of damaged vehicle impact attenuators (crash cushions and guardrail end treatments) which are a portion of the work, will be paid for as "Extra Work", in accordance with Article 4.3.

Except for damage by the Contractor or that caused by the Contractor's operations, the Contractor will not be responsible for repair of damage to existing appurtenances such as guard fence, bridge wings and railing, illumination assemblies, underpass structures, traffic barriers, delineator assemblies, signs, sign bridges, vehicle impact attenuators (crash cushions and guardrail end treatments) and traffic signals, where such damage is caused by (a) motor-vehicle, seacraft, aircraft or railroad-train collision; or (b) vandalism. Such release from responsibility for damage includes only appurtenances, or portions thereof, which were existing at the beginning of the proposed work and for which no work is proposed under this contract; or for existing appurtenances that do require work under this contract but for which no work has yet begun. Except for damage caused by the Contractor's operations, the release from responsibility also includes damage to existing appurtenances, to the existing pavement structure and to other existing structures which are damaged by fire or by chemical spills which are a result of motor-vehicle, seacraft, aircraft or railroad-train operation or accidents. In the event of damage to existing appurtenances, etc., as described in this article, the Contractor will be required to plan and prosecute his work so as not to interfere with or hinder the completion of the work required for this damage repair. An extension of time may be granted, if necessary, for delays caused to the Contractor by the damage-repair work.

Wherever in the opinion of the Engineer any roadway or portion thereof is in suitable condition for travel, it shall be opened to traffic, as may be directed, and such opening shall not be held to be in any way the final acceptance of the roadway or any part of it or as a waiver of any of the provisions of the contract. Where it is considered by the Engineer to be in the public interest and so ordered in writing by him, any substantially completed roadway or portion thereof may be opened to traffic as follows:

(1) When work is suspended for a considerable period of time at the convenience of the State, the Department will assume the responsibility for maintaining the entire roadway during the period of suspension; or

(2) When the roadway or portion thereof is opened to traffic during construction operations at the convenience of the State, the Department will assume responsibility for the maintenance of the traveled way and shoulders during the period in which it is opened to traffic.

The State in assuming responsibility for maintenance under this provision may require the work to be done in accordance with Article 4.3, or may do it with its own forces; provided, however, this shall not change the legal responsibilities set out in Article 7.11.

Upon completion of all work provided for in the contract for any individual limits, control or project, the Engineer may make an inspection, and if the work is found to be satisfactory the Contractor will be released from further maintenance on that portion of the work, except for damage caused by the Contractor or his operations. Such partial acceptance will be made in writing and shall in no way void or alter any terms of the contract. Other specific units of the project will be accepted on an individual basis when shown on the plans or as approved by the Engineer.

7.13. Personal Liability of Public Officials. In carrying out the provisions of the contract or in exercising any power or authority granted thereunder, there shall be no liability upon the Engineer or his authorized assistants, either personally or otherwise, as they are agents and representatives of the State.

7.14. Responsibilities to the Railroad Companies. If the project crosses or is in close proximity to a railroad, the Contractor shall conduct his operations in such manner as not to interfere with, hinder or obstruct the Railroad Company in any manner whatever in the use or operation of its trains or other property.

Whether the Contractor's work will be on or in the vicinity of an at-grade railroad crossing, involves incidental work on railroad right of way or involves construction of a railroad grade separation structure, the Contractor shall notify the Railroad Company's Division Engineer and the State's Project Engineer at least three (3) days prior to the performance of any work on the Railroad right of way, unless otherwise shown in the contract.

During the time this work is in progress the Contractor shall assign such responsible supervisory personnel as are necessary to assure that due caution is observed by his workmen to keep the tracks and adjacent areas

clear of debris and/or road materials and equipment which might damage the tracks and railroad facilities or obstruct the safe passage of trains.

In addition to the above, if the work requires construction, other than paving or surfacing, in the vicinity of the tracks (or shoofly), the Railroad Company will provide flaggers during the periods when beams are being erected and slab forms are being both constructed and removed over the tracks, when pilings are being driven or shafts drilled adjacent to the tracks and at such other times that the tracks may be subject to obstruction due to the construction operations. This flagging service will be paid for by the State as a Force Account Item with the Railroad Company and will be at no expense to the Contractor.

In the performance of said work no construction material or equipment shall be stored on the Railroad's right of way nearer than eight (8) meters from the centerline of any tracks. No forms or temporary false work shall be within 2.6 meters horizontally from centerline of any tracks or within 6.71 meters vertically above the top of rails of any track, unless otherwise shown on the plans.

Subject to the above conditions, the Contractor is allowed access on railroad right of way and is authorized to cross the tracks for the purpose of constructing a grade separation structure and approaches if shown on the plans.

When permitted by the Railroad Company, the Contractor will also be allowed to cross the tracks in hauling other roadway material across the tracks at points on the right of way near the structure. The Railroad Company will furnish and install and later remove standard crossing plank at the expense of the Contractor. If automatic warning devices are required for the temporary crossing as determined by the Railroad Company and the State, they will be provided without cost to the Contractor. It shall be the Contractor's responsibility to insure that the tracks are left clear of equipment and debris which would endanger the safe operation of railroad traffic. The Contractor shall provide one crossing watchman on each side of the crossing to direct his equipment when he is hauling across the tracks. Any railroad flaggers required by the Railroad Company for protection of this crossing due to the hauling operations will be paid for by the State as a Force Account Item with the Railroad Company and will be at no expense to the Contractor. Equipment traffic shall be halted a safe distance away from the crossing upon the approach of railroad traffic.

The Railroad Company may require the Contractor to execute an "Agreement for Contractor's Temporary Crossing". If required, it is the Contractor's responsibility to secure this agreement at no expense to the State.

7.15. Abatement and Mitigation of Excessive or Unnecessary Construction Noise. Throughout all phases of the construction of this project, including the moving, unloading, operating and handling of construction equipment prior to commencement of work, during the project and after the work is complete, the Contractor shall make every reasonable effort to minimize the noise imposed upon the immediate neighborhood surrounding the area of construction. Particular and special efforts shall be exercised by the Contractor to avoid the creation of unnecessary noise impacts on adjacent sensitive receptors in the placement of non-mobile equipment such as air compressors, generators, pumps, etc. The placement of temporary parked mobile equipment with the engine running shall be such as to cause the least disruption of normal adjacent activities not associated with the work to be performed by the Contractor.

All equipment associated with the work shall be equipped with components designed by the manufacturer wholly or in part to suppress excessive noise and these components shall be maintained in their original operating condition considering normal depreciation. Noise-attenuation devices installed by the manufacturer such as mufflers, engine covers, insulation, etc., shall not be removed nor rendered ineffectual nor be permitted to remain off the equipment while the equipment is in use.

7.16. Work Near Electrical Power Lines. Any operations by the Contractor which are located near any electrical power lines shall be accomplished using established industry and utility safety practices. The Contractor shall consult with the appropriate utility company prior to beginning any such work. All associated costs will be the responsibility of the Contractor.

7.17. Preservation of Cultural Resources. Where material sources and waste sites are not listed in the contract, the Contractor shall provide sources of material and waste sites acceptable to the Engineer.

As soon as the Contractor determines the location of specific material sources (base material, aggregate, common borrow, sandpits, etc.) and waste sites for project use and prior to any surface disturbance of these material sources and waste sites, the Engineer shall be notified so that archaeological surveys can be initiated. The Engineer will initiate

archaeological surveys within a timely manner. Work in these areas and equipment storage areas, haul roads, etc., will not be permitted until surveys and any necessary testing have been completed and the Department has determined that significant archaeological resources do not exist or have been satisfactorily mitigated.

If the Contractor selects a commercial source that is in use, the requirements for archaeological clearance will not apply. However, if the Contractor owns a non-commercial source or if he negotiates with an owner to establish a pit, these requirements will apply.

If sites, buildings and locations of historical, archaeological, educational or scientific interest are discovered within the right of way or within non-commercial material sources outside the right of way after construction operations are begun, operation in that particular area shall cease immediately and the sites, buildings or locations shall be investigated and evaluated by the Department.

When necessary, an extension of working time will be granted, for delays caused by the above investigations and evaluations.

7.18. Work in Waters of the United States. Where it becomes necessary for the Contractor to work in waters of the United States or their adjacent wetlands as delineated by the U.S. Army Corps of Engineers, the Contractor should be aware that a Section 404 permit may be required. The Department will obtain any Section 404 permits prior to commencement of construction on a project by project basis. The Contractor will be required to adhere to any agreements, mitigation plans and standard best management practices required for a permit on any project. If the Contractor makes changes in the project construction method that would result in changes of project impacts to waters of the U.S., the Contractor will be responsible for any new Section 404 permit.

7.19. Work in Navigable Waters. Any operations by the Contractor relating to the placement of embankment into, or the placement or rehabilitation of structures in or over navigable waters of the U.S. as designated by the U.S. Army Corps of Engineers or the U.S. Coast Guard, is subject to regulation by these agencies. Approval will be coordinated by the Department and construction should not commence until the activity is approved by the regulatory agency. The Contractor will be required to adhere to the stipulations of the permit and the associated best management practices. If the Contractor makes changes in the project construction method that would result in changes of project impacts to navigable waters

of the U.S., the Contractor will be responsible for any new Section 9 permit from the U.S. Coast Guard.

7.20. Work Over the Recharge Zone of Protected Aquifers. Relating to work over the recharge zones of protected aquifers, as defined and delineated by the Texas Natural Resource and Conservation Commission (TNRCC), the Contractor shall make every reasonable effort to minimize the degradation of water quality resulting from construction impacts. The Contractor will be required to follow best management practices and to use and maintain those sedimentation and water pollution control devices as required by the Engineer.

If a Water Pollution Abatement Plan (WPAP) is required by the TNRCC, modification to the approved WPAP by the Contractor will require the Engineer's approval and be coordinated through the Department with the TNRCC.

ITEM 8

PROSECUTION AND PROGRESS

8.1. Assigning of Contract and Subcontracting.

(1) Assigning of Contract. The Contractor will not be permitted to assign, sell, transfer or otherwise dispose of the contract or any portion thereof, or his rights, title, or interest therein without the approval of the Commission. Any assignment proposed by the Contractor must be deemed justified or legally acceptable by the Department.

(2) Subcontracting. The Contractor will not be permitted to sublet any portion of the contract without the approval of the Engineer. No subcontract will, in any case, relieve the Contractor of his responsibility under the contract and bonds. The Contractor shall perform with his own organization and with the assistance of workmen under his immediate superintendence, work of a value not less than 50 percent of the value of all work embraced in the contract exclusive of items not commonly found in contracts for similar work, or which require highly specialized knowledge, craftsmanship and/or equipment not ordinarily available in the organizations of contractors performing work of the character embraced in the contract. Specialty items may be performed by subcontract and the amount of any item so performed may be deducted from the total original contract amount before computing the amount of work required to be performed by the Contractor's own organization. "His own organization" shall be construed **8.2**

to include only workers employed and paid directly by the prime Contractor and equipment owned or rented directly by the prime Contractor, with or without operators. Such term does not include employees or equipment of a subcontractor, agent of the prime Contractor, or any other entity. The Department reserves the right to require copies of cancelled checks from the prime Contractor to verify direct payment of laborers and equipment sufficient to meet the above requirements.

The Contractor shall give assurance that the minimum wage for labor and the maximum amount to be deducted for board, if furnished, as stated in the governing provisions shall apply to labor performed on all work sublet. Written consent to sublet any portion of the contract shall not be construed to relieve the Contractor of any responsibility for the fulfillment of the contract.

8.2. Prosecution of Work. Prior to beginning construction operations, a preconstruction conference between the Contractor and the Engineer will be conducted. The Contractor shall begin the work to be performed under the contract within 30 days (within seven (7) calendar days for routine maintenance contracts) after the date of the authorization to begin work as shown on the work order and shall continuously prosecute same with such diligence as will enable him to complete the work within the time limit specified. He shall notify the Engineer at least 24 hours before beginning work and any new operation. The Contractor shall not start new operations to the detriment of work already begun. The prosecution of the work shall be conducted in such a manner as to impose minimum interference to traffic.

Also, prior to beginning construction operations, the Contractor shall submit to the Engineer for approval a bar chart outlining the schedule of all planned major work activities or major phases that he intends to follow in order to complete the contract within the allotted time. A beginning date and a duration in working days shall be shown for each work activity or phase. An estimated production rate for each activity or phase shall also be shown. Material procurement, known utility relocations and other activities which may affect the completion of the project should be included with the work activities shown on the bar chart.

A project status meeting will be held with the Engineer during the first week of each third month after work begins. The progress of the work will be reviewed during this meeting. In the event the progress review indicates the Contractor is behind in the schedule, he will be expected to accelerate his work at his own cost until such time as his work is on

8.3

schedule. The Engineer may require the Contractor to submit a revised schedule reflecting the Contractor's accelerated work effort.

If a Critical Path Method (CPM) schedule is specified on the plans in lieu of a bar chart, such schedule must use the Arrow Diagram Method (ADM) or the Precedence Diagram Method (PDM). All planned major work activities and sequences as well as material procurements, known utility relocations and other activities which may affect the completion of the project should be included in the CPM. The review of the progress of the work at project status meetings will be as previously outlined for bar charts.

The Contractor may submit a revised bar chart or CPM schedule if, in his opinion, additional work, unforeseen conditions or delays beyond his control affect the completion of the project. The Engineer will promptly review the new schedule and will have the right of approval. The approved revised schedule will be used to evaluate the progress of the project. The original bar chart or CPM and any subsequent revisions must be signed by an officer of the Contractor's firm.

Neither a bar chart nor CPM schedule will be required if so specified on the plans.

The observance of the requirements herein is an essential part of the work to be done under the contract. No direct compensation will be allowed for fulfilling this requirement, as such work is considered subsidiary to the various bid items of the contract.

8.3. Workers and Equipment. The Contractor shall furnish such suitable machinery, equipment and construction forces as may be necessary, in the opinion of the Engineer, for the proper prosecution of the work, and failure to do so may cause the Engineer to withhold all estimates which have or may become due and the Engineer may suspend the work until his requests are complied with.

All workers employed by the Contractor shall have such skill and experience as will enable them to properly perform the duties assigned. Any person employed by the Contractor or a subcontractor who, in the opinion of the Engineer, does not perform his work in a proper and skillful manner, or who is disrespectful, intemperate, disorderly or otherwise objectionable, shall at the written request of the Engineer be forthwith discharged and shall not be employed again on any portion of the work without the written consent of the Engineer.

8.4

All workers installing electrical materials, including conduit and duct cable in trenches, service poles and all other system electrical apparatus, shall be directly supervised by persons who have completed an approved course in electrical underground installations. The Contractor shall furnish evidence of satisfactory completion of the Underground Electrical Installation for Roadway Illumination and Signal Control course taught by the Texas Engineering Extension Service for all personnel responsible for direct supervision of electrical installation work on this project.

8.4. Temporary Suspension of Work. The Engineer will have authority to suspend the work, wholly or in part, for such period as he may consider necessary. The "Time Charge" will be suspended during such period only if the cause or reason for the suspension is not under the control of the Contractor. Notice of such suspension with the reasons therefor will be given the Contractor in writing. The Contractor shall not suspend work without written approval of the Engineer.

If the performance of all or any portion of the work is suspended or delayed by the Engineer, in writing, for an unreasonable period of time (not originally anticipated, customary or inherent to the construction industry) and the Contractor believes that additional compensation and/or contract time is due as a result of such suspension or delay, the Contractor shall submit to the Engineer a written request for an adjustment, within seven (7) calendar days of receipt of the notice to resume work. The request shall set forth the reasons and support for such an adjustment.

The Engineer will evaluate the Contractor's request upon receipt. If the Engineer agrees that the cost and/or time required for the performance of the contract has increased as a result of such suspension and the suspension was caused by conditions beyond the control of and not the fault of the Contractor, its suppliers, or subcontractors at any approved tier, and not caused by weather, the Engineer will make an adjustment (excluding profit) and modify the contract in writing accordingly. The Contractor will be notified of the Engineer's determination, whether or not an adjustment of the contract is warranted.

No contract adjustment will be allowed unless the Contractor has submitted the request for an adjustment within the time prescribed.

No contract adjustment will be allowed under this Article to the extent that performance would have been suspended or delayed by any other cause, or for which an adjustment is provided for or excluded under any other term or condition of this contract.

8.5. Computation of Contract Time for Completion. The Contractor shall complete the work within the number of working days stated in the contract. For the purpose of computation of working days, time charges will be considered to begin 15 calendar days (within seven (7) calendar days for routine maintenance contracts) after the date of the written authorization by the Engineer to begin work, unless otherwise provided in the contract.

The Engineer will furnish the Contractor a monthly statement on forms furnished by the Department, showing the number of working days charged during the month, the total number of working days allowed in the contract and the working days remaining under the contract. The Contractor shall review the monthly statement of time charges and will be allowed up to the end of the next estimate period to protest the correctness. This protest shall be in writing, and shall show cause. Not filing a protest by the end of the next estimate period for any time statement will indicate the Contractor's approval of the time charges as shown on that time statement and future consideration of that statement will not be permitted. If the satisfactory completion of the contract requires unforeseen work or work and materials in greater amounts than those set forth in the contract, then additional working days or suspension of time charges will be allowed the Contractor equal to the time which, in the opinion of the Engineer, the work as a whole is delayed.

8.6. Failure to Complete Work on Time. If the Contractor fails to complete the contract in the working days specified, the time charge will be made for each working day thereafter.

The time set forth in the proposal for the completion of the work is an essential element of the contract. For each working day under the conditions described in the preceding paragraph that any work remains uncompleted after the expiration of the working days specified in the contract, together with any additional working days allowed, the amount per day shown in the proposal will be deducted from the money due or to become due the Contractor, not as a penalty, but as liquidated damages.

8.7. Abandonment of Work or Default of Contract. If the Contractor fails to begin the work within the time specified; fails to perform the work with sufficient workmen and equipment; has insufficient materials to insure the completion of the work within the contract time; performs the work unsuitably; neglects or refuses to remove materials or perform anew such work as may have been rejected as being defective or unsuitable; discontinues the prosecution of the work without authority; becomes

insolvent or is declared bankrupt; commits any act of bankruptcy or insolvency; makes an unauthorized assignment for the benefit of any creditor; or from any other cause whatsoever does not carry on the work in an acceptable manner, the Engineer may give notice in writing to the Contractor and his Surety of such delay, neglect or default, specifying the same. If the Contractor within a period of ten (10) days after such notice does not proceed in accordance therewith, then the Department will, upon written notification from the Engineer of the fact of such delay, neglect or default and the Contractor's failure to comply with such notice, have full power and authority, without violating the contract, to take the prosecution of the work out of the hands of the Contractor and to appropriate or use any or all materials and equipment on the ground as may be suitable and acceptable, and enter into an agreement for the completion of the contract according to the terms and provisions thereof or use such other methods as may be required for the completion of the contract in an acceptable manner. All costs and charges incurred by the Department together with the costs of completing the work under contract shall be deducted from any moneys due or which may become due the Contractor. In case the cost so incurred by the Department is less than the amount which would have been payable under the contract, if the work had been completed by the Contractor, the Department will be entitled to receive the difference. In case such cost exceeds the amount which would have been payable under the contract, then the Contractor and the Surety shall be liable and shall pay to the Department the amount of such excess.

8.8. Termination of Contract. The Department may terminate the contract in the event of a court order prohibiting construction activities. The Department may also terminate the contract in the event of a national emergency and when the work to be performed under the contract is stopped directly or indirectly, because of the freezing or diversion of materials, equipment or labor, as the result of an order or a proclamation of the President of the United States or an order of any Federal Authority.

When contracts, or any portion thereof, are terminated, and the Contractor is released before all items of work included in the contract have been completed, payment will be made for the work completed at contract unit prices and no claim for loss of anticipated profits shall be considered. Reimbursement for organization of the work and moving equipment to and from the job will be considered where the volume of the work completed is too small to compensate the Contractor for these expenses under the contract unit prices, the intent being that an equitable settlement will be made with the Contractor, as determined by the Engineer.

8.9 to 8.10

When contracts, or any portion thereof, are permanently terminated, acceptable materials, obtained by the Contractor for the work, that have been inspected, tested and accepted by the Engineer, and that are not incorporated in the work, will be purchased from the Contractor at the actual cost as shown by receipted bills and the actual cost records at such points of delivery as may be designated by the Engineer.

Termination of a contract, as stated above, will not relieve the Contractor or his Surety of the responsibility of replacing defective work as required by the contract.

8.9. Railroad Construction. When work to be done within the limits of a project involves a railroad company, the Contractor will be required to plan and prosecute his work to avoid interference with, or hindrance to, that portion of the work that is the responsibility of the railroad company. The observance of this is an essential part of the work to be done under the contract. No direct compensation will be allowed for fulfilling this requirement as such work is considered subsidiary to the various bid items of the contract.

An extension of working time will be granted, if necessary, for delays caused to the Contractor by the railroad company.

8.10. Hazardous Materials. Materials utilized in the project shall be free of any hazardous material as defined in Item 1, "Definition of Terms".

When the Contractor encounters existing materials on sites owned or controlled by the State or in required material sources that are suspected by visual observation or smell to contain hazardous materials, the Contractor shall immediately notify the Engineer. The State will be responsible for the testing for and removal or disposition of hazardous materials on sites owned or controlled by the State. The Engineer may suspend the work wholly or in part during the testing, removal or disposition of hazardous materials on sites owned or controlled by the State.

When materials delivered to the project are suspected by visual observation or smell to contain hazardous materials, they shall be tested for contamination. All testing shall be by a commercial laboratory approved by the Engineer. When materials delivered to the project are found to be contaminated, the material shall be removed and disposed of by the Contractor. The testing for and removal or disposition of such hazardous materials delivered to the project by the Contractor shall be at the

9.1

Contractor's expense. No suspending of the "Time Charges" and no extensions of working time will be granted to the Contractor resulting from hazardous material which he has delivered.

The Contractor shall indemnify and save harmless the State and its representatives, for the generation and/or disposition of hazardous materials generated by the Contractor on all work done by the Contractor on State owned or controlled sites. Further, the Contractor shall indemnify and save harmless the State and its representatives from any liability or responsibility arising out of the generation or disposition of any hazardous materials obtained, processed, stored, shipped, etc., on sites not owned or controlled by the State. Should the State be required to make any payments or pay any costs or fees or make restitution as a result of the Contractor's actions, the Contractor shall reimburse the State for any and all payments of moneys.

The rules, regulations, policies, procedures, standards, applications and reports of the various State agencies including but not limited to the Texas Natural Resource and Conservation Commission (TNRCC), the Texas Water Well Drillers Board (TWWDB) and the Railroad Commission (RRC), and of the applicable federal departments and agencies including but not limited to the Environmental Protection Agency (EPA), Department of Energy (DOE), Department of Transportation (DOT) and the Occupational Safety and Health Administration (OSHA) shall apply to all operations of the Contractor, including but not limited to the following: sampling, plugging, cleaning, testing, removing, disposing and backfilling.

ITEM 9

MEASUREMENT AND PAYMENT

9.1. Measurement of Quantities. All work completed under contract will be measured by the Engineer according to International System of Units (SI) measures unless otherwise specified. All longitudinal measurements for surface area will be made along the actual surface of the roadway and not horizontally, unless otherwise specified. No deduction will be made for structures in the roadway having an area of one (1) square meter or less. For all transverse measurements for areas of base courses, surface courses, and pavements, the dimensions to be used in calculating the pay areas will be the neat dimensions and shall not exceed those shown on plans or ordered in writing by the Engineer. All materials which are specified for measurement by the cubic meter in vehicles shall be hauled in approved vehicles and measured therein at the point of delivery on the

9.2 to 9.4

roadway. Vehicles for this purpose may be of any type or size satisfactory to the Engineer provided that the body is of such type that the actual contents may be readily and accurately determined. Each approved vehicle shall bear an identification mark indicating specific approval by the Engineer. The Inspector may reject all loads not hauled in such approved vehicles.

In those items which provide for payment by "Plan Quantity", the calculations used to determine such quantities shall be made by standard methods of calculation, using the methods described in the governing specification, and may or may not represent the exact quantity of material moved, handled or placed in the roadway or structure during the execution of the contract. The quantities shown on the plans, adjusted in accordance with the governing specification when required, will be the quantity for which payment will be made.

When the Engineer and Contractor agree in writing, the final payment for the pay items of sprinkling, rolling, scraper work, disking, blading, bulldozer work or road grader work may be fixed at plan quantity if the proposal quantity multiplied by the unit bid price is less than $250.00. This provision will apply regardless of whether the final quantity required is greater than or less than the quantity stated in the proposal.

9.2. Scope of Payment. The Contractor shall accept the compensation, as provided in the contract, as full payment for furnishing all materials, supplies, labor, tools and equipment necessary to complete the work under the contract; for any loss or damage which may arise from the nature of the work, or from the action of the elements, except as noted in Article 7.12, and as provided in Articles 8.4 and 9.7., until the final acceptance by the Engineer, for any infringement of patent, trademark, or copyright; and for completing the work according to the plans and specifications. The payment of any current or partial estimate shall in no way affect the obligation of the Contractor at his expense to repair or renew any defective parts of the construction or to replace any defective materials used in the construction and to be responsible for all damages due to such defects if such defects or damages are discovered on or before the final inspection and acceptance of the work.

9.3. Payment for Extra Work. Extra work ordered, performed and accepted will be paid for in accordance with Article 4.3.

9.4. Force Account. When extra work is ordered to be performed on a "Force Account" basis, payment for same will be made as follows:
9.4

The Contractor and the Department will agree in writing before beginning the work on the rate of wage which the Contractor will receive for all labor and foremen. The Contractor will be paid said rate for each hour that the labor and foremen are actually engaged in the work except that in the event that the particular laborers and foremen anticipated to be used in the work are not available then the individuals involved in the work will be reimbursed at the rate shown on the payrolls. In no case will the rate of wage be less than the minimum shown in the contract for a particular category. The Contractor will receive an additional 25 percent as compensation based on the total wages paid said laborers and foremen. No charge will be made by the Contractor for organization or overhead expenses. For cost of premiums on public-liability and workers-compensation insurance, Social-Security and unemployment-insurance taxes, an amount equal to 55 percent of the sum of the labor cost, excluding the 25 percent compensation provided above, will be paid to the Contractor. The actual cost of the Contractor's bond on the extra work will be paid. No charge for superintendence will be made unless considered necessary and ordered by the Engineer.

The Contractor will receive the actual cost, including freight charges, of the materials used on such work to which cost will be added a sum equal to 25 percent thereof as compensation. When material invoices indicate a discount may be taken, the actual cost will be the invoice price minus the discount.

For Contractor owned machinery, trucks, power tools or other equipment which are necessary for use on force account work, the **Rental Rate Blue Book** as modified by the following will be used to establish hourly rates. Equipment used shall be at the rates in effect for each section of the Blue Book at the time of use.

The following formula shall be used to compute the hourly rates:

$$H = \frac{M \times R1 \times R2}{176} + OP$$

Where H = Hourly Rate
M = Monthly Rate
R1 = Rate Adjustment Factor
R2 = Regional Adjustment Factor
OP = Operating Costs

If Contractor-owned equipment is not available and equipment is rented from outside sources, the hourly rate will be established by dividing **9.4**

the actual invoice cost by the actual number of hours the equipment is involved in the work. The State reserves the right to limit the hourly rate to comparable Blue Book rates. When the invoice specifies that the rental rate does not include fuel, lubricants, repairs and servicing, the **Rental Rate Blue Book** hourly operating cost shall be added for each hour the equipment operates.

If a rate has not been established for a particular piece of equipment in the **Rental Rate Blue Book**, the Engineer will allow the Contractor a reasonable hourly rate, as agreed upon in writing before such work is begun. This price will include the cost of fuel, lubricants and repairs.

If the Contractor has to mobilize equipment from an off-project site, rates for the hauling equipment and personnel will be included as part of the force account work.

The established equipment hourly rates will be paid for each hour that the equipment is involved in the work to which will be added 15 percent as compensation. In the event that the equipment is used intermittently during the work, full payment for an eight-hour day will be made if the equipment is not idle more than four (4) hours of the day. If the equipment is idle more than four (4) hours in a day, then payment will be made only for the actual hours worked.

The compensation, as herein provided for, shall be received by the Contractor as payment in full for extra work completed on the "Force Account" basis and will include use of small tools, overhead expense and profit. The Contractor's representative and the Inspector shall compare records of extra work completed on the "Force Account" basis at the end of each day. Copies of these records will be made upon suitable forms provided for this purpose by the Department and signed by both the Department's and the Contractor's representatives, one copy being forwarded to the Engineer and one to the Contractor. All claims for "Extra Work" performed on the "Force Account" basis shall be submitted to the Engineer by the Contractor upon statements to which shall be attached copies of invoices covering the cost of, and the freight charges on, all materials used in such work, and such statements shall be filed not later than the tenth day of the month following that month in which the work was actually performed.

When extra work is ordered to be performed on a "Force Account" basis, and the estimated cost is less than $5000.00, payment of same may be made on the basis of a certified correct invoice submitted to the Engineer **9.5**

by the Contractor. The invoice shall include the Contractor's actual cost for materials, labor, equipment and incidentals necessary to complete the extra work. The invoice will also include additional compensation allowed above, in

this article, as well as the cost of the Contractor's bond on the extra work.

9.5. Partial Payments. Once each month, the Engineer will make an approximate estimate, in writing, of the materials in place, the amount of work performed and the value thereof at the contract unit prices.

In addition to the above and upon presentation of copies of invoices, freight bills or other acceptable evidence to establish cost, an estimate shall be made and included for the invoice cost of acceptable reinforcing steel, structural steel, precast concrete members, stone, gravel, sand or any other non-perishable materials delivered on the work or in acceptable storage places and which have not been used in the work prior to such estimate. For contracts of $100,000.00 or more, the invoice(s) or other acceptable evidence to establish cost submitted by the Contractor for a particular material must total $1,000.00 or more before it can be eligible for partial payment. For contracts less than $100,000.00, invoices as previously described must total $200 or more before the particular material can be eligible for partial payment.

For materials where storage on or near the project is not practical and for acceptable structural components (structural steel, concrete members, piling, etc.) fabricated in accordance with details shown on the plans and stored in any location approved by the Director of Materials and Tests, an estimate will be made and included for the invoice cost, exclusive of any transportation costs, of the material involved after the Contractor has furnished the Engineer with a copy of the invoice. Only materials which are completely constructed and/or fabricated on the Contractor's order for a specific project, and are so marked, and on which an approved Test Report has been issued, are eligible. This may also include the following items: concrete traffic barrier, precast concrete box culverts, concrete piling, reinforced concrete pipe and illumination poles. Any repairs required, after fabricated materials have been approved for storage, shall require approval by the Engineer prior to being made and shall be made at the expense of the Contractor.

The Contractor shall furnish the Department with a paid invoice on all material on hand within 60 days (two estimate cycles). The paid invoice shall contain a signed statement by the Contractor indicating that payment for the material shown on the invoice has been made. Repeated failure to **9.6**

provide a signed paid invoice within 60 days will result in the removal of the particular material from the monthly estimates. This material will not be considered for partial payment on subsequent monthly estimates.

The Contractor shall submit, with each request for partial payment, a

statement certifying that he has not previously received payment from the Department for the same material.

For precast concrete products which may be completely fabricated or constructed by the Contractor for which invoices or freight bills are not pertinent, and which have been stored in acceptable storage places, and which have not been used in the work, an estimate will be made and payment based on a certified statement of cost as provided by the Contractor and approved by the Engineer.

Partial payments for any material on hand or in acceptable storage shall not exceed the bid price less reasonable placement cost as approved by the Engineer.

From the total of the amounts so ascertained will be deducted five (5) percent to be retained until after the completion of the entire work to the satisfaction of the Engineer, and the remaining 95 percent of the amount so ascertained will be paid to the Contractor less such amounts as may be required by the contract to be deducted.

Partial estimates showing an amount of work performed since the last preceding estimate of less than $1,000.00 may be withheld until the amount of work performed on a partial estimate is at least $1,000.00.

Sixty percent of the retainage will be paid immediately after the "Final Acceptance".

9.6. Acceptance and Final Payment. When the work provided for in the contract has been completed by the Contractor, and all parts of the work have been approved and accepted by the Engineer, a final estimate showing the amount of the work and the amount due the Contractor under the contract will be prepared by the Engineer. The amount of the final estimate, less any sums previously paid under the contract will be paid to the Contractor.

9.7. Differing Construction-site Conditions. During the progress of the work, if subsurface or latent physical conditions are encountered at the site, differing materially from those indicated in the contract, or if unknown physical conditions of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in the work provided for in the contract, are encountered at the site, the Party discovering such conditions shall promptly notify the other Party in writing of the specific differing conditions before they are disturbed and before the affected work is performed.

Upon written notification, the Engineer will promptly investigate the conditions, and if he determines that the conditions materially differ and cause an increase or decrease in the cost or time required for the performance of any work under the contract, an adjustment, excluding loss of anticipated profits, will be made and the contract modified in writing in accordance with Article 9.3. The Contractor will be notified of the Engineer's determination whether or not an adjustment of the contract is warranted.

No contract adjustment which results in a benefit to the Contractor will be allowed unless the Contractor has provided the required written notice in accordance with Article 4.4.

No contract adjustment will be allowed under this clause for any effects caused on unchanged work.

9.8. Plans Quantity Measurement. When plans quantity measurement is specified for an item, adjustment of quantities will be made by the following:

If the quantities measured as outlined under "Measurement" vary from those shown in the proposal and on the "Estimate and Quantity" sheet by more than five (5) percent (or as stipulated under the measurement article for the Item), either party to the contract may request, in writing, an adjustment of the quantities by each separate bid item, except that when stated in the particular item, the adjustment will be made based upon a designated element shown in the Item. The party to the contract which requests the adjustment shall present, to the other, one copy of field measurements and calculations showing the revised quantities in question. These revised quantities, when approved by the Engineer, together with all other quantities under the same bid item, shall constitute the final quantity for which payment will be made.

When quantities are revised by a change in design, the "Plan Quantity" will be increased or decreased by the amount involved in the design change.

Payment for revised quantities will be paid for at the unit price bid for that bid item, except as provided for in Article 4.2.

PART II, CONSTRUCTION DETAILS

DIVISION I
EARTHWORK

ITEM 100

PREPARING RIGHT OF WAY

100.1. Description. This Item shall govern for the preparation of the right of way for construction operations by the removal and disposal of all obstructions from the right of way and from designated easements, where removal of all such obstructions is not otherwise shown on the plans and specifications.

Such obstructions shall be considered to include remains of houses, foundations, floor slabs, concrete, brick, lumber, plaster, septic tank drain fields, basements, abandoned utility pipes or conduits, equipment, fences, retaining walls, outhouses and shacks.

This Item shall also include the removal of trees and shrubs and other landscape features not designated for preservation, stumps, brush, roots, vegetation, logs, curb and gutter, driveways, paved parking areas, miscellaneous stone, sidewalks, drainage structures, manholes, inlets, abandoned railroad tracks, scrap iron and debris, whether above or below ground except live utility facilities.

These obstructions do not include wells which shall be removed under Item 103, "Disposal of Wells".

100.2. Construction Methods.

(1) General. All areas, as shown on the plans, shall be cleared of all structures and obstructions as defined above. Those trees, shrubs and other landscape features specifically designated by the Engineer for preservation shall be carefully protected from abuse, marring, or damage during construction operations. Continual parking and/or servicing of equipment under the branches of trees marked for preservation will not be permitted. When trees and shrubs are designated for preservation and require pruning, they shall be trimmed as directed by the Engineer and all exposed cuts over 50 millimeters in

diameter shall be treated with a material approved by the Engineer.

100.2

Culverts, storm sewers, manholes and inlets shall be removed in proper sequence for maintenance of traffic and drainage.

Underground obstructions, except those items designated for preservation, shall be removed to the following depths:

(a)In areas to receive embankment: 0.6 meter below natural ground, except when permitted by the plans, trees and stumps may be cut off as close to natural ground as practicable on areas which are to be covered by at least one (1) meter of embankment.

(b)In areas to be excavated: 0.6 meter below the lower elevation of the excavation.

(c)All other areas: 0.3 meter below natural ground.

(2) Disposal of Material. Unless otherwise shown herein, all materials and debris removed shall become the property of the Contractor, including all merchantable timber, and shall be removed from the right of way and disposed of in a manner satisfactory to the Engineer, except that gravel, brick, stone, or broken concrete, when approved by the Engineer, may be used in the roadway embankment. This material shall conform to the requirements of Item 132, "Embankment".

(a) State or National Forest or Park.

The provisions shown on the plans for removal of timber shall apply.

No timber shall be cut or defaced outside of the right of way lines or material pit limits as indicated on the plans or by the Engineer.

(b) Burning of Brush. When burning of brush is permitted under applicable laws and by the Engineer, the following shall govern:

(i) Where construction is on new location, the brush shall be piled and burned in the center of the work area.

(ii) Where construction is on an existing location through which the traveling

public is to be routed during construction, brush shall be burned

as near the center of the work area as is practical without creating a hazard to traffic.

(iii) In the event there are material pits which require clearing and grubbing, the brush shall be placed in the center of the pit before burning.

(iv) When a portion of the project falls within the limits of a State or National Forest or Park, the Contractor shall notify the responsible agencies prior to any burning.

(3) Backfill. Holes remaining after removal of all obstructions, objectionable material, trees, stumps, etc., shall be backfilled with approved material, compacted and restored to approximately its original contours by blading, bulldozing, or by other methods, as approved by the Engineer. In areas to be immediately excavated, the backfilling of holes may not be required when approved by the Engineer.

Before backfilling, the remaining ends of all abandoned storm sewers, culverts, sanitary sewers, conduits, and water or gas pipes over 75 millimeters in diameter, shall be plugged with an adequate quantity of concrete to form a tight closure.

100.3. Measurement.

(1) Methods of Measurement. This Item will be measured by one of the following methods:

(a) Preparing Right of Way (Hectare).

(b) Preparing Right of Way (Kilometer). The work performed will be measured by the 1-kilometer, or portion of, regardless of the width of the right of way as shown on the plans.

(c) Preparing Right of Way (Palms). The work performed will be measured by each palm removed. Palms shall be preserved unless shown on the plans or directed by the Engineer to be removed. Measurement of palms for payment will not include sprouts or volunteer palms unless the sprouts or volunteer palms are more than two (2) meters high measured from the ground up to the base of the head.

(d) Preparing Right of Way (Tree). The work performed will be measured

by each tree removed of the diameter specified.

100.4 to 103.1

(2) General. Measurement for payment for "Preparing Right of Way (Hectare)" and for "Preparing Right of Way (Kilometer)" will be made only on areas indicated and classified on the plans as "Preparing Right of Way". Work required by the Engineer on additional areas (such as additional right of way, additional cut and embankment areas, etc.) shall be measured as specified above.

Areas other than those set forth above will not be measured for payment.

100.4. Payment. The work performed and material furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Preparing Right of Way", "Preparing Right of Way (Palms)", and/or "Preparing Right of Way (Trees)" of the diameter specified. This price shall be full compensation for trimming designated trees and shrubs; for removal and disposal of all obstructions and debris; for backfilling all holes; for furnishing and placing all concrete for plugs; for restoring areas to original condition; and for all labor, equipment, tools and incidentals necessary to complete the work.

All work performed in areas not so designated on the plans as "Preparing Right of Way", except "additional areas" as defined under "Measurement" or specifically covered otherwise, will not be paid for directly but shall be considered as subsidiary work pertaining to the various bid items.

The total payment for this Item will not exceed 10 percent of the original contract amount until after the completion of the entire contract work to the satisfaction of the Engineer. That portion of the contract amount for this Item in excess of 10 percent of the total contract amount will then be paid on the next estimate after the work is accepted and after the partial release of retainage.

ITEM 103

DISPOSAL OF WELLS

103.1. Description. This Item shall govern for the removal and disposal of water, petroleum or sulfur wells, both contaminated and uncontaminated, removing their appurtenances; sealing and plugging wells; restoring the area as shown on the plans and specifications and preparation and filing of required documents to the applicable agencies.

103.2. Construction Requirements and Methods. The legal responsibilities and construction requirements and methods shall be in accordance with Articles 7.1 and 7.2, together with the following:

(1) General. The contents of any petroleum or sulfur well shall be emptied as much as possible, according to applicable regulations, into approved containers. The filled containers shall be transported to an approved disposal facility or recycling center for disposal of the contents, according to applicable regulations.

All pump equipment, including pump, piping, motor, housing, well structures, foundations, flumes, windmills, casing and other projecting objects associated with the well shall be removed to one (1) meter below finished subgrade or existing grade, whichever is lower and to the constructions limits. All appurtenances and other removed materials, excluding existing contaminated soil and liquids, after necessary cleaning and disassembling, shall become the property of the Contractor, according to applicable regulations. Disposal of the items shall be in accordance with all applicable laws and regulations. All removed items shall become the property of the Contractor.

Piping to remain shall be capped unless otherwise shown on the plans or as approved by the Engineer. When required by the Texas Natural Resource and Conservation Commission (TNRCC) or the Texas Water Well Drillers Board (TWWDB) or the Railroad Commission (RRC), a "Plugging Report" shall be submitted to the appropriate responsible agency with a copy furnished to the Engineer.

After the various items described above have been removed, backfill shall be in accordance with Subarticle 100.2.(3).

Testing, removal or disposition of hazardous materials in or about the location of the well to be removed will be in accordance with Article 8.10.

(2) Water Wells. Water wells, including dry wells and those that are abandoned, shall have all removable casing removed from the well. The entire well shall be pressure filled with a mixture of portland cement and water at a water cement ratio (W/C) not to exceed 0.62, from the bottom of the well to the natural ground surface, or one (1) meter below the roadway surface, whichever is lower, in accordance with the requirements of the TWWDB. At the discretion of the Contractor, an alternative

procedure may be employed if it is approved in writing by the TNRCC and the Engineer.

When the well is in a cut section it shall be plugged, up to the proposed earthwork evaluation, prior to excavating the cut. After the specified plugging of a well in a cut section, the remainder of the well above the proposed earthwork elevation shall immediately be backfilled with earth.

(3) Petroleum and Sulfur Wells. The Contractor designated to plug these wells shall be on the approved list as maintained by the RRC.

The Contractor has the choice of protecting all water bearing strata with cementing plugs as shown on the plans or completely cementing the well.

103.3. Measurement. This Item will be measured as each well as properly plugged and disposed.

103.4. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement", will be paid for at the unit price bid for "Disposal of Water Well" or "Disposal of Petroleum or Sulfur Well". This price will be full compensation for removing and disposing of all items; for plugging (partially or completely); for furnishing records; for furnishing and placing any material or items; for site restoration and for all manipulation, labor, tools, equipment, and incidentals necessary to complete the work.

ITEM 104

REMOVING CONCRETE

104.1. Description. This Item shall govern for breaking, removing, and storing or disposing of existing portland cement concrete.

104.2. Construction Methods. Existing portland cement concrete shall be removed from locations shown on the plans. Where only a portion of the existing concrete is to be removed, special care shall be exercised to avoid damage to that portion of the concrete to remain in place. Unless otherwise approved by the Engineer, the existing concrete shall be saw cut and removed to the neat lines shown on the plans or established by the Engineer. Any existing concrete that is to remain in place and is beyond the neat lines so established, which is damaged or destroyed by these

operations, shall be replaced, as directed by the Engineer, at the Contractor's expense.

All concrete shown on the plans to be salvaged, shall be broken into pieces not greater than 600 millimeters in any dimension, unless otherwise specified. Air-driven machinery or other suitable means approved by the Engineer may be used. The use of explosives for breaking concrete will not be permitted except when approved in writing by the Engineer. Adequate precautions shall be taken to prevent damage to adjacent property and existing structures. Reinforcing steel shall be cut as necessary.

When shown on the plans, broken concrete to be salvaged shall be loaded, hauled and neatly stored at designated sites as shown on the plans, or used as directed by the Engineer.

Concrete to be removed, but not specified for salvage, shall be disposed of by the Contractor at locations approved by the Engineer. The provision that the concrete be broken into pieces not greater than that specified above shall not apply when concrete is to be removed from the project.

104.3. Measurement. This Item will be measured by one of the methods as follows and shown on the plans:

Removing concrete pavement, floors, porches, patios, riprap, medians, foundations, sidewalks and driveways will be measured by the square meter in its original position, regardless of its thickness, or by the cubic meter based on its calculated volume.

Removing combined curb and gutter, concrete curb and concrete traffic barrier will be measured by the meter in its original position, regardless of the dimensions of same. Removal of monolithic concrete curb and/or dowelled concrete curb on concrete pavement which is to be removed will be considered as part of the concrete pavement and will not be measured separately for payment.

Removing retaining walls will be measured by the square meter along the front face from the top of the wall to the top of the footing.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

104.4. Payment. The work performed in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Removing Concrete" of the type specified. This price shall be full compensation for breaking the concrete, removing any overlaying materials except as stated below, cutting reinforcing steel when required, loading, hauling, unloading, and satisfactorily storing or disposing of the material, and for all labor, tools, equipment, manipulation and incidentals necessary to complete the work.

All retaining wall footings will not be paid for directly but will be considered subsidiary to the various bid items.

Unless otherwise shown on the plans, removal of stabilized base or asphaltic concrete will be paid for by the applicable bid items.

ITEM 105

REMOVING STABILIZED BASE AND/OR ASPHALTIC PAVEMENT

105.1. Description. This Item shall govern for breaking, removing, and storing or disposing of existing asphalt pavement and/or asphalt, cement, lime or lime-fly ash stabilized base materials at the locations and of the depth shown on the plans.

105.2. Construction Methods.

(1) General. Existing stabilized base or asphaltic pavement shall be removed from locations shown on the plans. When present, the asphaltic pavement shall be removed before the stabilized base is disturbed and removed. The Contractor shall make every effort to prevent contamination of the asphaltic material, during removal and disposal in accordance with Subarticle 105.2.(2). Where only a portion of the material is to be removed, special care shall be exercised to avoid damage to that portion of the material to remain in place. The Contractor shall replace, at his expense and as directed by the Engineer, any material that he damages or destroys, which is beyond the limits established for

removal.

(2) Asphaltic Pavement. The asphaltic pavement shall be broken into pieces not greater than 600 millimeters in any direction. The loose material resulting from the operation shall remain the property of the State and shall be stockpiled at locations designated on the plans. Salvaged material shall be kept as free as possible from contamination by nonasphaltic materials during its removal, transportation and storage. The stockpile area shall be cleaned of trash, weeds and grass, and shall be relatively smooth and well drained. Placement of salvaged material in stockpiles shall conform to the dimensions and requirements shown in the plans. The Engineer may require separate stockpiling of salvaged asphaltic paving materials of differing type or quality.

(3) Treated Base. All treated base shown on the plans to be salvaged shall be broken into pieces not greater than 600 millimeters in any dimension, unless otherwise shown on the plans. When shown on the plans, the treated base to be salvaged shall be loaded, hauled and neatly stored at designated sites.

Treated base to be removed, but not specified for salvage, shall be used or disposed of by the Contractor at locations approved by the Engineer. The provision that the removed material be broken into pieces not greater than that specified above shall not apply when it is not used on the project.

105.3. Measurement. This Item will be measured as follows:

(1) Class 1. Measurement will be by the 1-kilometer, or portion of, measured along the baseline of each roadbed as defined in Item 1, "Definition of Terms".

(2) Class 2. Measurement will be by the square meter of the existing stabilized base and/or asphaltic pavement in its original position. Limits of measurement will be as shown on the plans.

(3) Class 3. Measurement will be by the cubic meter in its original position as calculated by the average end area method.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

105.4. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Removing Stabilized Base and/or Asphaltic Pavement", of the class and depth specified. This price shall be full compensation for breaking the material, loading, hauling, unloading, and satisfactorily stockpiling the material, and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work.

ITEM 106

OBLITERATING ABANDONED ROAD

106.1. Description. This Item shall govern for the obliteration of designated sections of abandoned road.

106.2. Construction Methods. After the designated sections of an abandoned road are no longer needed for traffic, the ditches, except where required for drainage, shall be filled and the roadway shaped by rounding the slopes to produce a pleasing appearance. If the existing pavement structure contains asphaltic concrete pavement, the ACP shall be removed by milling or by breaking and stockpiled at a location shown on the plans or approved by the Engineer. After removal of the ACP, if present, the abandoned roadbed shall be scarified and/or plowed so as to mix it with soil to the satisfaction of the Engineer. The entire area of the obliterated roadway shall be smoothed by blading or other methods. Except when shown on the plans, abandoned structures shall be removed. When left in place the abandoned structures may either be plugged or broken and buried to the satisfaction of the Engineer. When the plans require any of the material to be salvaged, such material shall be carefully removed to avoid damage and stored at designated sites or used in the construction of the new road where provided.

When shown on the plans, suitable topsoil shall be saved and used in covering designated areas for the purpose of facilitating regrowth of vegetation.

106.3. Measurement. This Item will be measured by the 1-kilometer, or portion of, along the baseline of the abandoned roadway.

106.4. Payment. The work performed in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Obliterating Abandoned Road". This price shall be full compensation for salvaging and replacing topsoil; for salvaging any other materials and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work.

Unless otherwise shown on the plans, removal of structures will not be paid for directly, but will be considered subsidiary to this Item.

Removal of any asphaltic material will be paid for in conformance with the applicable bid items.

ITEM 110

EXCAVATION

110.1. Description. This Item shall govern for the roadway, channel and/or special excavation of the required material in the areas shown on the plans and cross sections to the lines, grades and typical sections as specified. Excavation shall include all materials encountered regardless of their nature or of the manner in which they are removed.

110.2. Construction Methods. All excavation shall be performed as specified herein and the completed roadway and/or channels shall conform to the alignment, grades and typical sections as shown on the plans or project cross sections or as established by the Engineer.

Unsuitable excavation and excavation in excess of that needed for construction shall be known as "Waste" and shall become the property of the Contractor to be disposed of by him outside the limits of the right of way at a location approved by the Engineer. Unsuitable material encountered below subgrade elevation in roadway cuts, when declared "Waste" by the Engineer, shall be replaced with material from the roadway excavation or with other suitable material as approved by the Engineer. This work shall be done in accordance with the provisions of the applicable bid items.

When excavated materials, including topsoil, are utilized in constructing the required roadway sections, payment for placement will be made under the pertinent placement specification.

110.2

During construction the roadbed and ditches shall be maintained in such condition as to insure proper drainage at all times. Ditches and channels shall be so constructed and maintained as to avoid damage to the roadway section. During construction, channels shall be kept drained, insofar as practicable, and the work shall be prosecuted in a neat and workmanlike manner.

All slopes shall be accurately shaped, and care shall be taken that no material is loosened below or outside the required slopes. Exceptions shall be those slopes in rock or other material where, in the judgment of the Engineer, some variation may be permitted. All breakage and slides shall be removed and disposed of in a manner acceptable to the Engineer.

(1) Rock Cuts. The Contractor shall have the following options:

(a) Nonhomogeneous Rock.

(i) Excavate to finish subgrade elevation, manipulate and compact the subgrade in accordance with Section 132.3.(3).(a) without removal.

(ii) Excavate below grade (undercutting) and replace with embankment material approved by the Engineer. Compaction shall be in accordance with Section 132.3.(3).(a).

(b) Homogeneous Rock.

(i) Excavate to finish subgrade elevation.

(ii) Excavate to finish subgrade elevation, manipulate and compact the subgrade in accordance with Section 132.3.(3).(a) without removal.

(iii) Excavate below grade (undercutting) and replace with embankment material approved by the Engineer. Compaction shall be in accordance with Section 132.3.(3).(a).

(2) Earth Cuts

When base and/or pavement structure is placed under this project, all earth cuts shall be scarified to a uniform depth of at least 150 millimeters below the required finished subgrade elevation for the entire roadbed width. The material shall be mixed and reshaped by blading and then sprinkled and rolled

in accordance with Section 132.3.(3).(a) or as shown on the plans.

(3) Subgrade Tolerances. Tolerances shall be as follows:

(a) Stage Construction. Any deviation in excess of 30 millimeters in cross section and 30 millimeters in five (5) meters measured longitudinally shall be corrected by loosening, adding or removing the material, reshaping and recompacting by sprinkling and rolling.

(b) Turn Key Construction. Any deviation in excess of 15 millimeters in cross section and 15 millimeters in five (5) meters measured longitudinally shall be corrected by loosening, adding or removing the material, reshaping and recompacting by sprinkling and rolling.

110.3. Measurement. This Item will be measured by the cubic meter in its original position as computed by the method of average end areas.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

Excavation in backfill areas of retaining walls will not be measured for payment. Limits of measurement for excavation in retaining-wall areas will be as shown on Standard Details Sheet "Earthwork Measurement at Retaining Walls" (EMRW) in the plans.

Shrinkage or swellage factors will not be considered in determining the calculated quantities.

110.4. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Excavation (Roadway)", "Excavation (Channel)", "Excavation (Special)" or "Excavation (Roadway and Channel)". This price shall be full compensation for all authorized excavation; for undercutting subgrade and reworking or replacing the undercut material; for all hauling; for all work required for disposal of material not used elsewhere on the project and for furnishing all labor, materials, tools, equipment and incidentals necessary to complete the work.

When a slide, not due to the Contractor's negligence or operation, occurs, payments for removal and disposal of the slide material will be in accordance with Article 9.3.

ITEM 112

SUBGRADE WIDENING

112.1. Description. This Item shall govern for the widening of the existing subgrade in accordance with the typical sections shown on the plans and the requirements herein.

112.2. Materials. Water shall conform to the material requirements for Item 204, "Sprinkling".

112.3. Construction Methods.

(1) Preparation of Embankment. Prior to scarifying and re- moving material from the existing pavement sections the existing adjacent embankment slopes over which fill material is to be placed shall be scarified to a uniform depth of at least 150 millimeters.

(2) Pavement Structure Removal. Material along the edge of the existing pavement shall be removed by scarifying and/or blading or by other means approved by the Engineer. Limits of removal of material shall conform to the typical sections or as approved by the Engineer.

All removed material in excess of that needed to construct the widened subgrade section shall become the property of the Contractor and shall be disposed of at a location approved by the Engineer.

(3) Placing Material. Material which has been removed from the existing pavement structure in conformance with Subarticle 112.3(2) shall be placed in accordance with the following:

(a) Embankment Sections. Removed material shall be placed on adjacent embankment sections in successive layers up to the lines and grades shown on the typical sections or approved by the Engineer.

(b) Excavation Sections. Removed material shall be shifted by equipment approved by the Engineer to adjacent fill sections and placed in accordance with

Section 112.3.(3)(a).

(c) General. When additional embankment material is required, it shall be provided in accordance with the provisions of the applicable bid Items or Article 9.3.

(4) Compaction Methods. The widened section shall be compacted by "Ordinary Compaction" or by "Density Control" in accordance with the requirements of Section 132.3.(3)(a) or (b).

112.4. Measurement. This Item will be measured by the 1-kilometer, or portion of, along the baseline of each roadbed, as defined in accordance with Item 1, "Definition of Terms".

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required. No payment will be made for thickness or width exceeding that shown on the typical section or provided on the plans.

112.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement", will be paid for at the unit price bid for "Subgrade Widening (Ordinary Compaction)" or "Subgrade Widening (Density Control)". This price shall be full compensation for all excavation, including blading, scarifying, shaping, dragging, and finishing of the widening subgrade; for hauling and disposing of excess excavated material; and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work.

When "Ordinary Compaction" is shown on the plans, all sprinkling and rolling, except proof rolling, will not be paid for directly but will be considered subsidiary to this Item, unless otherwise shown on the plans.

When "Density Control" is shown on the plans, all sprinkling and rolling, except proof rolling, will not be paid for directly but will be considered subsidiary to this Item.

When subgrade is constructed under this project, correction of soft spots in the subgrade will be at the Contractor's expense. When subgrade is not constructed under this project, correction of soft spots in the subgrade will be in

accordance with Article 4.3.

132.1 to 132.2

When proof rolling is shown on the plans and directed by the Engineer, it will be paid for in accordance with Item 216, "Rolling (Proof)".

ITEM 132

EMBANKMENT

132.1. Description. This Item shall govern for the placement and compaction of all materials necessary for the construction of roadway embankments, levees and dykes or any designated section of the roadway where additional material is required.

132.2. Material. Materials may be furnished from required excavation in the areas shown in the plans or from off right of way sources obtained by the Contractor and meeting the requirements herein. All embankment shall conform to one of the following types as shown on the plans, except that material which is in a retaining-wall-backfill area shall meet the requirements for backfill material of the pertinent retaining-wall item:

Type A. This material shall consist of suitable granular material, free from vegetation or other objectionable matter, and reasonably free from lumps of earth. This material shall be suitable for forming a stable embankment and, when tested in accordance with Test Methods Tex-104-E, Tex-105-E, Tex-106-E and Tex-107-E, Part II shall meet the following requirements:

The liquid limit shall not exceed.....45
The plasticity index shall not exceed. 15
The bar linear shrinkage shall not be less than.....2

Type B. This material shall consist of suitable earth material such as rock, loam, clay, or other such materials as approved by the Engineer that will form a stable embankment.

Type C. This material shall be suitable and shall conform to the specification requirements shown on the plans.

Type D. This material shall be that obtained from required excavation areas shown on the plans and will be used in embankment.

132.3. Construction Methods.

(1) General. When off right of way sources are involved, the Contractor's attention is directed to Item 7, "Legal Relations and Responsibilities to the Public". Prior to placing any embankment, all work in accordance with Item 100, "Preparing Right of Way", shall have been completed on the areas over which the embankment is to be placed. Stump holes or other small excavations in the limits of the embankments shall be backfilled with suitable material and thoroughly tamped by approved methods before commencing embankment construction. The surface of the ground, including disk-loosened ground or any surface roughened by small washes or otherwise, shall be restored to approximately its original slope by blading or other methods. Where shown on the plans or required by the Engineer, the ground surface thus prepared shall be compacted by sprinkling and rolling.

The Engineer shall be notified sufficiently in advance of opening any material source to allow performance of any required testing.

Unless otherwise shown on the plans, the surfaces of unpaved areas (except rock) which are to receive embankment shall be loosened by scarifying to a depth of at least 150 millimeters. Hillsides shall be cut into steps before embankment materials are placed. Placement of embankment materials shall begin at the low side of hillsides and slopes. Materials which have been loosened shall be recompacted simultaneously with the new embankment materials placed upon it. The total depth of loosened and new materials shall not exceed the permissible depth of the layer to be compacted, as specified in Subarticle 132.3.(3).(a) and (b).

Trees, stumps, roots, vegetation or other unsuitable materials shall not be placed in embankment.

Unless otherwise shown on the plans, all embankment shall be constructed in layers approximately parallel to the finished grade of the roadbed.

Embankments shall be constructed to the grade and sections shown on the plans or as established by the Engineer. Each section of the embankment shall correspond to the detailed section or slopes established by the Engineer. After completion of the roadway, it shall be continuously maintained to its finished section and grade until the project is accepted.

(2) Constructing Embankments.

(a) **Earth Embankments**. Earth embankments shall be defined as those composed principally of material other than rock, and shall be constructed of acceptable material from approved sources.

Unless otherwise specified, earth embankments shall be constructed in successive layers for the full width of the individual roadway cross section and in such lengths as are best suited to the sprinkling and compacting methods utilized.

Layers of embankment may be formed by utilizing equipment and methods which will evenly distribute the material.

A minor quantity of rock or broken concrete encountered in the construction of this project may be incorporated in the lower layers of the embankment if acceptable to the Engineer. Or, it may be placed in the deeper fills, in accordance with the requirements for the construction of rock embankments, provided such placement of rock is not immediately adjacent to structures or in areas where bridge foundations are to be constructed. Also, rock or broken concrete may be placed in the portions of embankments outside the limits of the completed roadbed width where the size of the rock or broken concrete prohibits its incorporation in the normal embankment layers. All exposed reinforced steel shall be cut and removed from the broken concrete.

Each layer of embankment shall be uniform as to material, density and moisture content before beginning compaction. Where layers of unlike materials abut each other, each layer shall be featheredged for at least 30 meters, or the material shall be so mixed as to prevent abrupt changes in the soil. No material placed in the embankment by dumping in a pile or windrow shall be incorporated in a layer in that position, but all such piles or windrows shall be moved by blading or similar methods. Clods or lumps of material shall be broken and the embankment material mixed by blading, harrowing, disking or similar methods until a uniform material of uniform density is achieved in each layer.

Sprinkling required to achieve the moisture content necessary for compaction shall meet the material requirements of Item 204, "Sprinkling". It shall be the responsibility of the Contractor to secure a uniform moisture content throughout the layer by such methods as may be necessary. In order to facilitate uniform wetting of the embankment material, the Contractor may apply water at the material source if the sequence and

methods used do not cause an undue waste of water. Such procedures shall be subject to the approval of the Engineer.

(b) Rock Embankments. Rock embankments shall be defined as those composed principally of rock, and shall be constructed of acceptable material.

Unless otherwise specified, rock embankments normally shall be constructed in successive layers for the full width of the individual roadway cross section and of 450 millimeters or less in depth. When, in the opinion of the Engineer, the rock sizes necessitate a greater depth of layer, the layer depth may be increased as necessary, but in no case shall the depth of layer exceed 0.75 meter. Each layer shall be constructed in such a manner that the interstices between the larger stones are filled with smaller stones and spalls which have been created by this operation as well as from the placement of succeeding layers of material.

The maximum dimension of any rock used in embankment shall be less than the depth of the embankment layer, and in no case shall any rock over 0.6 meter in its greatest dimension be placed in the embankment unless otherwise approved by the Engineer. Unless otherwise shown on the plans, the upper or final layer of the embankment shall be composed of material so graded that the density and uniformity of the surface layer may be secured by the "Ordinary Compaction" or "Density Control" method. Exposed oversize material shall be reduced by sledging or other methods as approved by the Engineer.

When "Ordinary Compaction" is specified, each embankment layer shall be rolled and sprinkled when and to the extent directed by the Engineer. When "Density Control" is specified, each layer shall be compacted to the required density as outlined for "Earth Embankments", except that in those layers where rock will make density testing difficult, when shown on the plans, the Engineer may require the layer to be proof rolled to insure proper compaction.

(c) Embankment Adjacent to Culverts and Bridges. Embankments adjacent to culverts and bridges shall be compacted in the manner prescribed under Item 400, "Excavation and Backfill for Structures", or other appropriate bid items.

As a general practice, embankment material placed adjacent to any portion of any structure and in the first two layers above the top of any culvert or similar structure shall be free of any appreciable amount of gravel or stone particles more than 100 millimeters in greatest dimension and of such gradation as to permit thorough compaction. When, in the opinion of the Engineer, such material is not readily available, the use of rock or gravel mixed with earth will be permitted, in which case no particle larger than 300 millimeters in greatest dimension and 150 millimeters in least dimension may be used. The percentage of fines shall be sufficient to fill all voids and insure a uniform and thoroughly compacted mass of proper density.

(3) Compaction Methods. Compaction of embankments shall be by "Ordinary Compaction" or "Density Control" as shown on the plans.

(a) Ordinary Compaction. When "Ordinary Compaction" is shown on the plans, the following provisions shall govern:

Each layer shall not exceed 200 millimeters of loose depth, unless otherwise directed by the Engineer. Each layer shall be compacted in accordance with the provisions governing the Item or Items of "Rolling". Unless otherwise specified on the plans, the rolling equipment shall be as approved by the Engineer. Compaction shall continue until there is no evidence of further compaction. Prior to and in conjunction with the rolling operation, each layer shall be brought to the moisture content directed by the Engineer, and shall be kept leveled with suitable equipment to insure uniform compaction over the entire layer. Should the subgrade, for any reason or cause, lose the required stability or finish, it shall be recompacted and refinished at the Contractor's expense.

(b) Density Control. When "Density Control" is shown on the plans, the following provisions shall apply:

Each layer shall be compacted to the required density by any method, type and size of equipment which will give the required compaction. The depth of layers, prior to compaction, shall depend upon the type of sprinkling, mixing and compacting equipment used. However, maximum depth (400 millimeters loose and 300 millimeters compacted) shall not be exceeded unless approved by the Engineer. Prior to and in conjunction with the rolling operation, each layer shall be brought to the moisture content necessary to obtain the required density and shall be kept leveled with suitable equipment to insure uniform compaction over the entire layer.

Each layer shall be sprinkled as required and compacted to the extent necessary to provide the density specified below, unless otherwise shown on the plans.

Description	Density, Percent	Moisture
Non-swelling soils with plasticity index less than 20	Not less than 98	
Swelling soils with plasticity index of 20 to 35	Not less than 98 nor more than 102	Not less than optimum
Swelling soils with plasticity index over 35	Not less than 95 nor more than 100	Not less than optimum

The density determination will be made in accordance with Test Method Tex-114-E. Field density determination will be made in accordance with Test Method Tex-115-E.

After each layer of earth embankment is complete, tests as necessary may be made by the Engineer. When the material fails to meet the density requirements or should the material lose the required stability, density, moisture or finish before the next course is placed or the project is accepted, the layer shall be reworked as necessary to obtain the specified compaction, and the compaction method shall be altered on subsequent work to obtain specified density. Such procedure shall be subject to the approval of the Engineer.

Excessive loss of moisture shall be construed to exist when the subgrade soil moisture content is four (4) percent less than the optimum.

The Contractor may be required to remove a small area of the layer in order to facilitate the taking of density tests. Replacement and compaction of the removed material in the small area shall be at the Contractor's expense.

When shown on the plans and when directed by the Engineer, the Contractor shall proof roll in accordance with Item 216, "Rolling (Proof)". Soft spots shall be corrected as directed by the Engineer.

132.4 to 132.5

132.4. Tolerances. The tolerances shall be as follows:

(1) Grade Tolerances.

(a) Stage Construction. Any deviation in excess of 30 millimeters in cross section and 30 millimeters in five (5) meters measured longitudinally shall be corrected by loosening, adding or removing the material, reshaping and recompacting by sprinkling and rolling.

(b) Turnkey Construction. Any deviation in excess of 15 millimeters in cross section and 15 millimeters in five (5) meters measured longitudinally shall be corrected by loosening, adding or removing the material, reshaping and recompacting by sprinkling and rolling.

(2) Gradation Tolerances. The Engineer may accept the material, providing not more than one (1) out of the most recent five (5) gradation tests performed are outside the specified limit on any individual sieve by more than five (5) percent.

(3) Density Tolerances. The Engineer may accept the work providing not more than one (1) out of the most recent five (5) density tests performed is outside the specified density, provided the failing test is no more than 50 kilograms per cubic meter outside the specified density.

(4) Plasticity Tolerances. The Engineer may accept the material providing not more than one (1) out of the most recent five (5) plasticity index samples tested are outside the specified limit by no more than two (2) points.

132.5. Measurement. This Item will be measured as follows:

(1) General.

Retaining-wall-backfill areas which are also in embankment areas will be measured for payment as embankment except as shown on the plans; such material shall meet the requirements for backfill material of the pertinent retaining-wall item(s). Limits of measurement for embankment in retaining-wall areas will be as shown on Standard Detail Sheet "Earthwork Measurement at Retaining Walls" (EMRW) in the plans.

Shrinkage or swellage factors will not be considered in determining the calculated quantities.

(2) Class 1. Embankment will be measured in its original, natural position, and the volume computed in cubic meters by the method of average end area.

(3) Class 2. Embankment will be measured by the cubic meter in vehicles as delivered on the road.

(4) Class 3. Embankment will be measured by the cubic meter in its final position as the volume of embankment computed in place between (1) the original ground surfaces or the surface upon which the embankment is to be constructed, and (2) the lines, grades and slopes of the accepted embankment, using the average end area method.

Class 3 is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

132.6. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Embankment", of the compaction method, type and class specified. This price shall be full compensation for furnishing embankment; for hauling; for placing, compacting, finishing and reworking; and for all labor, royalty, tools, equipment and incidentals necessary to complete the work.

When proof rolling is shown on the plans and directed by the Engineer, it will be paid for in accordance with Item 216, "Rolling (Proof)".

When "Ordinary Compaction" is shown on the plans, all sprinkling and rolling, except proof rolling, will not be paid for directly, but will be considered subsidiary to this Item, unless otherwise shown on the plans.

When "Density Control" is shown on the plans, all sprinkling and rolling, except proof rolling, will not be paid for directly, but will be considered subsidiary to this Item.

When subgrade is constructed under this project, correction of soft spots in the subgrade will be at the Contractor's expense. When subgrade is not constructed under this project, correction of soft spots in the subgrade will be in accordance with Article 4.3.

ITEM 134

BACKFILLING PAVEMENT EDGES

134.1. Description. This Item shall govern for backfilling pavement edges in conformity with widths and typical sections shown on the plans. This Item also includes the application of an emulsified asphalt and/or fertilizer with the backfill material, when specified on the plans.

134.2. Material.

(1) General. Unless otherwise indicated on the plans, the top 100 millimeters of the backfill material shall be capable of sustaining vegetation. When less than 100 millimeters of backfill is required, the material supplied shall be capable of sustaining vegetative growth.

(2) Backfill Material. Backfill material shall be one of the following types:

Type A. Backfill material shall be provided from a source outside the right of way and be in accordance with the requirements shown on the plans.

Type B. Backfill material shall be secured from within the existing right of way as shown on the plans or as directed by the Engineer.

Type C. Backfill material shall be mulch sodding provided from an approved source in accordance with Subarticle 162.3(8).

(3) Emulsified Asphalt. The emulsified asphalt shall be of the type specified on the plans and shall meet the requirements of Item 300, "Asphalts, Oils and Emulsions".

(4) Fertilizer. Fertilizer, of the type shown on the plans, shall meet the requirements of Item 166, "Fertilizer".

(5) Water. Water required for proper compaction, the promotion of plant growth, and/or emulsion dilution shall conform to Item 204, "Sprinkling".

134.3. Construction Methods. Unless otherwise permitted by the Engineer, when backfill material is required to be hauled to or within the project site, the backfill material shall be hauled to the approximate required location prior to placement of the pavement finish surface course. After the pavement finish surface course has been placed, the backfill material shall be spread, compacted, and shaped in accordance with the typical sections.

(1) Types A and B Backfill. After the surface course has been placed, the necessary backfill material shall be brought to the approved moisture content, bladed, and compacted as directed by the Engineer. The material shall be shaped to the lines and grades as shown on the plans. After the backfill has been compacted, the roadway sideslopes shall be bladed to a smooth surface conforming to the details indicated on the typical sections or as directed by the Engineer.

(2) Type C Backfill. Mulch sodding backfill material shall be placed in a uniform windrow and kept moist as directed by the Engineer.

After the surface course has been placed, the necessary backfill material shall be bladed and compacted in accordance with Subarticle 162.3(8) or as directed by the Engineer. After the backfill has been compacted, the pavement side slopes shall be bladed to a smooth surface conforming to the details indicated on the typical sections or as directed by the Engineer.

(3) Emulsified Asphalt. Emulsified asphalt mixture, when shown on the plans, shall be applied following final finishing of the backfill material until the specified amount of mixture has been applied. The rate of application, after dilution, shall be as specified on the plans.

(4) Fertilizer. Fertilizer, when shown on the plans, shall be distributed uniformly at the rate specified over the backfilled area following final finishing. After the application of fertilizer, the backfill areas shall be thoroughly moistened to a depth of 100 millimeters or to the maximum depth of the backfill whichever is less.

134.4. Measurement. Backfilling pavement edges shall be measured by the 1-kilometer, or portion of, along the baseline of each roadbed as defined in Item 1, "Definition of Terms".

134.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Backfill" of the type specified. This price shall be full compensation for furnishing the emulsified asphalt, water, fertilizer, mulch sod and backfill material, and for furnishing and operating all equipment and for all labor, fuel, materials, tools and incidentals necessary to complete the work.

ITEM 150

BLADING

150.1. Description. This Item shall govern for blading those portions of the roadway as shown on the plans, or as directed by the Engineer.

150.2. Equipment. All equipment shall be approved by the Engineer prior to use and shall be able to efficiently produce the desired results. Unless otherwise specified, equipment used for blading shall be a power maintainer and shall be in good operating condition. The power maintainer shall have dual or four-wheel drive, shall be equipped with pneumatic tires, shall have a blade of not less than 3.6 meters in length and a wheel base of not less than 4.8 meters. A reduced blade length may be permitted by the Engineer, when site conditions prohibit use of a 3.6 meter or longer blade. If the maintainer is not equipped with a satisfactory scarifier attachment, a scarifier of approved type shall be provided.

150.3. Construction Methods. The work shall be performed on the designated portions of the roadway by the use of the equipment specified, which shall be operated by capable and efficient operators. All areas shall be completed to the section, line and grade shown on the plans, or established by the Engineer.

When necessary to loosen materials prior to blading, or at other points when so directed by the Engineer, the scarifier attachment or separate scarifier shall be used. When a separate scarifier is used, it shall be drawn by suitable power equipment of adequate tractive effort. Around and adjacent to structures, trees, and other obstructions where it is impractical

to do the required work with a blade, such work shall be done by hand methods or other means as approved by the Engineer.

The dragging, pushing, or scraping of materials along or across completed pavements will not be permitted.

150.4. Measurement. This Item will be measured by (1) the 1-kilometer, or portion of, as measured along the base line of each roadbed or by (2) the actual number of hours of blading, including scarifying, performed as shown on the plans or as directed by the Engineer. Where measurement is by the 1-kilometer, or portion of, each roadbed shall be as defined in Item 1, "Definition of Terms".

150.5. Payment. The work performed in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Blading" or "Blading (Erosion Control)" as specified on the plans. This price shall be full compensation for furnishing and operating all equipment, for all labor, fuel, materials, tools and incidentals necessary to complete the work.

All work required to be done by hand labor methods adjacent to structures, trees and other obstructions will not be paid for directly, but shall be considered as subsidiary work to this Item.

Work performed under this Item shall not include work specified for payment under other specification items.

ITEM 152

ROAD GRADER WORK

152.1. Description. This Item shall govern for construction of the earthwork portion of a roadway in conformity with the typical cross sections shown on the plans when the topography is such that it will not be necessary to control the finished grade line for purposes other than to obtain a uniform riding surface and to provide the desirable earth cover over culverts. This Item is intended for constructing subgrade and adjacent slopes. Movement of earthwork for significant volumes and/or for significant distances is to be done under the Items "Scraper Work" and/or

"Bulldozer Work". The limits of "Road Grader Work" shall be shown on the plans and no section shall consist of less than 150 meters, with the exception of bridge replacement projects.

152.2. Equipment. All equipment shall be approved by the Engineer prior to use and shall be able to efficiently produce the desired results. Unless otherwise specified, equipment used for blading shall be a power maintainer and shall be in good operating condition. The power maintainer shall have dual or four-wheel drive, shall be equipped with pneumatic tires, shall have a blade of not less than 3.6 meters in length and a wheel base of not less than 4.8 meters. A reduced blade length may be permitted by the Engineer, when site conditions prohibit use of a 3.6 meter or longer blade. If the maintainer is not equipped with a satisfactory scarifier attachment, a scarifier of approved type shall be provided.

152.3. Construction Methods. All unsuitable or unstable materials shall be removed or reworked as specified under Article 110.2 or as directed by the Engineer. The roadway shall then be graded and shaped to the typical section shown on the plans and to a finished profile uniform and consistent with the topography and as indicated by the plans.

When shown on the plans, "Road Grader Work" will be supplemented by "Scraper Work" and/or "Bulldozer Work" in accordance with the requirements of the governing specifications for these items.

During the shaping or manipulation of the roadbed, in the event insufficient moisture is present in the existing earth material, water shall be applied as necessary to facilitate compaction of the roadbed, by the method specified, prior to the placing of the base materials.

When the existing natural ground or the roadbed of an existing road is not in a uniformly compacted state, the existing ground or roadbed, as the case may be, shall be scarified for the full width of the new roadbed for a minimum depth of 150 millimeters or as shown on the plans. The scarified area shall then be sprinkled and rolled as directed by the Engineer, in conjunction with the new material placed on the roadbed and slopes, in order that the resultant subgrade will be uniformly compacted. Compaction shall be in accordance with the method specified on the plans and as outlined in Item 132, "Embankment".

All equipment shall be operated by capable and efficient operators to the extent, in the manner, in the sequence of work, and within the limits of "Road Grader Work" as shown on the plans or as directed by the Engineer.

152.4. Measurement. This Item will be measured by the 1-kilometer, or portion of, as measured along the base line of each roadbed or by the square meter. When measurement is by the 1-kilometer, or portion of, each roadbed shall be as defined in Item 1, "Definition of Terms". Measurement of this Item will include areas in which "Scraper Work" and/or "Bulldozer Work" are shown on the plans.

152.5. Payment. The work performed in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Road Grader Work (Ordinary Compaction)" or "Road Grader Work (Density Control)". This price shall be full compensation for all labor, tools, equipment, and incidentals necessary to complete the work, except as follows:

All "Scraper Work" and "Bulldozer Work", performed as required, will be paid for at the unit price bid for those items respectively.

When "Ordinary Compaction" method of compaction is specified, "Sprinkling" and "Rolling", performed as required, will not be paid for directly, but shall be considered as subsidiary work pertaining to this Item, unless otherwise specified on the plans.

When "Density Control" method of compaction is specified, "Sprinkling" and "Rolling", performed as required, will not be paid for directly, but shall be considered as subsidiary work pertaining to this Item.

The work performed under this Item shall not include work specified for payment under other specification items.

All work involved in removing and replacing, or reworking unsuitable or unstable material will be paid for as specified under Article 110.4.

ITEM 154

SCRAPER WORK

154.1. Description. This Item shall govern for required excavation as shown on plans or as directed by the Engineer; the removal and proper utilization or disposal of excavated materials; and the constructing, shaping, and finishing of earthwork, except as hereinafter specified, on the designated sections of the roadway and approaches to same, in conformity with the required lines, grades, and typical cross sections and in accordance with this specification.

154.2. Equipment. Unless otherwise indicated by plans, the equipment shall consist of a scraper of not less than 5.7 cubic meters flush capacity. The flush capacity shall be based on the manufacturer's flush rated capacity or 70 percent of the manufacturer's heaped rated capacity, whichever is less. The scraper may be self propelled or drawn by suitable power equipment of adequate tractive effort. It shall be capable of self loading to capacity or additional necessary power equipment shall be provided to push or pull the scraper unit to load to capacity. The scraper with the power unit or units shall be considered a scraper unit. All such equipment shall be in good operating condition.

154.3. Construction Methods. "Scraper Work" shall be performed on those areas as shown on the plans or as directed by the Engineer.

The work shall be performed on the above sections by the use of the equipment specified, which shall be operated by capable and efficient operators.

Embankment work, including compaction, shall be in accordance with Item 132, "Embankment".

Where plans designate "Scraper Work", and "Blading", or "Road Grader Work", within the same limits, the "Scraper Work" shall be roughed in as directed by the Engineer and finished in accordance with specifications for the pertinent supplementing items.

All excavated materials shall become the property of the Contractor, unless otherwise shown on the plans. Suitable excavated materials including topsoil may be furnished by the Contractor and utilized in constructing the

required roadway sections. All excavation not utilized in constructing the required roadway sections shall be disposed of by the Contractor at a location acceptable to the Engineer.

154.4. Measurement. This Item will be measured by the cubic meter·hour. A scraper unit's cubic meter·hour shall consist of the scraper's flush capacity in cubic meters multiplied by the actual number of hours of scraper work performed as directed by the Engineer. The flush capacity shall be as determined under Article 154.2.

154.5. Payment. The work performed in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Scraper Work (Ordinary Compaction)", "Scraper Work (Density Control)", "Scraper Work (Ordinary Compaction/Erosion Control)" or "Scraper Work (Density Control/Erosion Control)" as specified on the plans. This price shall be full compensation for furnishing and operating all equipment, for all hauling, labor, fuel, materials, tools and incidentals necessary to complete the work, except that any "Blading" or "Road Grader Work" required to be performed on sections constructed under this Item will be measured and paid for in accordance with the specifications for those respective items.

When "Ordinary Compaction" method of compaction is specified, "Sprinkling" and "Rolling", performed as required, will not be paid for directly, but shall be considered as subsidiary work pertaining to this Item, unless otherwise specified on the plans.

When "Density Control" method of compaction is specified, "Sprinkling" and "Rolling" will not be paid for directly, but shall be considered as subsidiary work pertaining to this Item.

ITEM 156

BULLDOZER WORK

156.1. Description. This Item shall govern for required excavation as shown on plans or as directed by the Engineer, the removal and proper utilization or disposal of excavated materials; and the constructing, shaping, and finishing of earthwork, except as hereinafter specified, in conformity with the required lines, grades, and typical cross sections and in accordance with this specification.

156.2 to 156.4

156.2. Equipment. The equipment shall consist of a tractor with a blade attachment, and where the work is of such nature as to require use of a scarifier or ripper for efficient performance of the work, such attachments designed for operation with the required tractor shall also be furnished. The tractor shall be either of the crawler type or rubber tired type and shall be of adequate tractive effort to perform the work in an efficient manner. The blade attachment shall be not less than 2.4 meters in length. A reduced blade length may be permitted by the Engineer, when site conditions prohibit use of an 2.4 meter or longer blade. All equipment shall be in good operating condition. The equipment used shall be of the type specified on the plans and shall conform to the requirements as indicated below.

Type A. The Type A bulldozer shall have a manufacturer's rated net flywheel power of less than 112 kilowatts based on the SAE standard J1349.

Type B. The Type B bulldozer shall have a manufacturer's rated net flywheel power of 112 or greater kilowatts based on the SAE standard J1349.

156.3. Construction Methods. "Bulldozer Work" shall be performed on those areas as shown on the plans or designated by the Engineer.

The work shall be performed on the above sections by the use of the equipment specified, which shall be operated by capable and efficient operators.

Embankment work, including compaction, shall be in accordance with Item 132, "Embankment".

Where plans designate "Bulldozer Work", and "Blading", or "Road Grader Work", within the same limits, the bulldozer work shall be roughed in as directed by the Engineer and finished in accordance with the specifications for the pertinent supplementing items.

156.4. Measurement. This Item will be measured by the actual number of hours the specified type of equipment is operated either as a bulldozer or as a bulldozer with scarifier as directed by the Engineer. The type of equipment shall be in accordance with Article 156.2.

156.5 to 158.2

156.5. Payment. The work performed in accordance with this Item and

measured as provided under "Measurement" will be paid for at the unit price bid for "Bulldozer Work (Ordinary Compaction)", "Bulldozer Work (Density Control)", "Bulldozer Work (Ordinary Compaction/Erosion Control)" or "Bulldozer Work (Density Control/Erosion Control)", of the type specified. This price shall be full compensation for furnishing and operating all equipment, for all hauling, labor, fuel, materials, tools, and incidentals necessary to complete the work, except that any "Blading", or "Road Grader Work", required to be performed on sections constructed under this Item will be measured and paid for in accordance with the specifications for those respective items.

When "Ordinary Compaction" method of compaction is specified, "Sprinkling" and "Rolling", performed as required, will not be paid for directly, but shall be considered as subsidiary work pertaining to this Item, unless otherwise specified on the plans.

When "Density Control" method of compaction is specified "Sprinkling" and "Rolling" will not be paid for directly, but shall be considered as subsidiary work pertaining to this Item.

ITEM 158

SPECIALIZED EXCAVATION WORK

158.1. Description. This Item shall govern for required excavation as shown on the plans or as directed by the Engineer in conformity with the required lines, grades and typical cross sections and in accordance with this specification. This work is intended for erosion control or other specialized needs.

158.2. Equipment. The equipment will consist of the following or as shown on the plans. All equipment shall be in good operating condition.

All equipment shall be of the track mounted or wheel mounted variety and shall be of adequate tractive effort and with sufficient power to perform the work in an efficient manner.

When permitted in writing by the Engineer, equipment other than that specified which will consistently produce satisfactory results may be used.

158.3 to 158.5

Type A. Dragline. The equipment shall be self-propelled and equipped

with a bucket of 0.38 cubic meter capacity or more.

Type B. Backhoe. The equipment shall be a tractor mounted backhoe capable of excavating a trench at least 300 millimeters wide in one pass.

Type C. Excavator. The equipment shall consist of a hydraulic excavator with a retractable, telescoping, rotatable boom and attached interchangeable excavating or grading bucket of not less than 900 millimeters width. The entire excavating mechanism shall be mounted on a platform which rotates on a turntable assembly.

Type D. Front End Loader. The equipment shall consist of a tractor mounted front end loader with a minimum bucket capacity of one (1) cubic meter.

158.3. Construction Methods. The work shall be performed at those locations shown on the plans or as directed by the Engineer.

All excavated materials shall become the property of the Contractor, unless otherwise shown on the plans. Suitable excavated materials, including topsoil, may be furnished by the Contractor and utilized in constructing the required roadway sections. All excavation not utilized in constructing the required roadway sections shall be disposed of by the Contractor at a location acceptable to the Engineer.

Materials placed in the embankment shall conform to the requirements of Item 132, "Embankment".

All equipment shall be operated by capable and efficient operators.

158.4. Measurement. This Item will be measured by the actual number of hours the specified type of equipment is operated as directed by the Engineer or by the cubic meters excavated.

When measurement is by the cubic meter, it will be measured in its original position as computed by the method of average end areas.

158.5. Payment. The work performed in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Specialized Excavation Work" or "Specialized Excavation Work (Erosion Control)", of the equipment type specified on the plans.

160.1 to 160.4

This price shall be full compensation for furnishing and operating all equipment; for all hauling; for all work required for disposal of material not used elsewhere on the project and for all labor, fuel, materials, tools and incidentals necessary to complete the work.

ITEM 160

FURNISHING AND PLACING TOPSOIL

160.1. Description. This Item shall govern for the furnishing and placing of approved topsoil to the depths and area shown on the plans or as directed by the Engineer.

160.2. Materials.

(1) Topsoil. The topsoil shall be fertile soil, be easily cultivated, be free from objectionable material, have a relatively high erosion resistance and be readily able to support the growth of planting, seeding or sodding.

(2) Water. Water shall conform to the requirements of Item 204, "Sprinkling".

160.3. Sources. The topsoil may be obtained from the right of way at sites of proposed excavation or embankment when shown on the plans or designated by the Engineer. The approximate quantity of acceptable topsoil to be salvaged from the project will be shown on the plans. The topsoil may also be obtained from approved sources which are outside of the right of way and have been secured by the Contractor.

When it is necessary to obtain material sources off of the right of way, the Contractor's attention is directed to Article 7.17.

160.4. Construction Methods. Any trash, wood, brush, stumps or other objectionable materials encountered at the source shall be removed and disposed of as approved by the Engineer prior to beginning of work required by this Item. The source and stockpile areas shall be kept drained, insofar as practicable, during the period of topsoil removal. The source and stockpile areas shall be left in a neat and presentable condition upon completion of the removal of all material required.

The placement of the topsoil shall be undertaken as soon as the grading operations have been completed or at such time as specified by the Engineer. The topsoil shall be spread so as to form a cover of uniform thickness (loose) as shown on the plans. After the topsoil has been placed and shaped, it shall be sprinkled and/or rolled if directed by the Engineer. Rolling shall be performed with a light corrugated drum roller of the type approved by the Engineer.

(1) Right of Way Sources. The existing topsoil shall be moved from within the limits of construction as shown on the plans and stockpiled in a windrow along the right of way line, or at designated locations. It also may be spread over an area that is ready for topsoil application in accordance with the plans or as directed by the Engineer.

(2) Contractor-Obtained Sources. The Contractor shall notify the Engineer sufficiently in advance of the opening of any material source to permit inspection of the site and to prepare for any necessary measurement. Only material which meets the approval of the Engineer shall be utilized.

160.5. Measurement. This Item will be measured by one of the following methods as shown on the plans.

When **Class 1** measurement is specified, topsoil will be measured by the 1-kilometer, or portion of, as measured along the baseline of each roadbed.

When **Class 2** measurement is specified, topsoil will be measured by the square meter complete in place.

When **Class 3** measurement is specified, topsoil will be measured by the cubic meter in vehicles at the point of delivery.

When **Class 4** measurement is specified, topsoil will be measured in the stockpile and the volume computed in cubic meters by the method of average end areas.

When **Class 5** measurement is specified, topsoil will be measured in its original position at the source and the volume computed in cubic meters by the method of average end areas.

160.6. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Furnishing and Placing Topsoil"

of the class and depth specified. This price shall be full compensation for securing any necessary source(s) and any royalty involved; for furnishing all materials, for all excavation, loading, hauling, stockpiling and placing; and for furnishing all labor, tools, equipment and incidentals necessary to complete the work.

"Rolling" and "Sprinkling" will not be paid for directly, but will be considered subsidiary to this Item, unless otherwise shown on the plans.

Payment will not be made for any material which is used for purposes other than as required by this Item.

Excavation required by this Item in cut sections will be measured and paid for in accordance with the provisions of the various excavation items involved, with the provision that excavation will be measured and paid for once only, regardless of the manipulations involved.

Excavation which will be paid for directly, in accordance with the various excavation Items involved, will include the original in-place volume of topsoil salvaged from cut sections, as well as the additional volume of excavation made necessary for placing the topsoil, in cut areas. Excavation, for topsoil, in areas upon which embankment will be placed will neither be measured nor paid for directly; its cost will be included in the unit price bid for this Item. The foregoing provisions are depicted in Figure 1.

160.6

Figure 1

Roadway Cross Sections Showing Payment for
Excavation and Embankment

ITEM 162

SODDING FOR EROSION CONTROL

162.1. Description. This Item shall govern for providing and planting Bermudagrass, St. Augustine grass or other acceptable grass sod at locations designated on the plans or as directed by the Engineer in accordance with this Item.

162.2. Materials.

(1) General. The sod shall consist of live, growing Bermudagrass, St. Augustine grass when shown on the plans, or other acceptable grass secured from sources which are approved by the Engineer. Bermudagrass sod, St. Augustine grass sod, or other grass sod as shown on the plans, shall have a healthy virile root system of dense, thickly matted roots throughout the soil of the sod for a minimum thickness of 25 millimeters. The Contractor shall not use sod from areas where the grass is thinned out, nor where the grass roots have been dried out by exposure to the air and sun to such an extent as to damage its ability to grow when transplanted.

Care shall be taken at all times to retain the native soil on the roots of the sod during the process of excavating, hauling and planting. The sod existing at the source shall be watered to the extent required by the Engineer prior to excavating. Sod material shall be kept moist from the time it is dug until planted.

(2) Block Sod. Block sod shall be virtually free from noxious weeds, Johnson grass or other grasses or any matter deleterious to its growth or which might affect its subsistence or hardiness when transplanted. Unless the area has been closely pastured, it shall be closely mowed and raked to remove all weeds and long-standing stems.

(3) Mulch Sod. Mulch sod shall be substantially free from noxious weeds, Johnson grass or other grasses or any matter deleterious to its growth or which might affect its subsistence or hardiness when transplanted. Unless the area has been closely pastured, it shall be closely mowed and raked to remove all weeds and long-standing stems.

(4) Fertilizer. Fertilizer shall conform to the requirements of Article 166.2.

(5) **Water.** Water shall conform to the requirements of Article 168.2.

(6) **Mulch.** Straw mulch shall be oat, wheat, or rice straw. Hay mulch shall be prairie grass, Bermudagrass, or other hay as approved by the Engineer. The straw or hay mulch shall be free of Johnsongrass or other noxious weeds and foreign materials. It shall be kept in a dry condition and shall not be molded or rotted.

(7) **Tacking Agents.** Tacking agents for straw or hay mulch shall be SS-1, unless otherwise shown on the plans. A biodegradable tacking agent may be used in lieu of the SS-1 tacking agent when approved by the Engineer. Asphaltic material shall conform to the requirements of Item 300, "Asphalts, Oils and Emulsions".

162.3. Construction Methods.

(1) **General.** After the designated areas have been completed to the lines, grades, and cross sections shown on the plans and as provided for in other items of this contract, sodding of the type specified shall be performed in accordance with the requirements hereinafter described.

Where rolling is specified by the following subarticles, the roller shall be a light corrugated drum roller of the type approved by the Engineer.

(2) **Watering.** Watering shall be done in accordance with Article 168.3.

(3) **Fertilizing.** Fertilizing shall be done in accordance with Article 166.3.

(4) **Planting Season.** All planting shall be done between the average date of the last freeze in the spring and six weeks prior to the average date for the first freeze in the fall according to the Texas Almanac or U.S. Weather Bureau for the area in which the project is located except as specifically authorized by the Engineer in writing.

(5) **Spot Sodding.** Spot sodding shall be planted as shown below and be of the type specified on the plans.

(a) Bermudagrass. Furrows parallel to the roadway and approximately 125 millimeters deep and 450 millimeters on centers shall be opened on areas to be sodded. In two furrows adjacent to the roadways, sod shall form a continuous row not less than 75 millimeters wide. In all other furrows, sod approximately 75 millimeters square shall be placed on 375 millimeters centers. Sod shall be placed so that when it has been firmed against the bottom of the furrow or hole, the root system shall be completely covered by soil. Soil shall be firmed against all sides of the sod. Covering of the sod will not be permitted except for small amounts of soil incidental to raking or leveling, provided the quantity of soil is not enough to hinder growth in the opinion of the Engineer.

Unless otherwise indicated on the plans, fertilizer shall be applied uniformly in the furrows or rows in accordance with Article 166.3. The furrows or rows shall then be thoroughly watered in accordance with Article 168.3.

(b) St. Augustine Grass. St. Augustine grass sod shall be of the "Raleigh" variety and shall be not less than 75 millimeters square and shall be planted on a maximum of 450 millimeters centers. Planting of the sod may be in furrows of uniform depth or in holes of like depth. Sod shall be placed so that when it has been firmed against the bottom of the furrow or hole, the top of the sod shall not be more than 15 millimeters below finished grade. Soil shall be firmed against all sides of the sod. Covering of the sod will not be permitted except for small amounts of soil incidental to raking or leveling, provided the quantity of soil is not enough to hinder growth in the opinion of the Engineer.

Unless otherwise indicated on the plans, fertilizer shall be applied uniformly in the furrows or holes in accordance with Article 166.3. The furrows or holes shall then be thoroughly watered in accordance with Article 168.3.

(c) Other Approved Sods. When specified on the plans, other approved sods are permitted. Planting shall be in accordance with acceptable methods approved by the Engineer.

(6) Block Sodding. At locations shown on plans or where directed by the Engineer, sod blocks shall be carefully placed on the prepared areas. The fertilizer shall then be applied in accordance with Article 166.3 and thoroughly watered in accordance with Article 168.3. When sufficiently dry, the sodded area shall be rolled or tamped to form a thoroughly compacted, solid mat. Any voids left in the block sodding shall be filled

with additional sod and tamped. Surfaces of block sod, which, in the opinion of the Engineer, may slide due to the height and slope of the surface or nature of the soil, shall be pegged with wooden pegs, or other methods as approved by the Engineer, driven through the sod blocks into firm earth sufficiently close to hold the block sod firmly in place.

Edges along curbs and drives, walkways, etc., shall be carefully trimmed and maintained until accepted.

(7) Grass Retards. Trenches shall be excavated across the side ditches or along the side or back slopes to the lines and dimensions shown on plans. After the trenches have been prepared, they shall be filled with sod blocks to an elevation flush with the adjacent ground surface. The fertilizer shall then be applied in accordance with Article 166.3, and thoroughly watered in accordance with Article 168.3. When sufficiently dry, the sodded area shall be rolled or tamped to form a thoroughly compacted, solid mat. Any voids left between the sod blocks shall be filled with additional sod and tamped.

(8) Mulch Sodding. The sod source shall be disked in two directions cutting the sod thoroughly to a depth of not less than 100 millimeters. Sod material shall be excavated to a depth of not more than 50 millimeters below the existing root system, being careful to avoid having soil containing no grass roots. The disked sod may be windrowed, or otherwise handled in a manner satisfactory to the Engineer. The material shall be rejected if not kept in a moist condition.

Prior to placing mulch sod, the cut slopes shall be scarified by plowing furrows 100 millimeters to 150 millimeters deep along horizontal slope lines at 600 millimeters vertical intervals. Excavated material from the furrows shall not protrude more than 75 millimeters above the original surface of the cut. Fertilizer shall be distributed uniformly over the area in accordance with Article 166.3. The sod shall then be dumped upon the prepared area and spread uniformly to the required approximate thickness shown on plans.

Any section not true to lines and cross sections shall be remedied by the addition of sod material or by reshaping the material to meet the requirements of "Finishing". After the sod material has been spread and
shaped, it shall be thoroughly watered in accordance with Article 168.3. All rolling of sloped areas shall be along the contour of the slope.

(9) Straw Mulch or Hay Mulch. Where applicable, "Spot Sodding" and "Mulch Sodding" shall have straw or hay mulch spread uniformly over the area as indicated on the plans or as directed by the Engineer. The rate of application shall be 3.4 to 4.5 megagrams of hay or 4.5 to 5.6 megagrams of straw per hectare.

A mulching machine approved by the Engineer shall be equipped to inject tacking agent uniformly into the mulch as it leaves the equipment at a rate of 0.25 to 0.50 liter of tacking agent per square meter of mulched area or as directed by the Engineer. If the mulch and tacking agent are placed by hand, then the rate of application for the tacking agent shall be approximately 0.70 liter per square meter of mulched area.

(10) Finishing. Where applicable, the shoulders, slopes and ditches shall be smoothed, after planting has been completed, and shaped to conform to the desired cross sections. Any excess soil from planting operations shall be spread uniformly over adjacent areas or disposed of as directed by the Engineer so that the completed surfaces will present a neat appearance.

162.4. Measurement. "Spot Sodding", "Block Sodding", "Grass Retards" and "Straw or Hay Mulch" will be measured by the square meter complete in place. "Mulch Sodding" will be measured by the square meter complete in place or by the cubic meter in vehicles as delivered to the place of planting.

162.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Spot Sodding", "Block Sodding", "Grass Retards", "Straw or Hay Mulch", or "Mulch Sodding". This price shall be full compensation for securing a source, if necessary, and any royalty involved; for furnishing all materials, for all excavation, loading, hauling, placing, rolling; finishing; and for furnishing all labor, equipment, tools, supplies and incidentals necessary to complete the work.

All water, except that used for maintaining and preparing the sod prior to planting, will be measured and paid for in accordance with Item 168, "Vegetative Watering".

Water used for preparing the sod for digging and keeping the sod moist from the source until it is planted shall be considered subsidiary to the various pay items involved.

"Fertilizer" will not be paid for directly, but will be considered subsidiary to this Item unless otherwise shown on the plans.

ITEM 164

SEEDING FOR EROSION CONTROL

164.1. Description. This Item shall govern for preparing ground, providing for sowing of seeds, mulching with straw, hay, or cellulose fiber and other management practices on areas shown on the plans and in accordance with this Item.

It includes seeding for permanent erosion control and seeding for temporary erosion control during the initial winter season.

164.2. Materials.

(1) Seed. All seed must meet the requirements of the Texas Seed Law including the labeling requirements for showing pure live seed (PLS = purity x germination), name and type of seed. Seed furnished shall be of the previous season's crop and the date of analysis shown on each bag shall be within nine months of the time of use on the project. Each variety of seed shall be furnished and delivered in separate bags or containers. A sample of each variety of seed shall be furnished for analysis and testing when directed by the Engineer. Buffalograss shall be treated with a dormancy method approved by the Engineer. The species and varieties of seed shall be from among the types specified in Tables 1A and 1B.

Table 1A. List of Selected Grass Species with Their Scientific and Common Names

Scientific Name	Common Name (Acceptable Varieties)	Season Warm/Cool	Native/ Introduced
Agropyron smithii	Western Wheatgrass	C	N
Andropogon hallii	Sand Bluestem	W	N
Avena sativa	Oats	C	I
Bothriochloa ischaemum	K-R Bluestem	W	I
Bouteloua curtipendula	Sideoats Grama (see seed mix table for appropriate varieties)	W	N
Bouteloua eriopoda	Black Grama	W	N
Bouteloua gracilis	Blue Grama (see seed mix table for appropriate varieties)	W	N
Buchloe dactyloides	Buffalograss	W	N
Cenchrus ciliaris	Buffelgrass	W	I
Chloris guyana	Rhodesgrass	W	I
Cynodon dactylon	Bermudagrass	W	I
Eragrostis trichodes	Sand Lovegrass (see seed mix table for appropriate varieties)	W	N
Festuca arundinaceae	Tall Fescue	C	N
Hordeum vulgare	Barley	C	I

Scientific Name	Common Name (Acceptable Varieties)	Season Warm/Cool	Native/ Introduced
Leptochloa dubia	Green Sprangletop	W	N
Panicum virgatum	Switchgrass (see seed mix table for appropriate varieties)	W	N
Paspalum notatum	Bahiagrass (Pensacola variety)	W	I
Schizachyrium scoparium	Little Bluestem (Texas origin only)	W	N
Setaria italica	Foxtail Millet	W	I
Setaria macrostachya	Plains Bristlegrass	W	N
Sorghastrum avenaceum	Indiangrass (see seed mix table for appropriate varieties)	W	N
Sporobolus cryptandrus	Sand Dropseed	W	N
Triticum aestivum	Wheat (Red, Winter)	C	I

Table 1B. List of Selected Legumes Species with Their Scientific and Common Names

Scientific Name	Common Name	Season Warm/Cool	Native/ Introduced
Trifolium incarnatum	Crimson Clover	C	I
Melilotus officinalis	Yellow Sweetclover	C	I
Vicia villosa	Hairy Vetch	C	I

(2) Fertilizer. Fertilizer shall conform to the requirements of Item

166, "Fertilizer". The fertilizer used shall have the analysis as shown on the plans.

(3) Water. Water shall conform to the requirements of Item 168, "Vegetative Watering".

(4) Mulch.

(a) Straw Mulch or Hay Mulch. Straw mulch shall be oat, wheat or rice straw. Hay mulch shall be prairie grass, bermudagrass or other hay as approved by the Engineer. The straw mulch or hay mulch shall be free of Johnson grass or other noxious weeds and foreign materials. It shall be kept in a dry condition and shall not be molded or rotted.

(b) Cellulose Fiber Mulch. It shall meet the requirements of and be approved by the Director of Construction and Maintenance. A list of pretested and approved materials will be maintained and can be obtained by writing the Director of Construction and Maintenance, 125 East 11th Street, Austin, Texas 78701-2483.

The mulch shall be designed for use in conventional mechanical planting, hydraulic planting of seed or hydraulic mulching of grass seed, either alone or with fertilizers and other additives. The mulch shall be such that, when applied, the material shall form a strong, moisture-retaining mat without the need of an asphalt binder. It shall be kept in a dry condition until applied and shall not be molded or rotted.

(5) Soil Retention Blanket. Soil retention blanket shall meet the requirements of Item 169, "Soil Retention Blanket".

(6) Tacking Agents. Tacking agents for straw or hay mulch shall be SS-1, unless otherwise shown on the plans. A biodegradable tacking agent may be used in lieu of the SS-1 tacking agent when approved by the Engineer. Asphaltic material shall conform to the requirements of Item 300, "Asphalt, Oils and Emulsions".

164.3. Construction Methods. After designated areas have been completed to the lines, grades and cross sections shown on the plans and as provided for in other items of this contract, seeding shall be performed in accordance with the requirements hereinafter described. Unless otherwise approved by the Engineer, all areas to be seeded shall be cultivated to a depth of

at least 100 millimeters, except where seeding is to be done using a seed drill suitable for seeding into untilled soil. The seedbeds shall be cultivated sufficiently to reduce the soil to a state of good tilth when the soil particles on the surface are small enough and lie closely enough together to prevent the seed from being covered too deeply for optimum germination. **164.3**

Cultivation of the seedbed will not be required in loose sand where depth of sand is 100 millimeters or more.

The cross section previously established shall be maintained throughout the process of cultivation. Any necessary reshaping shall be done prior to any planting of seed.

(1) Planting Season and Seed Mixes. All planting shall be done between the dates specified for each highway district except as specifically authorized in writing by the Engineer.

The pure live seed planted per hectare shall be of the type specified in Table 2 for rural areas (warm season), Table 3 for urban areas (warm season), Tables 4A and 4B for temporary erosion control (cool season) and Table 5 for temporary erosion control (warm season), with the mixture, rates and planting dates except as shown on the plans.

Table 2.
Rural Area Species-Specific Warm-Season Seeding Mixtures in Kilograms of Pure Live Seed Per Hectare, by District.

District and Planting Dates *	Mixture for Use in Clay or Tight Soils		Mixture for Use in Sand or Sandy Soils			
1 (Paris)	(Eastern Sections)		(Western Sections)		(All Sections)	
Feb 1 - May 15	Green Sprangletop	1.0	Green Sprangletop	0.8	Green Sprangletop	1.2
	Bermudagrass	1.3	Bermudagrass	1.0	Bermudagrass	1.7
	Little Bluestem	1.9	Little Bluestem	1.6	Bahiagrass (Pensacola)	7.5
	Indiangrass (Lometa)	2.6	Indiangrass (Lometa)	2.0		
			Switchgrass (Alamo or Blackwell)	1.6		

District and Planting Dates *	Mixture for Use in Clay or Tight Soils		Mixture for Use in Sand or Sandy Soils	
2 (Eastern Sections)	(Western Sections)		(All Sections)	
(Ft. Worth)				
Feb 1 - Green Sprangletop	0.7	Green Sprangletop	0.7	Green Sprangletop	0.8
May 1 Sideoats Grama	2.0	Sideoats Grama	2.0	Sideoats Grama	2.5
(El Reno)	(Haskell or El Reno)			(Haskell)	
Bermudagrass	0.9	Little Bluestem	1.2	Bermudagrass	1.0
Little Bluestem	1.2	Indiangrass	1.7	Little Bluestem	1.6
K-R Bluestem	0.8	(Lometa or Cheyenne)	Sand Dropseed		0.2
Switchgrass	1.3	K-R Bluestem	0.8		
(Alamo or Blackwell)	Switchgrass	1.3			
	(Alamo or Blackwell)				
3 (Eastern Sections)	(Western Sections, i.e., Clay Co. West)		(All Sections)	
(Wichita Falls)				
Feb 1 - Green Sprangletop	0.8	Green Sprangletop	0.8	Green Sprangletop	0.7
May 1 Sideoats Grama	2.5	Sideoats Grama	2.5	Sideoats Grama	2.0
** (El Reno)	(El Reno)		(El Reno)		
*** Bermudagrass	1.0	Blue Grama	0.7	Bermudagrass	0.9
Buffalograss	7.2	(Lovington)		Little Bluestem	1.2
Western Wheatgr.	3.1	Buffalograss	7.2	Sand Dropseed	0.2
		Western Wheatgr.	3.1	Sand Bluestem	0.2
4 (All Sections)				(All Sections)	
(Amarillo)					
Feb 15 - Green Sprangletop	1.0			Green Sprangletop	0.8
May 15 Sideoats Grama	3.1			Sideoats Grama	2.5
*** (El Reno)				(El Reno)	
Blue Grama	0.9			Blue Grama	0.7
(Lovington)				(Lovington)	
Buffalograss	9.0			Sand Dropseed	0.2
				Sand Bluestem	0.2

District and Planting Dates *			Mixture for Use in Clay or Tight Soils		Mixture for Use in Sand or Sandy Soils	
5	(E. of IH 27)		(W. of IH 27)		(All Sections)	
(Lubbock)						
Feb 15 -	Green Sprangletop	1.0	Green Sprangletop	1.0	Green Sprangletop	0.8
May 15	Sideoats Grama	3.1	Sideoats Grama	3.1	Sideoats Grama	2.5
* * *	(El Reno)		(Coronado)		(Coronado)	
	Blue Grama	0.9	Blue Grama	0.9	Blue Grama	0.7
	(Lovington)		(Lovington)		(Lovington)	
	Buffalograss	9.0	Buffalograss	9.0	Sand Dropseed	0.2
					Sand Bluestem	0.2
6	(N. of Pecos River)		(S. of Pecos River)		(All Sections)	
(Odessa)						
Feb 1 -	Green Sprangletop	0.8	Green Sprangletop	1.0	Green Sprangletop	0.7
May 15	Sideoats Grama	2.5	Sideoats Grama	3.1	Black Grama	0.3
	(Premier or Uvalde)		(Premier or Tucson)		Blue Grama	0.6
	Black Grama	0.5	Black Grama	0.6	(Hachita)	
	Blue Grama	0.7	Blue Grama	0.9	Little Bluestem	1.2
	(Hachita)			Sand Dropseed		0.2
	Little Bluestem	1.6			Sand Bluestem	0.2
7	(All Sections)				(All Sections)	
(San Angelo)						
Feb 1 -	Green Sprangletop	0.8			Green Sprangletop	0.8
May 1	Sideoats Grama	2.5			Sideoats Grama	2.5
	(Haskell)			(Haskell)		
	Buffalograss	7.2			Little Bluestem	1.6
	Little Bluestem	1.6			K-R Bluestem	0.9
	K-R Bluestem	0.9			Sand Dropseed	0.2
8	(N., W., E. of and		(S. of Fisher Co.)		(All Sections)	
(Abilene)	including Fisher Co.)					
Feb 1 -						
May 15	Green Sprangletop	1.0	Green Sprangletop	1.0	Green Sprangletop	0.8
* * *	Sideoats Grama	3.1	Sideoats Grama	3.1	Sideoats Grama	2.5
	(Haskell)	(Haskell)		(Haskell)		
	Buffalograss	9.0	Buffalograss	9.0	K-R Bluestem	0.9
	Blue Grama	0.9	Little Bluestem	1.9	Sand Dropseed	0.2
	(Hachita)			Sand Bluestem 0.2		

District and Planting Dates *			Mixture for Use in Clay or Tight Soils		Mixture for Use in Sand or Sandy Soils	
9	(E. of IH 35)		(W. of IH 35)		(All Sections)	
(Waco)						
Feb 1 -	Green Sprangletop	0.7	Green Sprangletop	0.7	Green Sprangletop	1.0

May 15	Bermudagrass	0.9	Sideoats Grama	2.0	Bermudagrass	1.3
	Little Bluestem	1.2	(Haskell or Premier)		K-R Bluestem	1.1
	Indiangrass	1.7	Buffalograss	5.9	Sand Dropseed	0.3
	(Lometa)		Little Bluestem 1.2			
	K-R Bluestem	0.8	K-R Bluestem	0.8		
	Switchgrass	1.3	Switchgrass	1.3		
	(Alamo)		(Alamo)			
10	(All Sections)				(All Sections)	
(Tyler)						
Feb 1 -	Green Sprangletop	0.8			Green Sprangletop	1.9
May 15	Bermudagrass	1.0			Bermudagrass	2.6
	Little Bluestem	1.6				
	Indiangrass	2.0				
	(Lometa)					
	Switchgrass	1.6				
	(Alamo)					
11	(All Sections)				(All Sections)	
(Lufkin)						
Feb 15 -	Green Sprangletop	0.7			Green Sprangletop	1.9
May 15	Bermudagrass	1.0			Bermudagrass	2.6
	Little Bluestem	1.6				
	Indiangrass	2.0				
	(Lometa)					
	Switchgrass	1.6				
	(Alamo)					

District and Planting Dates *			Mixture for Use in Clay or Tight Soils		Mixture for Use in Sand or Sandy Soils	
12 (Houston)	(All Sections)				(All Sections)	
Jan 15 - May 15	Green Sprangletop	0.7			Green Sprangletop	1.0
	Bermudagrass	0.9			Bermudagrass	1.3
	Little Bluestem	1.2			Bahiagrass	5.6
	Indiangrass (Lometa)	1.7			(Pensacola)	
	K-R Bluestem	0.8			K-R Bluestem	1.1
	Switchgrass (Alamo)	1.3				
13 (Yoakum)	(Wharton and Matagorda Cos.)		(All Other Sections)		(All Sections)	
Jan 15 - May 15	Green Sprangletop	1.0	Green Sprangletop	0.7	Green Sprangletop	0.8
	Bermudagrass	1.3	Bermudagrass	0.9	Bermudagrass	1.0
	Little Bluestem	1.9	Little Bluestem	1.2	Bahiagrass	4.5
	K-R Bluestem	1.1	Indiangrass (Lometa)	1.7	(Pensacola)	
					Little Bluestem	1.6
			K-R Bluestem	0.8	K-R Bluestem	0.9
			Switchgrass (Alamo)	1.3		
14 (Austin)	(E. of IH 35)		(W. of IH 35)		(All Sections)	
Feb 1 - May 15	Green Sprangletop	0.7	Green Sprangletop	0.7	Green Sprangletop	1.0
	Bermudagrass	0.9	Little Bluestem	1.2	Bermudagrass	1.3
	Little Bluestem	1.2	Indiangrass (Lometa)	1.7	Sand Lovegrass	0.9
	Indiangrass (Lometa)	1.7			K-R Bluestem	1.1
	Buffalograss	5.9	Buffalograss	5.9		
	Sideoats Grama (Haskell or Uvalde)	2.0	Sideoats Grama (Haskell or Uvalde)	2.0		
			Switchgrass (Alamo)	1.3		

District and Planting Dates *			Mixture for Use in Clay or Tight Soils		Mixture for Use in Sand or Sandy Soils	
15 (San Antonio)	(Uvalde, Frio, and Atascosa Cos., N.E.)		(Zavala, LaSalle, and McMullen Cos., S.W.)		(All Sections)	
Feb 1 - May 1	Green Sprangletop	0.7	Green Sprangletop	0.7	Green Sprangletop	1.0
	Sideoats Grama (Haskell or Uvalde)	2.0	Sideoats Grama (Haskell or Uvalde)	2.0	Bermudagrass	1.3
	Little Bluestem	1.2	Buffalograss	5.9	Buffelgrass	2.2
	Bermudagrass	0.9	Plains Bristlegr.	1.1	K-R Bluestem	1.1
	Buffalograss	5.9	K-R Bluestem	0.8		
	K-R Bluestem	0.8	Bermudagrass	0.9		
16 (Corpus Christi)	(E. of U.S. 77)		(W. of U.S. 77)		(All Sections)	
	Green Sprangletop	0.8	Green Sprangletop	0.8	Green Sprangletop	1.0
Jan 15 -	Bermudagrass	1.0	Rhodesgrass	0.5	Bermudagrass	1.3
May 1	Sideoats Grama (Haskell or Uvalde)	2.5	Plains Bristlegr.	1.3	Buffelgrass	2.2
			Buffalograss	7.2	K-R Bluestem	1.1
	Little Bluestem	1.6	K-R Bluestem	0.9		
	K-R Bluestem	0.9				
17 (Bryan)	(All Sections)				(All Sections)	
Feb 1 -	Green Sprangletop	0.7			Green Sprangletop	1.2
May 15	Bermudagrass	0.9			Bermudagrass	1.7
	Little Bluestem	1.2			Bahiagrass (Pensacola)	7.5
	Indiangrass (Lometa)	1.7				
	K-R Bluestem	0.8				
	Switchgrass (Alamo)	1.3				

District and Planting Dates *			Mixture for Use in Clay or Tight Soils		Mixture for Use in Sand or Sandy Soils	
18 (Dallas)	(E. of U.S. 75)		(W. of U.S. 75)		(All Sections)	
Feb 1 - May 1	Green Sprangletop	0.7	Green Sprangletop	0.8	Green Sprangletop	1.2
	Bermudagrass	0.9	Bermudagrass	1.0	Bermudagrass	1.7
	Little Bluestem	1.2	Sideoats Grama (El Reno)	2.5	Sand Dropseed	0.5
	Indiangrass (Lometa or Cheyenne)	1.7	Little Bluestem	1.6		
	Buffalograss	5.9	Indiangrass (Lometa or Cheyenne)	2.0		
	Switchgrass (Alamo or Blackwell)	1.3				
19 (Atlanta)	(All Sections)				(All Sections)	
Feb 1 - May 15	Green Sprangletop	0.7			Green Sprangletop	1.2
	Bermudagrass	0.9			Bermudagrass	1.7
	Little Bluestem	1.2			Bahiagrass (Pensacola)	7.5
	Indiangrass (Lometa or Cheyenne)	1.7				
	Switchgrass (Alamo)	1.3				
	Bahiagrass (Pensacola)	3.7				
20 (Beaumont)	(All Sections)				(All Sections)	
Jan 15 - May 15	Green Sprangletop	0.8			Green Sprangletop	1.2
	Bermudagrass	1.0			Bermudagrass	1.7
	Little Bluestem	1.6			Bahiagrass (Pensacola)	7.5
	Indiangrass (Lometa)	2.0				
	Switchgrass (Alamo)	1.6				
21 (Pharr)	(All Sections)				(All Sections)	
Jan 15 - May 1	Green Sprangletop	0.8			Green Sprangletop	0.8
	Rhodesgrass	0.5			Bermudagrass	1.0
	Plains Bristlegr.	1.3			Rhodesgrass	0.5
	Buffalograss	7.2			Buffelgrass	1.3
	K-R Bluestem	0.9			Sand Dropseed	0.2

District and Planting Dates *			Mixture for Use in Clay or Tight Soils		Mixture for Use in Sand or Sandy Soils	
22 (Laredo)			(Val Verde Co.)		(All Sections)	
Jan 15 -	Green Sprangletop	0.8	Green Sprangletop	1.4	Green Sprangletop	0.8
May 1	Rhodesgrass	0.5	Sideoats Grama	2.7	Bermudagrass	1.0
	Plains Bristlegr.	1.3	K-R Bluestem	1.1	Rhodesgrass	0.5
	Buffalograss	7.2	Buffalograss	9.0	Buffelgrass	1.3
	K-R Bluestem	0.9			Sand Dropseed	0.2
23 (Brownwood)	(All Sections)				(All Sections)	
Feb 1 -	Green Sprangletop	0.8			Green Sprangletop	0.7
May 15	Little Bluestem	1.6			Little Bluestem	1.2
	Sideoats Grama (Haskell)	2.5			Sideoats Grama (Haskell)	2.0
	Buffalograss	7.2			Bermudagrass	0.9
	K-R Bluestem	0.9			Sand Lovegrass	0.6
					Sand Dropseed	0.2
24 (El Paso)	(All Sections)				(All Sections)	
Feb 1 -	Green Sprangletop	0.8			Green Sprangletop	1.0
May 1	Black Grama	0.5			Black Grama	0.6
****	Blue Grama (Hachita)	0.7			Blue Grama (Hachita)	0.9
	Sideoats Grama (Tucson)	2.5			Sand Dropseed	0.3
	Sand Dropseed	0.2				
25 (Childress)	(All Sections)				(All Sections)	
Feb 1 -	Green Sprangletop	0.8			Green Sprangletop	0.8
May 15	Sideoats Grama (El Reno)	2.5			Sideoats Grama (El Reno)	2.5
**	Blue Grama (Lovington)	0.7			Blue Grama (Lovington)	0.7
	Buffalograss	7.2			Little Bluestem	1.6
	Western Wheatgr.	3.1			Sand Dropseed	0.2

* Planting dates are optima.
** In the seed mix, Western Wheatgrass must be sown between September 1 and February 28.
*** In the seed mix, use Woodward variety of Sand Bluestem in the Rolling Plains (including the Canadian River Valley), and Elida variety of Sand Bluestem in the High Plains.
**** In the seed mix, substitute Premier variety of Sideoats Grama in E. Brewster Co.

Table 3.
Urban Area Species-Specific Warm-Season Seeding Mixtures in Kilograms of Pure Live Seed Per Hectare, by District.

District and Planting Dates *	Mixture for Use in Clay or Tight Soils		Mixture for Use in Sand or Sandy Soils	
1 (Paris)	(All Sections)		(All Sections)	
Feb 1 - May 15	Green Sprangletop	1.9	Green Sprangletop	1.9
	Bermudagrass	2.6	Bermudagrass	2.6
2 (Ft. Worth)	(Eastern Sections)		(Western Sections)		(All Sections)	
Feb 1 - May 1	Green Sprangletop	1.0	Green Sprangletop	1.2	Green Sprangletop	1.2
	K-R Bluestem	1.1	K-R Bluestem	1.5	K-R Bluestem	1.5
	Bermudagrass	1.3	Buffalograss	12.0	Bermudagrass	1.7
	Buffalograss	9.0				
3 (Wichita Falls)	(Eastern Sections)		(Western Sections)		(All Sections)	
	Green Sprangletop	1.2	Green Sprangletop	1.0	Green Sprangletop	1.2
Feb 1 - May 1 **	Bermudagrass	1.7	Sideoats Grama (El Reno)	3.1	Bermudagrass	1.7
	Buffalograss	12.0	Western Wheatgr.	3.9	Sand Dropseed	0.5
			Buffalograss	9.0		

District and Planting Dates *	Mixture for Use in Clay or Tight Soils		Mixture for Use in Sand or Sandy Soils	
4 (Amarillo)	(All Sections)		(All Sections)	
Feb 15 - May 15	Green Sprangletop	1.0	Green Sprangletop	1.0
	Sideoats Grama (El Reno)	3.1	Sideoats Grama (El Reno)	3.1
	Blue Grama (Lovington)	0.9	Blue Grama (Lovington)	0.9
	Buffalograss	9.0	Sand Dropseed	0.4
5 (Lubbock)	(All Sections)		(All Sections)	
Feb 15 - May 15	Green Sprangletop	1.0	Green Sprangletop	1.0
	Sideoats Grama (El Reno)	3.1	Sideoats Grama (Coronado)	3.1
	Blue Grama (Lovington)	0.9	Blue Grama (Lovington)	0.9
	Buffalograss	9.0	Sand Dropseed	0.4
6 (Odessa)	(All Sections)		(All Sections)	
Feb 1 - May 15 ***	Green Sprangletop	1.0	Green Sprangletop	1.0
	Black Grama	0.6	Black Grama	0.6
	Blue Grama (Hachita)	0.9	Blue Grama (Hachita)	0.9
	Sideoats Grama	3.1	Sand Dropseed	0.3
7 (San Angelo)	(All Sections)		(All Sections)	
Feb 1 - May 1	Green Sprangletop	1.0	Green Sprangletop	1.0
	Buffalograss	9.0	K-R Bluestem	1.1
	K-R Bluestem	1.1	Sand Dropseed	0.3
	Sideoats Grama (Haskell)	3.1	Sideoats Grama (Haskell)	3.1

District and Planting Dates *			Mixture for Use in Clay or Tight Soils		Mixture for Use in Sand or Sandy Soils	
8 (Abilene)	(All Sections)				(All Sections)	
Feb 1 - May 15	Green Sprangletop	0.8			Green Sprangletop	1.0
	Buffalograss	7.2			Sand Dropseed	0.3
	Sideoats Grama (Haskell)	2.5			Sideoats Grama (Haskell)	3.1
	K-R Bluestem	0.9			K-R Bluestem	1.1
	Blue Grama (Hachita)	0.7				
9 (Waco)	(E. of IH 35)		(W. of IH 35)		(All Sections)	
Feb 1 - May 15	Green Sprangletop	1.0	Green Sprangletop	1.0	Green Sprangletop	0.8
	Bermudagrass	1.3	Sideoats Grama (Premier or Haskell)	3.1	Bermudagrass	1.0
	K-R Bluestem	1.1	K-R Bluestem	1.1	Sideoats Grama (Premier or Haskell)	2.5
	Buffalograss	9.0	Buffalograss	9.0	K-R Bluestem	0.9
					Sand Dropseed	0.2
10 (Tyler)	(All Sections)				(All Sections)	
Feb 1 - May 15	Green Sprangletop	1.9			Green Sprangletop	1.9
	Bermudagrass	2.6			Bermudagrass	2.6
11 (Lufkin)	(All Sections)				(All Sections)	
Feb 1 - May 15	Green Sprangletop	1.9			Green Sprangletop	1.9
	Bermudagrass	2.6			Bermudagrass	2.6
12 (Houston)	(All Sections)				(All Sections)	
Jan 15 - May 15	Green Sprangletop	1.2			Green Sprangletop	1.2
	Bermudagrass	1.7			Bermudagrass	1.7
	K-R Bluestem	1.5			K-R Bluestem	1.5
13 (Yoakum)	(All Sections)				(All Sections)	
Jan 15 - May 15	Green Sprangletop	1.2			Green Sprangletop	1.2
	Bermudagrass	1.7			Bermudagrass	1.7
	K-R Bluestem	1.5			K-R Bluestem	1.5

164.3

District and Planting Dates *		Mixture for Use in Clay or Tight Soils	Mixture for Use in Sand or Sandy Soils
14 (Austin)	(E. of IH 35)	(W. of IH 35)	(All Sections)

Feb 1 -	Green Sprangletop	1.0	Green Sprangletop	1.0	Green Sprangletop	1.0
May 15	Bermudagrass	1.3	Buffalograss	9.0	K-R Bluestem	1.1
	Buffalograss	9.0	K-R Bluestem	1.1	Bermudagrass	1.3
	Sideoats Grama	3.1	Sideoats Grama	3.1	Sand Lovegrass	0.9
	(Haskell)		(Haskell or Uvalde)			
15	(E. of U.S. 281)		(W. of U.S. 281)		(All Sections)	
(San Antonio)						
Feb 1 -	Green Sprangletop	1.2	Green Sprangletop	1.0	Green Sprangletop	1.2
May 1	Buffalograss	12.0	Sideoats Grama	3.1	Bermudagrass	1.7
	Bermudagrass	1.7	(Haskell or Uvalde)		Sideoats Grama	4.1
			Buffalograss	9.0	(Haskell or Uvalde)	
			Bermudagrass	1.3		
16	(E. of U.S. 77)		(W. of U.S. 77)		(All Sections)	
(Corpus Christi)						
Jan 15 -	Green Sprangletop	1.2	Green Sprangletop	1.0	Green Sprangletop	1.0
May 1	Bermudagrass	1.7	K-R Bluestem	1.1	Bermudagrass	1.3
	K-R Bluestem	1.5	Buffalograss	9.0	K-R Bluestem	1.1
			Bermudagrass	1.3	Sand Dropseed	0.3
17	(All Sections)				(All Sections)	
(Bryan)						
Feb 1 -	Green Sprangletop	1.2			Green Sprangletop	1.2
May 15	Bermudagrass	1.7			Bermudagrass	1.7
	K-R Bluestem	1.5			K-R Bluestem	1.5
18	(All Sections)				(All Sections)	
(Dallas)						
Feb 1 -	Green Sprangletop	1.2			Green Sprangletop	1.2
May 1	Bermudagrass	1.7			Bermudagrass	1.7
	Buffalograss	12.0			Sand Dropseed	0.5
19	(All Sections)				(All Sections)	
(Atlanta)						
Feb 1 -	Green Sprangletop	1.9			Green Sprangletop	1.9
May 15	Bermudagrass	2.6			Bermudagrass	2.6

164.3

District and Planting Dates *			Mixture for Use in Clay or Tight Soils		Mixture for Use in Sand or Sandy Soils	
20	(All Sections)				(All Sections)	
(Beaumont)						
Jan 15 -	Green Sprangletop	1.7			Green Sprangletop	1.7
May 15	Bermudagrass	1.3			Bermudagrass	1.3
21	(E. of U.S. 281)		(W. of U.S. 281)		(All Sections)	
(Pharr)						
Jan 15 -	Green Sprangletop	1.0	Green Sprangletop	1.0	Green Sprangletop	1.0
May 1	Bermudagrass	1.3	Sideoats Grama	3.1	Bermudagrass	1.3

	K-R Bluestem	1.1	(Premier or Uvalde)		K-R Bluestem	1.1
	Buffalograss	9.0	K-R Bluestem	1.1	Sand Dropseed	0.3
			Buffalograss	9.0		
22			(Val Verde Co.)		(All Sections)	
(Laredo)						
Jan 15 -	Green Sprangletop	1.0	Green Sprangletop	1.0	Green Sprangletop	1.0
May 1	Sideoats Grama	3.1	Sideoats Grama	3.1	Bermudagrass	1.3
	(Premier or Uvalde)		(Haskell or Uvalde)		K-R Bluestem	1.1
	K-R Bluestem	1.1	Buffalograss	9.0	Sand Dropseed	0.3
	Buffalograss	9.0	Bermudagrass	1.3		
23	(All Sections)				(All Sections)	
(Brownwood)						
Feb 1 -	Green Sprangletop	0.8			Green Sprangletop	0.8
May 15	Buffalograss	7.2			K-R Bluestem	0.9
	K-R Bluestem	0.9			Bermudagrass	1.0
	Sideoats Grama	2.5			Sideoats Grama	2.5
	(Haskell)				(Haskell)	
	Bermudagrass	1.0			Sand Dropseed	0.2
24	(All Sections)				(All Sections)	
(El Paso)						
Feb 1 -	Green Sprangletop	0.8			Green Sprangletop	1.0
May 1	Black Grama	0.5			Black Grama	0.6
****	Blue Grama	0.7			Blue Grama	0.9
	Sideoats Grama	2.5			Sand Dropseed	0.3
	(Tucson)					
	Sand Dropseed	0.2				

District and Planting Dates *	Mixture for Use in Clay or Tight Soils		Mixture for Use in Sand or Sandy Soils	
25 (Childress)	(All Sections)		(All Sections)	
Feb 1 - May 15 **	Green Sprangletop	0.8	Green Sprangletop	0.8
	Sideoats Grama (El Reno)	2.5	Sideoats Grama (El Reno)	2.5
	Blue Grama (Lovington)	0.7	Blue Grama (Lovington)	0.7
	Western Wheatgr.	3.1	Western Wheatgr.	3.1
	Buffalograss	7.2	Sand Dropseed	0.2

* Planting dates are optima.

** In the seed mix, Western Wheatgrass must be sown between September 1 and February 28.

*** North of Pecos River use either Premier or Uvalde varieties of Sideoats Grama in the seed mix. South of the Pecos River use either Premier or Tucson varieties in the seed mix.

**** In the seed mix, substitute Premier variety of Sideoats Grama in E. Brewster County.

(2) Broadcast Seeding. The seed or seed mixture, in the quantity specified, shall be uniformly distributed over the areas shown on the plans or where directed by the Engineer. If the sowing of seed is by hand, rather than by mechanical methods, the seed shall be sown in two directions at right angles to each other. If mechanical equipment is used, all varieties of seed as well as fertilizer, may be distributed simultaneously provided that each component is uniformly applied at the specified rate. When seed and fertilizer are to be distributed as a water slurry, the mixture shall be applied to the area to be seeded within 30 minutes after components are placed in the equipment. After planting, the planted area shall be rolled with a light corrugated drum roller or another type of roller approved by the Engineer. All rolling of the sloped areas shall be along the contour of the slopes.

(3) Straw or Hay Mulch Seeding. The seed or seed mixture, in the quantity specified, shall be uniformly distributed over the areas shown on the plans or where directed by the Engineer. If the sowing of seed is by hand, rather than by mechanical methods, the seed shall be sown in two directions at right angles to each other. If mechanical equipment is used, all varieties of seed, as well as fertilizer, may be distributed simultaneously

provided that each component is uniformly applied at the specified rate. When seed and fertilizer are to be distributed as a water slurry, the mixture shall be applied to the area to be seeded within 30 minutes after all components are placed in the equipment.

Immediately upon completion of planting of the seed, straw or hay mulch shall be spread uniformly over the seeded area at the rate of approximately 3.4 to 4.5 megagrams of hay mulch or 4.5 to 5.6 megagrams of straw mulch per hectare. When a mulching machine is used it must be approved by the Engineer and may be equipped to inject a tacking agent into the straw or hay mulch uniformly as it leaves the equipment at a rate of 0.25 to 0.5 liter of tacking agent per square meter of mulched area. When the tacking agent is placed by hand, then the rate of application for the tacking agent shall be approximately 0.7 liter per square meter.

(4) Cellulose Fiber Mulch Seeding. The seed or seed mixture, in the quantity specified, shall be uniformly distributed over the areas shown on the plans or where directed by the Engineer. If the sowing of seed is by hand, rather than by mechanical methods, the seed shall be sown in two directions at right angles to each other. If mechanical equipment is used all varieties of seed, as well as fertilizer, may be distributed simultaneously, provided that each component is uniformly applied at the specified rate. When seed and fertilizer are to be distributed as a water slurry, the mixture shall be applied to that area to be seeded within 30 minutes after all components are placed in the equipment.

Immediately upon completion of planting of the seed, cellulose fiber mulch shall be spread uniformly over the seeded area at the following rates:

Sandy soils with 1:3 slope or less - min. 2.3 Mg/ha
Sandy soils with greater than 1:3 slope - min. 2.6 Mg/ha
Clay soils with 1:3 slope or less - min. 2.8 Mg/ha
Clay soils with greater than 1:3 slope - min. 3.4 Mg/ha

Cellulose fiber mulch rates are based on dry mass of mulch per hectare. When used, a mulching machine, approved by the Engineer, shall be equipped to eject the thoroughly wet mulch material at a uniform rate to provide the mulch coverage specified.

(5) Drill Seeding. The seed or seed mixture, in the quantity specified, shall be uniformly distributed over the areas shown on the plans or where directed by the Engineer. All varieties of seed, as well as fertilizer, may be distributed simultaneously provided that each component

is uniformly applied at the specified rate. Seed shall be drilled at a depth of from five (5) to ten (10) millimeters utilizing a pasture or rangeland type drill. All drilling shall be along the contour of the slope. After planting, the area shall be rolled with a roller integral to the seed drill, or a light corrugated drum roller or with another type of roller approved by the Engineer. All rolling of sloped areas shall be on the contour of the slopes.

(6) Straw or Hay Mulching. Mulch shall be spread uniformly over the area indicated on plans or as designated by the Engineer at the rate of approximately 3.4 to 4.5 megagrams of hay mulch or 4.5 to 5.6 megagrams of straw mulch per hectare. When used, a mulching machine approved by the Engineer shall be equipped to inject a tacking agent into the straw or hay mulch uniformly as it leaves the equipment at a rate of 0.25 to 0.5 liter of tacking agent per square meter of mulched area. If the straw or hay mulch and tacking agent are placed by hand, then the rate of application for the tacking agent shall be approximately 0.7 liter per square meter.

(7) Soil Retention Blanket. If specified on the plans, a soil retention blanket shall be applied in accordance with Item 169, "Soil Retention Blanket".

(8) Watering. Watering of the seeded area shall be conducted when, in the judgement of the Engineer, sufficient seedling survival is threatened by insufficient natural precipitation and shall be in accordance with Item 168, "Vegetative Watering".

(9) Fertilizer. Fertilizer, when required, shall be applied in accordance with Item 166, "Fertilizer".

164.4. Seeding for Cool Season Temporary Erosion Control.

(1) Standard Seeding. When specified on the plans or directed by the Engineer, temporary erosion control measures shall be performed. These measures shall consist of the sowing of seed mixtures appropriate for the season and the work and materials as required in Article 164.3. These measures shall be performed over the areas shown on the plans or where directed by the Engineer. Temporary erosion control measures shall be performed in addition to other "Seeding for Erosion Control" as herein specified. The pure live seed, of the cool season plants, planted per hectare shall be of the type specified, with the mixture, rate and planting dates as follows in Tables 4A and 4B, except as shown on the plans.

Table 4A.
Cool Season Grass Seeding Mixtures for Temporary Erosion Control, in Kilograms of Pure Live Seed per Hectare, by District.

Districts & Optimum Planting Dates	Common Name	Rate
Paris (1), Fort Worth (2), Wichita Falls (3), Amarillo (4),	Tall Fescue	4.5
Lubbock (5), Abilene (8), Dallas (18), Brownwood (23),	Western Wheatgrass	5.6
Childress (25)	Wheat (Red, Winter)	33.6
August 15 - November 30		
Odessa (6), San Angelo (7), El Paso (24)	Western Wheatgrass	8.4
August 15 - November 30	Wheat (Red, Winter)	50.4
Waco (9), Tyler (10), Lufkin (11), Austin (14),	Tall Fescue	4.5
San Antonio (15), Bryan (17), Atlanta (19)	Oats	23.5*
September 1 - November 30	Wheat (Red, Winter)	33.6
Houston (12), Yoakum (13), Corpus Christi (16),	Oats	71.7*
Beaumont (20), Pharr (21), Laredo (22)		
September 1 - November 30		

* May substitute Barley at 80.6 kg/ha divided by the number of species in the mix.

(2) Legume Seeding. When specified on the plans or directed by the Engineer, the following regionally adapted legumes shall be planted.

Table 4B.
Cool Season Legume Seeding for Temporary Erosion Control, in Kilograms of Pure Live Seed per Hectare, by District.

Districts & Optimum Planting Dates	Common Name	Rate
Paris (1), Fort Worth (2), Wichita Falls (3), Waco (9),	Crimson Clover	7.8
Tyler (10), Lufkin (11), Houston (12), Bryan (17),		
Dallas (18), Atlanta (19), Beaumont (20)		
August 15 - November 30		
Yoakum (13), Austin (14), San Antonio (15),	Hairy Vetch	9.0
Corpus Christi (16), Pharr (21), Laredo (22)		
September 1 - November 30		

Amarillo (4), Lubbock (5), Odessa (6), San Angelo (7), Abilene (8), Brownwood (23), El Paso (24), Childress (25) August 15 - November 30	Yellow Sweetclover	4.5

164.5. Seeding for Warm Season Temporary Erosion Control.

(1) Standard Seeding. When specified on the plans or directed by the Engineer, temporary erosion control measures shall be performed. This measure shall consist of the sowing of seed appropriate for the season and the work and materials as required in Article 164.3. These measures shall be performed over the areas shown on the plans or where directed by the Engineer. Temporary erosion control measures shall be performed in addition to other "Seeding for Erosion Control" as herein specified. The pure live seed planted per hectare shall be of the type specified, rate and seed planting date as follows in Table 5 except as shown on the plans.

Table 5.
Warm Season Seeding for Temporary Erosion Control, in Kilograms of Pure Live Seed per Hectare, by District.

Districts & Optimum Planting Dates	Common Name	Rate
Fort Worth (2), Wichita Falls (3), San Angelo (7), San Antonio (15), Corpus Christi (16), Dallas (18), Pharr (21), Laredo (22), El Paso (24) May 1 - August 31	Foxtail Millet	33.6
Paris (1), Amarillo (4), Lubbock (5), Odessa (6), Abilene (8), Waco (9), Tyler (10), Lufkin (11), Houston (12), Yoakum (13), Austin (14), Bryan (17), Atlanta (19), Beaumont (20), Brownwood (23), Childress (25) May 15 - August 31	Foxtail Millet	33.6

164.6. Measurement. "Straw or Hay Mulch" will be measured by the square meter or by the hectare, complete and in place.

All "Seeding", of the type specified, will be measured by the square meter or by the hectare, complete and in place.

164.7. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will

be paid for at the unit price bid for "Broadcast Seeding", "Straw or Hay Mulch Seeding", "Cellulose Fiber Mulch Seeding", "Drill Seeding", "Straw or Hay Mulching", "Standard Seeding for Cool Season Temporary Erosion Control", "Legume Seeding for Temporary Erosion Control" or "Standard Seeding for Warm Season Temporary Erosion Control", of the common names specified. This price will be full compensation for furnishing all materials, including water for seed-fertilizer slurry and

hydraulic mulching, tacking agents if required, and for performing all operations necessary to complete the work.

Unless otherwise shown on the plans, fertilizer will not be paid for directly, but will be considered subsidiary work pertaining to this Item.

"Soil Retention Blanket" will be paid for under Item 169, "Soil Retention Blanket".

Water for irrigating the cultivated area or seedbed, when required, will be paid for under Item 168, "Vegetative Watering".

ITEM 166

FERTILIZER

166.1. Description. This Item shall govern for providing and distributing fertilizer over such areas as designated on the plans and in accordance with these specifications.

166.2. Materials. All fertilizer shall be delivered in bags or containers clearly labeled showing the analysis. The figures in the analysis represent the percent of nitrogen, phosphoric acid, and potash nutrients, respectively, as determined by the methods of the Association of Official Analytical Chemists. The fertilizer is subject to testing by the Texas A&M Feed and Fertilizer Control Service in accordance with the Texas Fertilizer Law.

The fertilizer shall have the analysis shown on the plans. The Contractor shall have the option of providing a fertilizer of a different analysis, if approved by the Engineer. However, the amount of each nutrient specified shall not be less than that shown on the plans.

166.3. Construction Methods. Fertilizer shall be in an acceptable condition for distribution and shall be applied uniformly over the specified area and at the rate shown on the plans. Distribution of fertilizer for the particular item of work shall be approved by the Engineer.

166.4. Measurement. When Fertilizer is specified on the plans to be a pay item, work and acceptable material for "Fertilizer" will be measured by the

megagram as determined by approved scales or guaranteed mass of bags or containers as shown by the manufacturer.

166.5. Payment. Unless otherwise specified on the plans, the work performed and materials furnished in accordance with this Item will not be paid for directly but will be considered subsidiary to the various bid items of the contract.

When fertilizer is specified on the plans to be a pay item, the work performed and materials furnished and measured as provided under "Measurement" will be paid for at the unit price bid for "Fertilizer", of the analysis specified. This price shall be full compensation for furnishing all materials and performing all operations necessary to complete the work.

ITEM 168

VEGETATIVE WATERING

168.1. Description. This Item shall govern for the authorized application of water through an aboveground system to promote and sustain growth of grasses and other plants on those portions of the right of way as shown on the plans or as directed by the Engineer, and in accordance with this Item.

168.2. Materials. Water shall be furnished by the Contractor and shall be clean and free of industrial wastes and other substances harmful to the growth of vegetation.

168.3. Construction Methods. This work shall be done only at such time as directed by the Engineer. The Contractor shall furnish and operate watering equipment approved by the Engineer which will insure the distribution of water in a uniform and controllable rate of application. The Contractor shall apply the water in the required quantity where shown on the plans or as directed by the Engineer.

168.4. Measurement. This Item will be measured by the kiloliter as delivered on the designated areas.

168.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will

be paid for at the unit price bid for "Vegetative Watering". This price shall be full compensation for furnishing and operating approved watering equipment and measuring devices and for furnishing and applying the water as directed including hauling, equipment, labor and incidentals necessary to complete the work.

169.1 to 169.2

ITEM 169

SOIL RETENTION BLANKET

169.1. Description. This Item shall govern for providing and placing wood, straw or coconut fiber mat, synthetic mat, paper mat, jute mesh or other material as a soil retention blanket for erosion control on slopes or ditches or for short-term or long-term protection of seeded or sodded areas as shown on the plans or as specified by the Engineer.

169.2. Materials.

(1) Soil Retention Blankets. All soil retention blankets must be prequalified by the Director of Construction and Maintenance prior to use.

Prequalification procedures and a current list of prequalified materials may be obtained by writing to the Director of Construction and Maintenance, 125 East 11th Street, Austin, Texas 78701-2483. A 300 millimeters x 300 millimeters sample of the material may be required by the Engineer in order to verify prequalification. Samples taken, accompanied by the manufacturer's literature, will be sent, properly wrapped and identified, to the Construction and Maintenance Division for verification.

The soil retention blanket shall be one (1) of the following classes and types as shown on plans:

(a) Class 1. "Slope Protection"

(i) Type A. Slopes 1:3 or flatter - Clay soils

(ii) Type B. Slopes 1:3 or flatter - Sandy soils

(iii) Type C. Slopes steeper than 1:3 - Clay soils

(iv) **Type D.** Slopes steeper than 1:3 - Sandy soils

(b) **Class 2.** "Flexible Channel Liner"

(i) **Type E.** Short-term duration (Up to 2 years)
Shear Stress (t_d) < 48 Pa

(ii) **Type F.** Short-term duration (Up to 2 years)
Shear Stress (t_d) 48 to 96 Pa

(iii) **Type G.** Long-term duration (Longer than 2 years)
Shear Stress (t_d) > 96 to < 239 Pa

(iv) **Type H.** Long-term duration (Longer than 2 years)
Shear Stress (t_d) $\geq$ 239 Pa

(2) Fasteners. Fasteners shall conform to the requirements shown on Standard Detail Sheet "Soil Retention Blanket (SRB)".

169.3. Construction Methods.

(1) General. The soil retention blanket shall conform to the class and type shown on the plans. The Contractor has the option of selecting an approved soil retention blanket conforming to the class and type shown on the plans and according to the current approved material list.

(2) Installation. The soil retention blanket, whether installed as slope protection or as flexible channel liner in accordance with the approved materials list, shall be placed within 24 hours after seeding or sodding operations have been completed, or as approved by the Engineer. Prior to placing the blanket, the area to be covered shall be relatively free of all rocks or clods over 40 millimeters in maximum dimension and all sticks or other foreign material which will prevent the close contact of the blanket with the soil. The area shall be smooth and free of ruts and other depressions. If as a result of rain, the prepared bed becomes crusted or eroded or if any eroded places, ruts or depressions exist for any reason, the Contractor shall be required to rework the soil until it is smooth and to reseed or resod the area at the Contractor's expense.

Installation and anchorage of the soil retention blanket shall be in

accordance with the Manufacturer's recommendations and the Standard Detail Sheet "Soil Retention Blanket (SRB)".

(3) Literature. The Contractor shall submit one (1) full set of manufacturer's literature and manufacturer's installation recommendations for the soil retention blanket selected in accordance with the approved material list.

169.4. Measurement. This Item will be measured by the square meter of surface area covered.

169.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" 170.1 to 170.3

will be paid for at the unit price bid for "Soil Retention Blanket" of the class and type shown on the plans. This price shall be full compensation for furnishing all materials, labor, tools, equipment and incidentals necessary to complete the work. Anchors, checks, terminals or junction slots, and wire staples or wood stakes will not be paid for directly but will be considered subsidiary to this Item.

ITEM 170

IRRIGATION SYSTEM

170.1. Description. This Item shall govern for constructing an irrigation system as shown on the plans and as approved by the Engineer.

170.2. General.

License Requirements. The Contractor shall be required to possess an irrigator's license issued by the Texas Board of Irrigators or employ such a licensed irrigator to construct the irrigation system. The Engineer may require documentation of such license for his records. The irrigation system shall be installed and maintained under the supervision of the licensed irrigator who must be on the site at all times during this work or at such times as required by the Engineer.

170.3. Materials. Materials shall conform to the requirements shown on the plans and to the following requirements.

(1) Irrigation Pipe. Irrigation pipe shall be polyvinyl chloride (PVC)

conforming to ASTM D 1785, Schedule 40 or ASTM D 2241, SDR 13.5 or SDR 17 or SDR 21, as shown on the plans.

(2) Fittings. Fittings, not including valves or sprinkler heads, shall conform to ASTM D 2466.

(3) Encasement Pipe. Unless otherwise shown on the plans and specifications, encasement pipe shall be PVC conforming to ASTM D 1785, Schedule 40.

(4) Bentonite Slurry. The slurry shall be a viscous mixture of a commercial bentonite and fresh water. The slurry shall contain two (2) to eight (8) percent of the bentonite additive by mass.

(5) Miscellaneous Accessories. Accessory material, such as valves, sprinkler heads or backflow preventers shall meet the requirements shown on the plans.

170.4. Equipment.

(1) General. The machinery, tools, and equipment necessary for proper prosecution of the work shall be on the project and approved by the Engineer prior to beginning the work.

All machinery, tools, and equipment used shall be maintained in a satisfactory working condition.

(2) Boring and Water Jetting Equipment. A boring machine or jetting equipment shall be capable of boring or jetting the lengths shown on plans in one direction only. The equipment shall be capable of maintaining horizontal and vertical alignment to an accuracy of 25 millimeters in three (3) meters.

170.5. Construction Methods.

(1) Site Preparation. The limits of work shall include the area(s) shown on the plans. All operations shall be confined to these areas and such other areas of the right of way that may be required to gain access to the site(s) shown on the plans. The contractor shall vary access routes across the right of way as far as possible, to prevent any damage to slopes and existing vegetation.

The contractor shall be responsible for the repair and replacement of slopes and vegetation damaged by construction operations.

(2) Site Amenities and Protection. During the execution of the work, utmost care shall be exercised to prevent damage to any utilities, structures, right of way or other site amenities.

The Contractor shall not repair or service any equipment or perform any operations on the right of way which will in any way mar the landscape by rendering the soil sterile, damage existing vegetation or which may have an adverse effect on the proposed use of the land. The Contractor shall be responsible for maintaining the work site in a neat appearance and safe condition at all times.

(3) Excavation and Trenching. Excavation and trenching shall be performed in accordance with the plans and specifications. Unless otherwise shown on the plans, trenches shall be of sufficient depth to

provide for a minimum of 450 millimeters of cover for all lines. Common trenches for irrigation lines shall be utilized wherever feasible.

(4) Boring. All boring shall be performed at the locations shown on the plans or as approved by the Engineer.

(5) Trench Protection. Excavation for trenches and/or boring pits in excess of 1.5 meters in depth shall be protected as shown in Item 402, "Trench Excavation Protection", or Item 403, "Temporary Special Shoring".

Where pipe is required to be installed under roadways or other facilities by boring, construction shall be performed in such a manner that it will not weaken or damage the roadway or other facilities. The use of water or other fluids in connection with the boring operation will be permitted only to the extent to lubricate cuttings; jetting will not be permitted.

In unconsolidated soil formations, a bentonite slurry may be used to consolidate cuttings of the bit, seal the walls of the hole and furnish lubrication for subsequent removal of cuttings and installation of the pipe immediately thereafter.

(6) Water Jetting. Water jetting will be allowed only when shown on

the plans or approved in writing by the Engineer.

When jetting operations fail to produce a smooth stable hole, operations shall cease and all necessary work will be completed by boring.

All damage caused by improper or incorrect jetting shall be corrected at the Contractor's expense.

(7) Encasement. The lines shall be encased at locations as shown on the plans. The inside diameter of the casing pipe shall be not less than 25 millimeters nor more than 75 millimeters larger than the outside diameter of the irrigation line. A minimum of 600 millimeters of cover shall be provided for encasement pipe under paved areas and a minimum of 450 millimeters of cover for encasement pipe placed under sidewalks, non-loadbearing slabs, or other unpaved areas.

(8) Pipe and Valve Assembly. Pipe and fittings of the size shown on the plans shall be assembled as recommended by the manufacturer(s) and as approved by the Engineer. Pipe and fittings shall be thoroughly cleaned

170.5

of all dust, dirt and moisture before assembly. Solvent shall be applied with a non-synthetic bristle brush. All connections between plastic pipe and metal valves shall be made with threaded fittings and plastic adapters.

Backflow assemblies shall be installed as shown on the plans or as required by ordinances of local public entities.

Control valves shall be installed in valve boxes as shown on the plans and shall be grouped together where practical. Valves and pipelines shall be installed no closer than 300 millimeters from sidewalk edges, buildings, and walls.

(9) Sprinkler Heads. Sprinkler heads shall be installed at locations shown on the plans and in accordance with the Manufacturer's recommendations.

(10) Closing of Pipe and Flushing of Lines. The lines shall be capped or plugged immediately after installation to prevent the entrance of materials which would obstruct the pipe. The caps or plugs shall be left in place until removal is necessary for the completion of the installation. All water lines shall

be thoroughly flushed before installing heads or valves.

(11) Hydrostatic Tests. The Contractor shall request the presence of the Engineer in writing at least 48 hours in advance of testing. All preliminary testing shall be accomplished in the presence of the Engineer. All piping to be tested shall be center loaded with small amounts of backfill to prevent arching or slipping while under pressure. A continuous and static water pressure of 700 kilopascals minimum shall be applied after all welded plastic joints have been allowed to cure at least 24 hours. With all valves closed, the preliminary testing for all main and lateral lines from the meter to the valves shall be performed for a minimum of two (2) consecutive hours. Any leaks which occur during the preliminary test period shall be repaired immediately following the test. The lines shall then be retested until approved by the Engineer. Before final approval, the lines shall remain under designated static pressure for a period of 48 hours without leaks for the final test. The Contractor shall supply the pressuring equipment and all other test equipment.

(12) Backfill and Compaction. After the irrigation system is fully operational and all required tests and inspections have been performed and approved, the excavations and trenches shall be backfilled with layers of clean soil, free of rubbish and large rocks, and as approved by the Engineer. Each layer shall not exceed 200 millimeters of loose depth and

shall be compacted until uniform compaction is obtained as approved by the Engineer. All areas shall be smoothed and dressed to final grade and to the approval of the Engineer.

170.6. Measurement. This Item will be measured by the lump sum unit, complete in place.

170.7. Payment. The work performed and the materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Irrigation System". This price shall be full compensation for furnishing and assembling all pipe, fittings, valves and sprinkler heads; for all site preparation, excavation, sheeting and/or bracing of excavations up to 1.5 meters in depth, backfilling and boring; for flushing of lines and hydrostatic testing; and for all other materials, labor, tools, equipment and incidentals necessary to complete the work except that protection methods for excavations greater than 1.5 meters in depth shall be measured and paid for as required under Item 402, "Trench Excavation Protection", or Item 403,

"Temporary Special Shoring".

ITEM 180

WILDFLOWER SEEDING

180.1. Description. This Item shall govern for ground preparation, supplying and sowing of specified wildflower seed, as designated on the plans and in accordance with this Item.

180.2. Materials. All seed shall meet the requirements of the Texas Seed Law including the testing and labeling for pure live seed (PLS=purity x germination), name, and type of seed. All seed shall be tested in a certified seed laboratory with certified results submitted to the Engineer in writing prior to planting. All seed shall be of the previous season's crop and the date of the analysis shown on the container shall be within the past twelve months of the time of use on this project. Each variety of seed shall be supplied and delivered to the job site in separate bags or containers unless otherwise approved by the Engineer.

180.3. Equipment. All equipment shall be as shown on the plans or as approved by the Engineer. All equipment used on the right of way in relation to the wildflower seeding operation shall use pneumatic tires unless otherwise approved by the Engineer.

180.4 to 192.2

180.4. Construction Methods. The areas designated as wildflower planting areas shall be scalp mowed to an approximate height of 25 millimeters above the existing ground level and all cut material removed and disposed of as approved by the Engineer.

The amount and type of seed planting per hectare shall be as shown on the plans. Seed shall be sown in rates based on PLS per hectare according to the plans. The seed or seed mixture shall be uniformly and evenly distributed over the areas shown on the plans or as approved by the Engineer. The sowing method used shall insure that the seed makes positive contact with the soil. Hydro-seeding will not be permitted as a method of distribution.

180.5. Measurement. This Item will be measured by the hectare, complete in place.

180.6. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Wildflower Seeding". This price shall be full compensation for supplying all seed, labor, tools, equipment, and incidentals, and for performing all operations necessary to complete the work.

ITEM 192

ROADSIDE PLANTING AND ESTABLISHMENT

192.1. Description. This Item shall govern for providing the specified plants and other materials, the initial installation of plants and other materials, any required repair or replacement of plants and other materials and establishment thereof as shown on the plans.

192.2. General.

(1) Plant Standards. Unless shown on the plans, the following published standards will apply. Standards for nursery stock will be as stated in the "American Standard for Nursery Stock", as published by the American Association of Nurserymen, Incorporated. Botanical names as shown on the plans will be as stated in the "Standardized Plant Names" by the American Joint Committee on Horticultural Nomenclature. Pruning standards will be as set forth by the National Arborist Association in the "Pruning Standards for Shade Trees".

192.3

(2) License Requirements.

(a) Pesticide. The Contractor shall be a licensed pesticide applicator or employ a licensed pesticide applicator for the treatment of insects, diseases, and animals as required by the Texas Pesticide Laws and Regulations of the Texas Department of Agriculture. The Engineer may require documentation of such certification as necessary for his records.

(b) Herbicide. The Contractor shall possess a permit or employ a person who possesses a permit to apply herbicide as required by the Texas Herbicide Law of the Texas Department of Agriculture. The Engineer may require documentation of such certification as necessary for his records.

(c) Irrigation. The Contractor shall possess an irrigator's license issued by the State of Texas and the Texas Board of Irrigators or employ such a licensed irrigator to perform the irrigation system maintenance. The irrigation system shall be maintained under the supervision of the licensed irrigator who shall be available on the site as required by the Engineer.

The Engineer may require documentation of such license for his records. The Contractor shall verify and adhere to the requirements and codes of any controlling utility authorities.

192.3. Materials.

(1) Preservation of Cultural Resources. When it is necessary to obtain material sources off the right of way, the Contractor's attention is directed to Article 7.17.

(2) Plant Material. All plants shall be healthy nursery grown stock unless otherwise shown on the plans. Nursery grown stock, either in containers or in the field, shall be nursery grown in accordance with accepted horticultural practices and under climatic conditions similar to those of the project site for at least twelve (12) months, unless specifically authorized otherwise by the Engineer.

(a) Container Plants. Soil volume for containers shall be three-fourths (3/4) the depth of the container or greater and contain roots of the plant throughout the root ball.

(i) Containerized Stock. This stock will be defined as nursery plant stock transplanted from a growing site with a ball of soil, containing the root system, left intact and placed into a container and grown in that

container continuously long enough for the new fibrous roots to have developed so that the root mass retains its shape and holds together after removal from the container. Containerized stock shall have been grown in the delivered containers for at least six (6) months, but not over two (2) years.

(ii) Container Grown Stock. This stock will be defined as nursery plant stock which has been planted in a container as a liner, seed or by other propagation method, and which has been systematically replanted or stepped up

in larger containers as required, and which has developed a root system in a planting medium capable of sustaining acceptable plant growth, and which has become established in the container and exhibits a well rooted condition as evidenced by the soil ball remaining intact when removed from its container.

(b) Balled and Burlapped Stock. This stock will be defined as nursery plant stock which has been removed from the growing site with a ball of soil, containing the root system, left intact and encased in burlap (or other approved similar material) to hold the soil in place. Ball sizes for balled and burlapped stock shall be as shown on the plans.

(c) Bare Root Stock. This stock will be defined as nursery plant stock which has been removed from the growing site with the root system substantially free of soil. Bare root stock shall have a well-branched root system, characteristic of the species. The approved minimum root spread and condition shall be as shown on the plans.

(d) Collected Stock. This stock will be defined as plant stock which has been removed from its original native habitat. All collected stock shall have specific approval of the Engineer before it can be removed from its existing habitat. This shall include on site visual inspection, acceptance and tagging. Tags shall be furnished by the Contractor. Ball sizes for collected stock shall be as shown on the plans, and shall be of such a diameter and depth to encompass enough fibrous and feeding root system as necessary for the full recovery of the plant. Collection may be by hand or mechanical method. For balled and burlapped or mechanical transplanting of collected plant materials refer to Article 192.4.

(e) Bag Grown Stock. This stock will be defined as nursery plant stock transplanted into a nonwoven fabric container which has been placed in the ground and the plant grown under nursery field conditions continuously long enough (normally one (1) month for each 25 millimeters of bag diameter, i.e., a plant with a 600 millimeter diameter bag, grown in **192.3**

its original planted location for 24 months) for the fibrous roots to have developed so that the root mass retains its shape and holds together after removal of the bag. The root ball shall be flat bottomed and straight sided. Ball sizes for bag grown stock shall be as shown on the plans. Bag grown stock shall not be pruned before delivery.

(f) Other Plant Materials. Other plant materials shall be as shown on

the plans.

(3) Plant Size. Plants will be measured when branches are in their normal position. Height and spread dimensions as shown on the plans, refer to the main body of the plant and not branch tip to tip. Plants having a spreading or semispreading habit will be measured by the average diameter of the spread. Plant heights will be measured by the mean height.

Caliper measurements will be taken at a point on the trunk 150 millimeters above natural ground line for trees up to 100 millimeters in caliper and at a point 300 millimeters above natural ground line for trees over 100 millimeters in caliper. The caliper size for multi-trunked plants will be determined by adding the calipers of the largest cane and one-half (1/2) the caliper(s) of the second and third largest cane(s).

When a range of size is shown on the plans, no plant shall be less than the minimum size and at least 40 percent of the plants shall be as large as the maximum size shown on the plans. The required measurements are the minimum sizes acceptable and are the measurements after pruning, when pruning is required.

Sizes of plants or plant types such as palms, roses, vines, groundcovers, seedings, bulbs, corms, tubers, young plants, understock, etc. will be measured in accordance with the plant standards or as shown on the plans.

(4) Rejection of Plants. Plant material having any of the following features will be subject to rejection:

1. An excessive amount of abrasions of the bark;
2. Dried or damaged root system;
3. Dried or damaged top wood of deciduous plants, or dried or damaged foliage and top wood of evergreens;
4. Prematurely opened or damaged buds;
5. Disease or insect infestation, including eggs or larvae;

192.3

6. Dry, loose, cracked, broken, and/or undersized balls or containers which do not conform to the sizes shown on the plans;
7. Evidence of heating, molding, freezing, wind burn, sunscald, etc.;
8. Container plants that are overgrown or root-bound;

9. Plants with bench balls (roots repacked with soil);
10. Plant balls encased in nonbiodegradable plastic or other impervious material;
11. Field grown or collected plants transplanted into containers less than six (6) months or more than two (2) years;
12. Trees which have damaged, pruned, crooked or multiple leaders, unless multiple leaders are specified or are normal for the species;
13. Plants with disfiguring knots or fresh cuts of limbs over 20 millimeters that have not completely calloused;
14. Plants that do not possess a normal balance between height and spread for the species;
15. Plant containers that are not structurally sound (cracked, bent, etc.)
16. Plants in containers with less than three-fourths (3/4) planting medium depth;
17. Any endangered or threatened plants; or plants of historical significance that have been collected;
18. Any other physical damage or adverse conditions that would prevent thriving growth or cause an unacceptable appearance; or
19. Plants that do not meet the standards shown on the plans.

(5) Mulch. Unless otherwise shown on the plans, mulch material shall consist of loose organic residue derived from plants or granular material as approved by the Engineer. It shall be of such nature that adequate protection is provided against sun baking and quick drying of the soil, and shall not impede aeration or water penetration nor deplete the soil nitrogen. Mulch material shall be free of excess amounts of large leaves and sticks that would prevent proper dressing of the mulched surface, free of harmful substances and free of detrimental amounts of soil or other foreign matter that would promote early compaction, matting or deterioration of the mulch.

(6) Peat Moss. Peat moss shall be of sphagnum origin.

192.3

(7) Backfill. Backfill shall be a loose friable sterilized material secured from an approved source. It shall be virtually free of reproductive parts of noxious weeds and shall be thoroughly mixed in the proportions shown on the plans. When shown on the plans, material excavated from the planting pit (excluding any rocks) may be used as backfill.

(8) Nursery Plant Containers. The sizes and volumes for the more common larger containers shall be as shown in Tables 1A and 1B:

TABLE 1A
POT SIZES

Container Name	Container Class	Minimum Vertical Depth	Minimum Inside Top Diameter	Minimum Inside Bottom Diameter	Minimum True Volume Liters
1	1 gallon	150 mm	150 mm	125 mm	2.3
2	2 gallon	190 mm	190 mm	165 mm	4.7
3	3 gallon	215 mm	240 mm	215 mm	8.8
4	4 gallon	265 mm	245 mm	220 mm	11.5
5	5 gallon	275 mm	245 mm	220 mm	12.1
7	7 gallon	275 mm	310 mm	275 mm	19.1
10	10 gallon	355 mm	355 mm	330 mm	32.8
15	15 gallon	380 mm	380 mm	340 mm	39.2
20	20 gallon	405 mm	465 mm	405 mm	61.2
25	25 gallon	405 mm	555 mm	440 mm	80.2
30	30 gallon	430 mm	555 mm	480 mm	91.8
45	45 gallon	440 mm	760 mm	595 mm	161.1
50	50 gallon	505 mm	735 mm	580 mm	174.1
55	55 gallon	555 mm	735 mm	580 mm	193.0
65	65 gallon	555 mm	785 mm	660 mm	229.9
95	95 gallon	580 mm	935 mm	785 mm	342.1
100	100 gallon	580 mm	910 mm	760 mm	321.7
200	200 gallon	710 mm	1,215 mm	1,015 mm	697.5

TABLE 1B
BOX SIZES

Nominal Box Size (Approx. Inside Square Top Dimensions)	Approx. Vertical Depth	Approx. Inside Square Bottom Dimensions	Approx. True Volume Liters
350 mm box	300 mm	300 mm	33
500 mm box	450 mm	400 mm	94
600 mm box	550 mm	500 mm	174
760 mm box	680 mm	600 mm	321
910 mm box	810 mm	760 mm	567
1,060 mm box	810 mm	760 mm	681
1,200 mm box	910 mm	910 mm	1,040
1,520 mm box	1,060 mm	1,060 mm	1,797

Any container that does not meet the minimum specifications for pots or the approximate specifications for boxes as shown in Tables 1A and 1B will be considered unclassified and must be approved by the Engineer prior to plant installation.

(9) Water. Water shall conform to the requirements of Article 168.2.

(10) Supports. Plant supports shall be of the type shown on the plans.

(11) Flagging Tape. Flagging tape shall be highly reflective, visible at night, and approved by the Engineer.

(12) Tree Wrapping. Tree wrapping shall be of the type shown on the plans.

(13) Fertilizer. Fertilizer shall conform to the requirements of Article 166.2.

(14) Pesticides including Herbicides. Pesticides including herbicides shall be of the types that are commercially available and shown on the plans.

(15) Antitranspirants. Antitranspirants, intended to prevent evaporation, shall be of the types that are commercially available and approved by the Engineer.

192.4. Construction Methods.

(1) General. The limits, for the purpose of site preparation, mowing, installation, cleanup and establishment operations, as required under this Item, will include all area(s) shown on the plans. All planting operations and associated work shall be confined to these areas and such other areas of the right of way that may be required to gain access to the site(s) specified herein. Insofar as possible, the Contractor shall vary access routes across the right of way to prevent any damage to slopes and existing vegetation. The Contractor shall be responsible for the repair and replacement of damaged slopes and vegetation which, in the opinion of the Engineer, could have been avoided.

(2) Site Amenities and Protection. During the execution of the work, utmost care shall be exercised to prevent damage to any utilities, structures, right of way or other site amenities.

The Contractor shall not repair or service any equipment or perform any operations on the right of way which may mar the landscape by rendering the soil sterile, damage existing vegetation or which may have an adverse effect on the proposed use of the land. The Contractor shall be responsible for maintaining the work site in a neat appearance and safe condition at all times.

(3) Inspection and Certification Prior to Delivery. All plants inspected by the Engineer at the nursery and at the original native habitat of the collected stock shall be tagged with serialized self-locking tags if required by the Engineer. Plants delivered to the site without these tags or with broken tags may be sufficient reason for rejection. Tags shall be furnished by the Contractor.

The Contractor shall provide certification that all plants conform to the requirements of Subarticle 192.3.(2).

(4) Delivery and Storage. The Engineer shall be notified of a proposed plant material delivery time at least 48 hours prior to its arrival at the project. Each plant material shipment shall be accompanied by an invoice showing the number, size and name (common and botanical) of each

of the kinds of plant material. All plants shall be individually tagged with nursery name tags designating the genus, species and variety of the plant.

The Engineer will make an inspection of the plant stock upon delivery to ensure that the plants comply with these specifications. Any plants rejected shall be immediately removed and replaced. Unless plants are planted in a timely manner as specified herein, they shall be properly "heeled in" or stored.

Plants shall be properly maintained during delivery, handling, storage and planting. The Engineer may inspect any phase of work and may reject any plant material improperly maintained.

(5) Staking of Planting Locations. All locations of trees, shrubs and beds shall be staked in the field by the Contractor. All locations will be approved by the Engineer prior to any excavation of plant pits or bed preparation. Stakes shall be placed and coded to denote the type of plant material.

(6) Excavation of Planting Pits.

(a) General. The Contractor shall not excavate plant pits more than 24 hours in advance of planting operations. Any plant pits left unattended for any length of time which may present a hazard shall be covered and/or clearly flagged as approved by the Engineer. The walls and bottoms of all plant pits shall be scarified immediately prior to the placement of plants.

(b) Pit Sizes. Planting pits may be dug by hand or by mechanical means and shall be circular or square (according to the shape of the root ball) with vertical sides, unless otherwise shown on the plans. Planting pit sizes shall be as follows, unless otherwise shown on the plans:

(i) A minimum horizontal dimension of 300 millimeters between the root ball and the sides of the planting pit for the following plant specifications:

* Container names of fifteen (15) or larger (same as having container class of fifteen (15) gallons or larger),
* Boxes of 350 millimeters size or larger and
* Balled and burlapped or bag grown plants with a root ball diameter larger than 350 millimeters.

(ii)A minimum horizontal dimension of two (2) times the diameter of the root ball for the following plant specifications:

* Container name of less than fifteen (15) (same as having container class of less than fifteen (15) gallons) and
* Balled and burlapped or bag grown plants with a root ball diameter of 350 millimeters or less.

(iii)A minimum diameter for bare root plants to permit the roots to spread without crowding or curving around the walls of the pit.

(iv)Planting pits shall be excavated to a depth of at least 100 millimeters but not more than 200 millimeters greater than the depth of the root ball of balled and burlapped, containerized, container grown or bag grown plants; or the depth of the root system of bare root plants. Pits dug to excess depths shall be backfilled and compacted to bring the pits to the specified depth. The depth of pits on slopes will be measured at the lower side.

(v)When performing mechanical transplanting the receiving plant pit shall be excavated with the same type of equipment used to remove the plant material or as approved by the Engineer.

(7) Planting Season. All planting shall be performed as shown in Table 2 or as approved by the Engineer.

TABLE 2
PLANTING SEASONS

STOCK	PLANTING DATES
Containerized or container grown	None specified
Balled and burlapped	November 15 to March 15
Bare Root	January 15 to March 15
Bag Grown	September 15 to April 15
Collected	As shown on the plans or as approved by the Engineer.

(8) Planting and Backfilling. In general, the top of the root ball shall stand, after settlement of the backfill, approximately level with the finish grade. When shown on the plans, fertilizer of the type and quantity specified shall be added to the backfill material prior to backfilling. Unless otherwise shown on the plans or approved by the Engineer, planting and backfilling shall be as follows:

(a) Plant Basin. A basin, 200 to 250 millimeters deep, shall be formed by constructing a neat levee around the planting pit. The inside measurement of the basin shall not be less than the minimum specified diameter of the planting pit, unless otherwise shown on the plans. On slopes, the backfill on the lower side shall be graded in such a manner that an adequate basin will be provided.

As shown on the plans, either material excavated from the planting pit (excluding any rocks) or Backfill, as specified in Subarticle 192.3.(7), may be used to form a basin around the plant. Excess excavated material may be scattered thinly and leveled off provided it is of such consistency and character that it can be readily scattered in an acceptable manner. If scattering of the material may interfere with drainage or mowing, all such material shall be removed and disposed of as approved by the Engineer.

(b) Bare Root Plants. After the backfill in the bottom of the planting pit has been firmed and the plant placed in the proper position, as shown on the plans, loose friable backfill shall be worked about the roots and thoroughly settled with water as the backfill is made. Care shall be taken to avoid bruising or breaking the roots. No sticks, sod, clods or other material which may form large air pockets in the soil or backfill shall be included in the backfill.

(c) Balled and Burlapped Plants. Plants of this type shall not be handled by the stems or in such manner that the soil of the ball may be loosened. The burlap shall not be removed from the ball. After the backfill in the bottom of the pit has been firmed and the plant placed in the proper position as shown on the plans, loose friable backfill shall be worked about the ball in 300 millimeters layers until the pit is two-thirds (2/3) full. The burlap shall then be opened on top of the root ball to expose the top one-third (1/3) of the root ball. The pit shall be filled with water and the backfilling completed, working the backfill and water well to prevent any air pockets.

For ball supporting devices such as wire baskets, the basket shall not be removed. The plant shall be placed in the prepared planting pit in the proper position and backfill shall be placed around the ball until the pit is about one-third (1/3) full. The basket shall be carefully removed to just above the backfill, leaving the bottom portion intact. Backfilling shall be completed as shown above.

(d) Containerized or Container Grown Plants. At the time of planting the root ball shall be carefully removed from the container to prevent damage to the plant and root ball. Container plants shall be placed and backfilled in the same manner as balled and burlapped plants.

(e) Bag Grown Plants. Prior to planting, the fabric bag shall be removed by using a knife to cut the side of the bag from top to bottom in three or four places of equidistance around the root ball. The bag shall be carefully peeled down and roots that do not easily peel away from the bag shall be pruned. The plastic bottom shall then be pulled from under the root ball. Bag grown plants shall be placed and backfilled in the same manner as balled and burlapped plants.

(9) **Mechanical Transplanting.**

(a) **Equipment.** Machinery shall be maintained in good operating condition. All blades shall be true to their designed spade and free of bends which could interfere with its operation. The tree spade shall be mounted on a suitable, stable machine capable of supporting the mass of all excavated materials and heavy enough to force all blades into the soil to the proper depth.

(b) **Transplanting Methods.** Mechanical transplanting of trees shall be in accordance with the equipment manufacturer's recommendations.

Root balls which disintegrate or plants which cannot be secured within their root balls will be rejected. This shall include plants with excessive tap roots which cannot be thoroughly cut with the blades of the transplanting machine.

Roots which protrude beyond the limits of the transplant machine blades shall be neatly cut with an instrument specifically designed for this procedure before transplanting plants to their final planting location. The Contractor shall secure tops of plants to minimize drying during trans- planting and to minimize structural damage due to wind, passing vehicles, overhead structures or other circumstances.

(c) **Planting and Backfilling.** After the backfill in the bottom of the planting pit has been firmed and the plant placed in the proper position, as shown on the plans, sand shall be worked about the roots and thoroughly settled with water as the backfill is made. Care shall be taken to avoid bruising or breaking the roots. No sticks, sod, clods or other material which may form large air pockets in the soil or backfill shall be included in the backfill.

(10) **Vegetative Watering.** During the planting operations, the Contractor shall keep the ground and backfill material moist to at least 300 millimeters around the root ball. The Contractor shall be required to meet the minimum watering requirements shown for all circumstances by a method approved by the Engineer. When an irrigation system is shown on the plans, the Contractor shall coordinate his work to insure that the irrigation system is operational as the plants are installed.

(11) Antitranspirants. When shown on the plans, the Contractor shall apply antitranspirants in accordance with the manufacturer's recommendations and as approved by the Engineer.

(12) Pruning. Plants shall not be pruned immediately before delivery to the project site, unless otherwise shown on the plans or as approved by Engineer. Common nursery pruning practices are acceptable. Any necessary pruning shall be done at the time of planting as approved by the Engineer and shall be appropriate to the various types of plants and the special requirements of each.

From 20 percent to 40 percent of all foliage of mechanically transplanted plants shall be removed by pruning interior branching, entangled limbs and small branches. Structural branching shall not be removed prior to planting. Branch tips shall not be removed to attain the above percentage.

Balled and burlapped deciduous plants shall be pruned to ultimately reduce foliage by approximately one-third (1/3) of that existing prior to digging and shall be performed in such a manner as to retain the natural shape of the plant. Containerized, container grown and bag grown plants shall not be pruned for shape or foliage reduction. All plants shall be pruned as necessary to remove damaged twigs, branches and roots and as much additional as required by the Engineer. All pruning shall be accomplished with tools specifically designed for this purpose. All pruned material shall become the property of the Contractor and shall be disposed of in a manner approved by the Engineer.

(13) Plant Supports. Plant supports such as staking, guying, and bracing shall be as shown on the plans or as required by the Engineer.

Trees shall be staked, guyed or braced for support during the same day as planted. Unless otherwise shown on the plans, plants shall stand approximately vertical after staking, guying, or bracing. The Contractor shall be responsible for material remaining approximately vertical and straight for all given conditions and shall repair plant supports as often as required until final acceptance of the project.

(14) Safety Flagging Tape. Staking, guying, or bracing which present a hazard shall be clearly flagged as shown on the plans or directed by the Engineer.

(15) Tree Trunk Protection. All trees shown on the plans to be wrapped shall be neatly and securely wrapped with a commercial tree wrapping material approved by the Engineer. The wrapping shall begin at the base of the trunk and extend upward with a 50 percent overlap to the second whorl of branches. Wrapping material shall be secured at the top of the wrap with soft twine or weatherproof tape, or any suitable method as approved by the Engineer. Wire, metal bands or other material for this purpose that may cause injury or damage to plants shall not be used.

(16) Mulching. All plants shall receive mulching to a depth of 50 to 75 millimeters within the water basin or across the beds unless otherwise shown on the plans. A small amount of backfill shall be sprinkled on top of the organic mulch to hold it in place if directed by the Engineer.

(17) Plant Material Removal and Replacement. A plant shall be removed and replaced as directed by the Engineer at any time during execution of the work under this Item including the Establishment Period if, in the judgement of the Engineer, a plant is found to be in any of the following conditions:

(a) Dead;
(b) Dying;
(c) Wilted for 48 hours or more; or
(d) Any other signs of detrimental consequence.

All replacement plants shall be the same species, size and quality as originally specified. The Contractor shall make every effort to ensure that the replacement material receives any additional care and maintenance required for the replacement plants to become well established. The Engineer will require replacement of plant material until satisfied that all of the plants on the project are in a healthy, vigorous condition. This is subject to the exception noted in Section 192.4.(18).(i).

(18) Establishment Period. The Contractor shall perform all of the activities listed below during placement of all of the plants. After completion of the project installation, as shown on the plans and as approved by the Engineer, the Contractor shall perform the following activities for a period of 90 calendar days:

(a) Mulching, Plant Basin and Bed Maintenance. The Contractor shall reshape or reform the existing plant basins and beds as necessary to conform to the plans, and as approved by the Engineer. As a part of the plant basin and bed maintenance, weeds and grass shall be removed prior to the application of mulch. Unless otherwise shown on the plans, the mulch shall be maintained to a minimum depth of 50 to 75 millimeters.

The Contractor shall maintain the plant basins, beds and site fixtures generally free of weeds and grass or other materials detrimental to the growth of the plants or appearance of the site. Herbicides (glyphosate or others as approved by the Engineer), if used by the Contractor, shall be limited to the plant basin and perimeter thereof or around site fixtures as approved by the Engineer. Extreme care shall be taken to insure that the herbicide does not come into contact with any part of the desirable plants. Under no circumstances shall the herbicide be used on days where the wind could cause drift hazard to desirable plants. The Contractor shall also follow the manufacturer's instruction for the use and application of any herbicide.

(b) Plant Irrigation. The Contractor shall be required to meet the minimum watering requirements for all circumstances by a method approved by the Engineer as stated under Subarticle 192.4.(10) and/or as shown on the plans.

Watering equipment other than an existing irrigation system shall have adequate and accurate measuring devices as approved by the Engineer.

(c) Mowing and Trimming. The Contractor shall mow and trim the areas shown on the plans. The work shall be performed at the frequency as shown on the plans. The initial cycle shall begin when directed by the Engineer. Mowing heights shall be as shown on the plans or approved by the Engineer.

The Contractor shall use power equipment as approved by the Engineer. Nylon cord trimmers shall not be used inside the plant basins or beds around plant material.

(d) Restaking, Reguying, and Rebracing of Plants. Any damaged or destroyed stakes, guys or braces shall be replaced by the Contractor in accordance with the details shown on the plans. This shall

include any adjustment to the staking or guying to prevent girdling of plants.

(e) Pruning. When directed by the Engineer or shown on the plans, plants shall be pruned by the Contractor to the satisfaction of the Engineer. Dead or damaged limbs on trees and shrubs, including sucker-growth on trunks of trees, shall be removed. All pruning shall be accomplished with tools specifically designed for this purpose. All pruned material shall become the property of the Contractor and shall be disposed of in a manner approved by the Engineer.

(f) Insect, Disease and Animal Control. The Contractor shall inspect plants, and the planted areas once each two (2) weeks as approved by the Engineer. The Contractor shall be required to notify the Engineer in writing of problems with insects, diseases, or animals as such problems arise. The Contractor also shall recommend corrective measures in writing.

The Contractor shall treat the plants and/or the planted areas in accordance with accepted methods of horticultural practices and the Texas Department of Agriculture guidelines regarding the use of pesticides. The Contractor also shall follow the manufacturer's instructions for the use and application of any pesticides.

(g) Litter Pick-Up. Unless otherwise shown on the plans, the Contractor shall collect and dispose of all litter within the landscaped areas. The work shall be performed at the frequency shown on the plans or as directed by the Engineer. All litter shall become the property of the Contractor and shall be disposed of in a manner acceptable to the Engineer.

(h) Fertilization. During the 90-day establishment period, the Contractor shall furnish and apply fertilizer only to those plants as shown on the plans. The analysis, times, and rates of application shall be as shown on the plans. The type of fertilizer and method of application shall be as shown on the plans or as approved by the Engineer.

(i) Plant Removal. In the judgement of the Engineer, any plant which is dead or dying for reasons beyond the control of the Contractor and is not to be replaced shall be removed by the Contractor to the satisfaction of the Engineer. This shall include repair of the plant pit and surrounding area.

192.5. Acceptability of Plants and Other Materials, Installation and Establishment. The Engineer will make an inspection of the project to determine its acceptability as shown on the plans at or near the end of the 90 day establishment period. At this time, an inventory of missing, dead or rejected plant material will be made and the Contractor notified as to which plants on the inventory shall be replanted within the time limits for replacement as specified by the Engineer. Plant material for the replacement planting shall meet all the requirements specified for the original plant material and shall be planted in accordance with Article 192.4.

192.6. Measurement. This Item will be measured as each plant of the type and size as specified complete and in place.

192.7. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for each plant of the type and size specified complete and in place, as follows:

(1) When the initial planting and any required replanting is satisfactorily accomplished, 55 percent of the unit price bid for each plant will be paid;

(2) When the first 30 days of the 90-day establishment period is satisfactorily accomplished, 15 percent (for a total of 70 percent) of the unit price bid for each plant will be paid;

(3) When the second 30 days of the 90-day establishment period is satisfactorily accomplished, another 15 percent (for a total of 85 percent) the unit price bid for each plant will be paid; and

(4) When the final 30 days of the 90-day establishment period is satisfactorily accomplished and after final inspection and acceptance, the final 15 percent (for a total of 100 percent) of the unit price bid for each plant will be paid.

This price shall be full compensation for furnishing all labor, pruning, mowing, insect control, disease control, animal control, watering, fertilizing, herbiciding, litter pick up, maintenance, tools, equipment, materials, supplies, and incidentals necessary to complete the work.

When an "Irrigation System" is specified, it will be paid for in accordance with Item 170, "Irrigation System".

ITEM 193

LANDSCAPE MAINTENANCE

193.1. Description. This Item shall govern for landscape maintenance as shown herein and on the plans or as directed by the Engineer.

When "Landscape Maintenance" is used in conjunction with Item 192, "Roadside Planting And Establishment", all work is to be accomplished subsequent to the work shown in Item 192, "Roadside Planting And Establishment".

193.2. Materials.

(1) Fertilizer. Fertilizer shall conform to the requirements of Article 166.2.

(2) Mulch. Mulch material shall consist of loose organic material of the wood chip or shredded bark variety as approved by the Engineer or as shown on the plans to ensure adequate protection against sun baking and quick drying of the soil. It shall be free of excess amounts of leaves and large sticks that may prevent proper dressing of the mulched surface, free of harmful chemicals and free of detrimental amounts of soil or other foreign matter that may promote early compaction, matting or deterioration of the mulch.

(3) Water. Water shall conform to the requirements of Article 168.2.

(4) Supports. Plant supports shall be of the type shown on the plans.

(5) Pesticides Including Herbicides. Pesticides including herbicides shall be of the types that are commercially available and as shown on the plans.

(6) Replacement Plants. Replacement plants shall conform to the requirements of Article 192.3.

193.3. License Requirements.

(1) Pesticide. The Contractor shall be a licensed pesticide applicator or employ a licensed certified pesticide applicator for the treatment of insects and diseases as required by the Texas Pesticide Laws and Regulations of the Texas Department of Agriculture. The Engineer may require documentation of such certification as necessary for his records.

(2) Herbicide. The Contractor shall possess a permit or employ a person who possesses a permit to apply herbicide as required by the Texas Herbicide Law of the Texas Department of Agriculture. The Engineer may require documentation of such certification as necessary for his records.

(3) Irrigation. The Contractor shall possess an irrigator's license issued by the State of Texas and the Texas Board of Irrigators or employ such a licensed irrigator to perform the irrigation system maintenance. The irrigation system shall be maintained under the supervision of the licensed irrigator who shall be on the site at all times during this work. The Engineer may require documentation of such license for his records. The Contractor shall verify and adhere to the requirements and codes of any controlling utility authorities.

193.4. Plant Maintenance. For the work of plant maintenance, all possible means shall be employed to preserve the plants and vegetative material existing within the site in a healthy and vigorous growing condition to insure their successful establishment. Plant maintenance shall include, as a minimum, the following items:

(1) Pruning. All trees and shrubs within the limits of landscape maintenance shall be pruned by the Contractor to the satisfaction of the Engineer. Pruning shall be done in accordance with accepted pruning practices as set forth by the National Arborist Association in Pruning Standards for Shade Trees (current edition). Dead or damaged limbs on trees and shrubs, including sucker-growth on trunks of trees, are to be removed. All pruned materials shall become the property of the Contractor and shall be disposed of in a manner acceptable to the Engineer. Unless otherwise shown on the plans, pruning shall be accomplished once during the term of this contract, as shown on the plans or as approved by the Engineer.

(2) Insect, Disease, and Animal Control. The Contractor shall inspect plants and the planted areas once each two (2) weeks or as approved by the Engineer. The Contractor shall be required to notify the Engineer in writing of problems with insects, diseases, or animals as such problems arise. The Contractor also shall recommend corrective measures in writing.

The Contractor shall treat the plants and/or the planted areas in accordance with accepted methods of horticultural practices and the Texas Department of Agriculture guidelines regarding the use of pesticides. The Contractor also shall follow the manufacturer's instructions for the use and application of any pesticides.

(3) Fertilization. Unless otherwise shown on the plans, the Contractor shall furnish and apply fertilizer to all plants as shown on the plans. The analysis, times and rates of application shall be as shown on the plans. The method of application shall be as shown on the plans or as approved by the Engineer.

(4) Mulching, Plant Basin, and Bed Maintenance. The Contractor shall reshape or reform the existing plant basins and beds as necessary to conform to details as shown on the plans, and as approved by the Engineer. As a part of the plant basin and bed maintenance, weeds and grass shall be removed prior to the application of mulch. Unless otherwise specified on the plans, the mulch shall be maintained to a minimum depth of 50 millimeters.

The Contractor shall maintain the plant basins, beds and site fixtures generally free of weeds and grass or other material detrimental to the growth of the plants or appearance at the site. Herbicides (glyphosate or others as approved by the Engineer), if used by the Contractor, shall be limited to the plant basin and perimeter thereof or around site fixtures as approved by the Engineer. Extreme care shall be taken to insure that the herbicide does not come into contact with any part of the desirable plants. Under no circumstances shall the herbicide be used on days where the wind could cause drift hazard to desirable plants. The Contractor shall also follow the manufacturer's instructions for the use and application of any herbicide.

(5) Mowing and Trimming. The Contractor shall mow and trim the areas shown on the plans. The work shall be performed at the frequency as shown on the plans. The initial cycle shall begin when directed by the Engineer. Mowing heights shall be as shown on the plans or approved by the Engineer.

The Contractor shall use power equipment as approved by the Engineer. Nylon cord trimmers shall not be used inside the plant basins or beds around plant material.

(6) Restaking, Reguying, and Rebracing of Plants. Any damaged or destroyed stakes, guys or braces shall be replaced by the Contractor in accordance with the details shown on the plans. This shall include any adjustment to the staking or guying to prevent girdling of plants.

(7) Removing Staking, Guying, and Bracing Materials. The Contractor shall remove all staking, guying and bracing materials when shown on the plans or as directed by the Engineer. Such removed materials shall become the property of the Contractor and shall be removed from the site in a manner acceptable to the Engineer.

193.5. Plant Replacement. Plant replacement, when shown on the plans, is based upon the estimated number of each plant species expected to be replaced due to typical mortality or other factors beyond the control of the Contractor. Plant replacement shall consist of removing plants selected by the Engineer, replacing with plants of the species and sizes as shown on the plans, and placing and backfilling in accordance with the details shown on the plans and to the satisfaction of the Engineer.

193.6. Vegetative Watering. Vegetative watering, when shown on the plans, shall be performed in areas which do not contain an underground irrigation system. The work shall consist of the application of water on landscape plantings with the quantity as shown on the plans or as approved by the Engineer.

Watering equipment shall have adequate and accurate measuring devices as approved by the Engineer. The work required for one (1) watering cycle of all plants shall be completed approximately every seven (7) days or as approved by the Engineer.

193.7. Irrigation System Operation and Maintenance. Permanent irrigation system operation and maintenance, when shown on the plans, shall consist of the monitoring, adjustment, repair and proper operation of the existing irrigation system as required to insure adequate moisture to the plant material existing on the project. The existing condition of the system and any known deficiencies will be shown on the plans and shall be corrected by the Contractor at his expense. The Contractor shall insure that all zones are operating and that the watering schedule, as shown on the plans or as approved by the Engineer, is being accomplished.

The Contractor shall provide all repair or replacement parts, at his expense, as may be required to maintain the irrigation system in proper operating condition as determined by the Engineer. All replacement parts shall be of the same type and manufacturer as originally installed. Substitute parts may be allowed with the approval of the Engineer prior to replacement.

In the event the irrigation system fails due to the Contractor's actions or neglect, the Contractor shall furnish plant irrigation by a method and quantity approved by the Engineer.

193.8. Litter Pick-Up. Unless otherwise shown on the plans the Contractor shall collect and dispose of all litter within the landscaped areas. The work shall be performed at the frequency shown on the plans or as directed by the Engineer. All litter shall become the property of the Contractor and shall be disposed of in a manner acceptable to the Engineer.

193.9. Measurement. This Item will be measured as follows:

(1) "Plant Maintenance" will be measured by the month (MO).

(2) "Plant Replacement" will be measured by each (EA) plant of the species and sizes shown on the plans.

(3) "Vegetative Watering" will be measured by the kiloliters of water.

(4) "Irrigation System Operation and Maintenance" will be measured by the month (MO).

193.10

193.10. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Plant Maintenance", "Plant Replacement", "Vegetative Watering" and/or "Irrigation System Operation and Maintenance". This price shall be full compensation for all work, labor, equipment, materials, accessories, litter pick-up, pruning, mowing and trimming, insect control, disease control, animal control, weed control, fertilizing and incidentals necessary to complete the work.

All repairs to any existing irrigation system will not be paid for directly but will be considered subsidiary to this Item, unless otherwise shown on the plans.

PART II, CONSTRUCTION DETAILS

DIVISION II
SUBBASE AND BASE COURSES

ITEM 204

SPRINKLING

204.1. Description. This Item shall govern for the authorized application of water for dust control, earthwork or base construction as required by the plans and specifications or as directed by the Engineer.

204.2. Materials. Water shall be furnished by the Contractor and shall be clean and free from industrial wastes and other objectionable matter.

204.3. Construction Methods. This work will be done only when directed by the Engineer. The Contractor shall furnish and operate approved sprinklers equipped with positive and rapidly working cut-off valves and approved spray bars which will insure the distribution of water in a uniform and controllable rate of application. The Contractor shall apply the water in the required quantity where shown on plans or as directed by the Engineer.

204.4. Measurement. When specified on the plans to be a pay Item, it will be measured by the kiloliters as delivered.

204.5. Payment. The work performed and materials furnished in accordance with this Item, will not be paid for directly but will be considered subsidiary to the various bid items of the contract, unless otherwise specified as a pay item in the contract. When this item is specified on the plans as a pay item, the water furnished and the work performed as prescribed by this item and measured as provided under "Measurement" will be paid for at the unit price bid for "Sprinkling, (Base)", "Sprinkling (Earthwork)", or "Sprinkling (Dust Control)". This price shall be full compensation for all costs in connection with furnishing the water; for all costs in connection with furnishing and operating approved sprinklers and all necessary measuring devices; and for applying the water as directed, including all hauling, equipment, tools, materials, labor, and incidentals necessary to complete the work.

ITEM 210

ROLLING
(Flat Wheel)

210.1. Description. This Item shall govern for the compaction of embankment, flexible base, or surface treatments, by the operation of approved power rollers as herein specified and as directed by the Engineer.

210.2. Equipment.

(1) Embankments and Flexible Bases. Power rollers shall be of the three-wheel, self-propelled type, weighing not less than nine (9) megagrams and shall provide a compression on the rear wheels of not less than 5800 kilograms per linear meter of tire width. All wheels shall be flat, the rear wheels shall have a diameter of not less than 1.2 meters, and each shall have a tire width of not less than 510 millimeters.

(2) Surface Treatments. Power rollers shall be the three-wheel or tandem, self-propelled type, weighing not less than 2.7 megagrams nor more than 5.4 megagrams. All wheels shall be flat.

In lieu of the equipment specified, the Contractor may, upon written permission from the Engineer, operate other compacting equipment that will produce equivalent relative compaction in the same period of time as the specified equipment. If the substituted compaction equipment fails to produce the desired compaction within the same period of time as would be expected of the specified equipment, as determined by the Engineer, its use shall be discontinued and the Contractor will be required to furnish the specified equipment.

210.3. Construction Methods. This work shall be done only when directed by the Engineer. Sufficient rollers shall be provided to compact the material in a satisfactory manner. When operations are so isolated from one another that one roller unit cannot perform the required compaction satisfactorily, additional roller units shall be provided.

(1) Embankments and Flexible Bases. The embankment layer or the base course shall be sprinkled if directed, and rolling with a power roller shall start longitudinally at the sides and proceed towards the center overlapping on successive trips by at least one-half of the width of the rear

210.4 to 211.2

wheel of the power roller. On superelevated curves, rolling shall begin at the low sides and progress toward the high sides. Alternate trips of the roller shall be slightly different in length. Rolling shall continue until discontinued by the Engineer. The rollers, unless otherwise directed, shall be operated at a speed between three (3) and five (5) kilometers per hour.

(2) Surface Treatments. Rolling shall be done as called for in surface treatment items. The sequence of work shall be as specified for embankment layer or base course in accordance with Subarticle 210.3.(1) or as directed by the Engineer. The operating speed shall be as directed by the Engineer.

210.4. Measurement. When shown on the plans to be a pay item, this Item will be measured by the actual hours the power roller works as directed by the Engineer.

210.5. Payment. The cost of furnishing and operating the equipment as prescribed by this item will not be paid for directly but will be considered subsidiary to the various bid items of the contract, unless this item is specified as a pay item in the contract.

When flat wheel rolling is specified as a pay item, the equipment furnished and operated in accordance with this item and measured as provided under "Measurement" will be paid for at the unit price bid for "Rolling (Flat Wheel)". This price shall be full compensation for furnishing and operating all equipment; and for all labor, fuel, tools and incidentals necessary to satisfactorily perform the work.

ITEM 211

ROLLING
(Tamping)

211.l. Description. This Item shall govern for the compaction of embankment or of flexible base by the operation of approved tamping rollers as herein specified and as directed by the Engineer.

211.2. Equipment. Equipment shall conform to the following requirements:

(1) It shall be a self propelled roller capable of operating in a forward or backward motion.

(2) It shall have one or more tamping drums with an effective rolling width of not less than 1.5 meters.

(3) Tamping drums shall be self cleaning.

(4) Tamping feet shall project not less than 75 millimeters from the surface of the drum.

(5) The load tamping foot shall exert a pressure of not less than 860 kilopascals nor more than 3800 kilopascals in a static mode.

(6) Compaction in a vibratory mode will be permitted.

(7) General. If approved by the Engineer, the Contractor may substitute rollers conforming to requirements in Item 212, "Rolling (Heavy Tamping)", in lieu of rollers specified above. Such units shall be considered a roller unit.

In lieu of the rolling equipment specified, the Contractor may, upon written permission from the Engineer, operate other compacting equipment that will produce equivalent relative compaction in the same period of time as the specified equipment. If the substituted compaction equipment fails to produce the desired compaction within the same period of time as would be expected of the specified equipment, as determined by the Engineer, its use shall be discontinued and the Contractor will be required to furnish the specified equipment.

211.3. Construction Methods. This work shall be done only when directed by the Engineer. The embankment layer or the base course shall be sprinkled if directed, and rolling with a tamping roller unit shall start longitudinally at the sides and proceed towards the center, overlapping on successive trips by at least one-half of the width of the tamping roller unit. On superelevated curves, rolling shall begin at the low sides and progress toward the high sides. Alternate trips of the unit shall be slightly different in length. Rolling shall continue until discontinued by the Engineer. The

tamping roller unit, unless otherwise directed, shall be operated at a speed between three (3) and five (5) kilometers per hour.

Sufficient rollers shall be provided to compact the material in a satisfactory manner. When operations are so isolated from one another that one roller unit cannot perform the required compaction satisfactorily, additional roller units shall be provided.

211.4. Measurement. When shown on the plans to be a pay item, this Item will be measured by the actual hours the tamping roller unit works as directed by the Engineer.

211.5. Payment. The cost of furnishing and operating the equipment as prescribed by this item will not be paid for directly but will be considered subsidiary to the various bid items of the contract, unless this item is specified as a pay item in the contract.

When tamping rolling is specified as a pay item, the equipment furnished and operated in accordance with this item and measured as provided under "Measurement" will be paid for at the unit price bid for "Rolling (Tamping)". This price shall be full compensation for furnishing and operating all equipment; and for all labor, fuel, tools, and incidentals necessary to satisfactorily perform the work.

If a non-self propelled roller is operated, the tractive unit will be considered subsidiary to this Item.

ITEM 212

ROLLING
(Heavy Tamping)

212.1. Description. This Item shall govern for the compaction of embankment, flexible base or other courses, by the operation of approved tamping rollers as herein specified, and as directed by the Engineer.

212.2. Compaction Equipment. The heavy tamping roller shall consist of two or three metal drums, rolls, or shells of 1.5 meters minimum diameter. If the two-drum type is furnished, each drum shall be not less than 1.5 meters in length. If the three-drum type is furnished, the roller shall consist of two forward drums and one rear drum, the drums

to be so arranged that the rear drum will compact the space between the two forward drums, and rollers of this type shall have an overall width of not less than three (3) meters.

The drums shall be unit-mounted in a rigid frame in such manner that each drum may oscillate independently of the other.

Each drum shall be surmounted by metal studs with tamping feet projecting not less than 180 millimeters from the surface and shall be so spaced as to result in one tamping foot for each 0.06 to 0.07 square meter of drum area. The area of each tamping foot shall be approximately 4500 square millimeters. All rollers shall be provided with cleaning teeth so designed and attached as to prevent the accumulation of material between the tamping feet.

The roller shall be so designed that by ballast loading, the load on each tamping foot may be varied up to at least 3800 kilopascal of cross-sectional area. The load per tamping foot will be determined by dividing the total mass of the roller by the number of tamping feet in one row parallel to or approximately parallel to the axis of the roller. The compression to be provided at any time shall be as directed by the Engineer.

One tamping roller, consisting of two drums or three drums, conforming to the above requirements and drawn by an approved type tractor of adequate tractive effort, shall be considered a heavy tamping roller unit.

Where turning is impractical or detrimental to the work, and when specifically directed by the Engineer, the roller shall be capable of being operated in a forward or backward motion.

When operations are confined to narrow widths and when specifically directed by the Engineer in writing, one roller, either pushed or pulled, by adequate power equipment shall be considered a roller unit.

In lieu of the rolling equipment specified, the Contractor may, upon written permission from the Engineer, operate other compacting equipment that will produce equivalent relative compaction in the same period of time as the specified equipment. If the substituted compaction equipment fails to produce the desired compaction within the same period of time as would

be expected of the specified equipment, as determined by the Engineer, its use

shall be discontinued and the Contractor will be required to furnish the specified equipment.

212.3. Construction Methods. This work shall be done only when directed by the Engineer. The embankment layer shall be sprinkled if directed, and rolling with a tamping roller unit shall start longitudinally at the sides and proceed towards the center, overlapping on successive trips by at least one-half of the width of the tamping roller. On superelevated curves, rolling shall begin at the low sides and progress toward the high sides. Alternate trips of the unit shall be slightly different in length. Rolling shall continue until discontinued by the Engineer. The tamping roller unit, unless otherwise directed, shall be operated at a speed between three (3) and five (5) kilometers per hour.

Sufficient rollers shall be provided to compact the material in a satisfactory manner. When operations are so isolated from one another that one roller unit cannot perform the required compaction satisfactorily, additional roller units shall be provided.

212.4. Measurement. When shown on the plans to be a pay Item, this Item will be measured by the actual hours the heavy tamping roller unit works as directed by the Engineer.

212.5. Payment. The cost of furnishing and operating the equipment in accordance with this Item will not be paid for directly but will be considered subsidiary to the various bid items of the contract, unless this item is specified as a pay item in the contract.

When heavy tamping rolling is specified as a pay item, the equipment furnished and operated in accordance with this item and measured as provided under "Measurement" will be paid for at the unit price bid for "Rolling (Heavy Tamping)". This price shall be full compensation for furnishing and operating all equipment; and for all labor, fuel, tools, and incidentals necessary to satisfactorily perform the work.

ITEM 213

ROLLING
(Pneumatic Tire)

213.1. Description. This Item shall govern for the compaction of embankment, flexible base, surface treatments, or pavements by the operation of approved pneumatic tire rollers as herein specified and as directed by the Engineer.

213.2. Equipment.

(1) General. When used on asphaltic surface treatments and bituminous mixture pavements, the roller shall be self-propelled and equipped with smooth tread tires whether "Rolling (Light Pneumatic Tire)" or "Rolling (Medium Pneumatic Tire)" is specified on the plans. The roller shall be so constructed as to be capable of being operated in both a forward and a reverse direction.

When used on bituminous mixture pavements, the roller shall have suitable provisions for moistening the surface of the tires while operating.

Where turning is impractical or detrimental to the work, and when specifically directed by the Engineer, the roller shall be capable of being operated in a forward or backward motion.

In lieu of the rolling equipment specified, the Contractor may, upon written permission from the Engineer, operate other compacting equipment that will produce equivalent relative compaction in the same period of time as the specified equipment. If the substituted compaction equipment fails to produce the desired compaction within the same period of time as would be expected of the specified equipment, as determined by the Engineer, its use shall be discontinued and the Contractor will be required to furnish the specified equipment.

(2) The light pneumatic tire roller. It shall consist of not less than nine pneumatic tired wheels, running on axles in such manner that the rear group of tires will cover the entire gap between adjacent tires of the forward group, and mounted in a rigid frame and provided with a loading platform or body suitable for ballast loading. The front axle shall be attached to the frame in such manner that the roller may be turned within a minimum

circle. The pneumatic tire roller under working conditions shall have an effective rolling width of approximately 1.5 meters and shall be so designed that by ballast loading, the total load may be varied uniformly from four (4) megagrams to eight (8) megagrams. The roller shall be equipped with tires that will afford ground contact pressures of 310 kilopascals or more. The operating load and tire air pressure shall be within the range of the manufacturer's charts or tabulations showing the contact areas and contact pressures for the full range of tire inflation pressures and for the full range of loadings for the particular tires furnished. The roller under working conditions shall provide a uniform compression under all wheels. Individual tire inflation pressures shall be within plus or minus 34 kilopascals of each other. The pneumatic tire roller shall be drawn by either a suitable crawler type tractor, a pneumatic tired tractor, or a truck of adequate tractive effort, or may be of the self-propelled type, and the roller, when drawn or propelled by either type of equipment, shall be considered a light pneumatic tire roller unit.

(3) The medium pneumatic tire roller (Type A). It shall consist of not less than seven (7) pneumatic tired wheels, running on axles in such manner that the rear group of tires will cover the entire gap between adjacent tires of the forward group, and mounted in a rigid frame and provided with a loading platform or body suitable for ballast loading. The front axle shall be attached to the frame in such manner that the roller may be turned within a minimum circle. The pneumatic tire roller under working conditions shall have an effective rolling width of approximately 2.1 meters and shall be so designed that by ballast loading the total load may be varied uniformly from 10.5 megagrams to 22.5 megagrams. The roller shall be equipped with tires that will afford ground contact pressures to 550 kilopascals or more. The operating load and tire air pressure shall be within the range of the manufacturer's chart as approved by the Engineer. The roller under working conditions shall provide a uniform compression under all wheels. Individual tire inflation pressures shall be within plus or minus 34 kilopascals of each other.

The pneumatic tire roller shall be drawn by either a suitable crawler type tractor, a pneumatic tired tractor, or a truck of adequate tractive effort, or may be of the self-propelled type and the roller, when drawn or propelled by either type of equipment, shall be considered a medium pneumatic tire roller unit. The power unit shall have adequate tractive effort to properly move the operating roller at variable uniform speeds up to approximately eight (8) kilometers per hour.

213.3 to 213.5

(4) The medium pneumatic tire roller (Type B). It shall conform to the requirements for Medium Pneumatic Tire Roller (Type A) as specified in Subarticle 213.2(3), except that the roller shall be equipped with tires that will afford ground contact pressures to 620 kilopascals or more.

213.3. Construction Methods. This work shall be done only when directed by the Engineer. The embankment layer or the base course shall be sprinkled if directed, and rolling with a pneumatic tire roller shall start longitudinally at the sides and proceed towards the center, overlapping on successive trips by at least one-half of the width of the pneumatic tire roller. On superelevated cures, rolling shall begin at the low sides and progress toward the high sides. Alternate trips of the roller shall be slightly different in length. Rolling shall continue until discontinued by the Engineer.

The light pneumatic tire roller shall be operated at speeds directed by the Engineer which shall be between six (6) and 19 kilometers per hour for asphalt surfacing work and between three (3) and ten (10) kilometers per hour for all other work.

The medium pneumatic tire roller shall be operated at speeds as directed by the Engineer.

Sufficient rollers shall be provided to compact the material in a satisfactory manner. When operations are so isolated from one another that one roller unit cannot perform the required compaction satisfactorily, additional roller units shall be provided.

213.4. Measurement. When shown on the plans to be a pay item, this Item will be measured by the actual hours the pneumatic tire roller unit works as directed by the Engineer.

213.5. Payment. The cost of furnishing and operating the equipment in accordance with this Item will not be paid for directly but will be considered subsidiary to the various bid items of the contract, unless this Item is specified as a pay item in the contract. When pneumatic rolling is specified as a pay item, the equipment furnished and operated in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Rolling (Light Pneumatic Tire)", "Rolling (Medium Pneumatic Tire) (Type A)" or "Rolling (Medium Pneumatic Tire)(Type B)". This price shall be full compensation for furnishing and

operating all equipment, and for all labor, fuel, tools, and incidentals necessary to satisfactorily perform the work.

ITEM 214

ROLLING
(Heavy Pneumatic Tire)

214.1. Description. This Item shall govern for the compaction of embankment, subgrade, flexible base, old concrete pavement (previously broken) or pavements by the operation of approved heavy pneumatic tire rollers as herein specified and as directed by the Engineer.

214.2. Equipment. The heavy pneumatic tire roller shall consist of not less than four pneumatic tire wheels, running on axles carrying not more than two wheels, and mounted in a rigid frame and provided with a loading platform or body suitable for ballast loading. All wheels shall be arranged so that they will carry approximately equal loads when operating on uneven surfaces.

The roller under working condition shall have a rolling width of from 2.5 to three (3) meters, and shall be so designed that, by ballast loading, the gross load may be varied uniformly from 23 megagrams to 45 megagrams. The tires shall be capable of operating under the various loads with variable air pressure up to 1000 kilopascals. The operating load and tire air pressure shall be within the range of the manufacturer's chart as approved by the Engineer. Tires shall be practically full of liquid. (Tires shall be considered as being practically full when liquid will flow from the valve stem of a fully inflated tire with the stem in the uppermost position). The Contractor shall furnish the Engineer charts or tabulations showing the contact areas and contact pressures for the full range of the tire inflation pressures and for the full range of loadings for the particular tires furnished.

There shall be a sufficient quantity of ballast available to load the equipment to a maximum gross mass of 45 megagrams.

Rubber tired tractive equipment shall be used on base courses and asphalt pavements. Other type tractive equipment may be used on embankment subgrade. The heavy pneumatic tire roller unit shall be capable of turning 180 degrees in the crown width.

The heavy pneumatic tire roller shall be drawn by a suitable crawler type tractor, or rubber tired tractor of adequate effort, or may be of the self-propelled type, and the roller, when drawn or propelled by either type of equipment, shall be considered a heavy pneumatic tire roller unit.

In lieu of the rolling equipment specified, the Contractor may, upon written permission from the Engineer, operate other compacting equipment that will produce equivalent relative compaction in the same period of time as the specified equipment. If the substituted compaction equipment fails to produce the desired compaction within the same period of time as would be expected of the specified equipment, as determined by the Engineer, its use shall be discontinued and the Contractor will be required to furnish the specified equipment.

214.3. Construction Methods. This work shall be done only when directed by the Engineer. The embankment layer or the base course shall be sprinkled if directed. Rolling with the pneumatic tire roller shall start longitudinally at the sides and proceed toward the center, overlapping on successive trips by at least one-half the width of the pneumatic tire roller. On superelevated curves, rolling shall begin at the low sides and progress to the high sides. Alternate trips of the roller shall be slightly different in length. Rolling shall continue until discontinued by the Engineer.

The rollers shall be operated at speeds directed by the Engineer which shall be between three (3) and ten (10) kilometers per hour.

Sufficient rollers shall be provided to compact the material in a satisfactory manner. When operations are so isolated from one another that one roller unit cannot perform the required compaction satisfactorily, additional roller units shall be provided.

214.4. Measurement. When shown on the plans to be a pay item, this Item will be measured by the actual hours the heavy pneumatic tire roller unit works as directed by the Engineer.

214.5. Payment. The cost of furnishing and operating the equipment in accordance with this Item will not be paid for directly but will be considered subsidiary to the various bid items of the contract, unless this Item is specified as a pay Item in the contract.

When heavy pneumatic tire rolling is specified as a pay Item, the equipment furnished and operated in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Rolling (Heavy Pneumatic Tire)". This price shall be full compensation for furnishing and operating all equipment; and for all labor, tools, fuel, and incidentals necessary to satisfactorily perform the work.

ITEM 215

ROLLING
(Grid)

215.1. Description. This Item shall govern for the compaction of embankments and bases or for breaking up existing asphalt mats or base materials, by the operation of approved grid rollers as herein specified and as directed by the Engineer. This type roller is to be used only where the character of materials is suitable to this method of rolling.

215.2. Equipment. The grid roller shall consist of two metal rollers 1.67 meters minimum diameter, 0.8 meter minimum width, mounted in a rigid frame with mass boxes to permit mass to be varied between 4.5 and 11.5 megagrams. The surface of the roller shall consist of a cast or welded steel fabric grid, composed of undulating bars 38 millimeters wide spaced 127 millimeters center to center each way. The bars shall be undulating in each direction approximately 25 millimeters between the high and low points. The grid roller shall be drawn by suitable crawler type tractor or pneumatic tire tractor of adequate tractive effort. The grid roller, conforming to the above prescribed requirements, drawn by an approved crawler type tractor, shall be considered a roller unit.

Where turning is impractical or detrimental to the work, and when specifically directed by the Engineer, the roller shall be capable of being operated in a forward or backward motion.

In lieu of the rolling equipment specified, the Contractor may, upon written permission from the Engineer, operate other compacting equipment that will produce equivalent relative compaction in the same period of time as the specified equipment. If the substituted compaction equipment fails to produce the desired compaction within the same period of time as would be expected of the specified equipment, as determined by the Engineer, its

use shall be discontinued and the Contractor will be required to furnish the specified equipment.

215.3. Construction Methods. This work shall be done only when directed by the Engineer. The embankment layer or the base course shall be sprinkled if directed, and rolling with a grid roller unit shall start longitudinally at the sides and proceed towards the center, overlapping on successive trips by at least one-half of the width of the grid roller unit. On superelevated curves, rolling shall begin at the low sides and progress toward the high sides. Alternate trips of the unit shall be slightly different in length. Rolling shall continue until discontinued by the Engineer.

Old asphalt mats or pit run material to be broken up shall be rolled with a grid roller unit as directed by the Engineer.

The grid roller unit, unless otherwise directed, shall be operated at a speed between three (3) and five (5) kilometers per hour.

Sufficient rollers shall be provided to perform the work in a satisfactory manner. When operations are so isolated from one another that one roller unit cannot perform the required compaction satisfactorily, additional roller units shall be provided.

215.4. Measurement. When shown on the plans to be a pay item, this Item will be measured by the actual hours the grid roller unit works as directed by the Engineer.

215.5. Payment. The cost of furnishing and operating the equipment in accordance with this Item will not be paid for directly but will be considered subsidiary to the various bid items of the contract, unless this Item is specified as a pay Item in the contract.

When grid rolling is specified as a pay Item, the equipment furnished and operated in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Rolling (Grid)". This price shall be full compensation for furnishing and operating all equipment; and for all labor, fuel, tools, and incidentals necessary to satisfactorily perform the work.

ITEM 216

ROLLING
(Proof)

216.1. Description. This Item shall govern for furnishing and operating heavy pneumatic tired compaction equipment for locating unstable areas of earthwork or base.

216.2. Equipment. The proof rolling equipment shall consist of not less than four pneumatic tired wheels, running on axles carrying not more than two wheels, and mounted in a rigid frame and provided with loading platform or body suitable for ballast loading. All wheels shall be arranged so that they will carry approximately equal loads when operating on uneven surfaces.

The proof roller under working conditions shall have a rolling width of from 2.5 meters to three (3) meters, and shall be so designed that, by ballast loading, the gross load may be varied uniformly from 23 megagrams to 45 megagrams. The tires shall be capable of operating under the various loads with variable air pressure up to 1000 kilopascals. Tires shall be practically full of liquid. (Tires shall be considered as being practically full when liquid will flow from the valve stem of a fully inflated tire with the stem in the uppermost position). The operating load and tire pressure shall be within the range of the manufacturer's chart as directed by the Engineer. The Contractor shall furnish the Engineer charts or tabulations showing the contact areas and contact pressures for the full range of tire inflation pressures and for the full range of loadings for the particular tires furnished.

The proof roller shall be towed by a suitable crawler type tractor or rubber tired tractor of adequate tractive capacity, or may be of the self-propelled type. A proof roller unit shall consist of either a self propelled roller or combination of roller and towing tractor.

There shall be a sufficient quantity of ballast available to load the equipment to a maximum gross mass of 45 megagrams.

Rubber tired tractive equipment shall be used on base courses and asphalt pavements. Other type tractive equipment may be used on embankment subgrade. The heavy pneumatic tire roller unit shall be

capable of turning 180 degrees in the crown width or operating in forward and reverse modes.

In lieu of the rolling equipment specified, the Contractor may, upon written permission from the Engineer, operate other compacting equipment that will produce equivalent results in the same period of time as the specified equipment. If the substituted compaction equipment fails to produce the desired results within the same period of time as would be expected of the specified equipment, as determined by the Engineer, its use shall be discontinued.

216.3. Construction Methods. This work shall be done only when directed by the Engineer. The subgrade and/or base layer shall be proof rolled to locate unstable areas when directed by the Engineer.

Within the ranges set forth in Article 216.2., the load and tire inflation pressures shall be adjusted as directed by the Engineer. It is proposed to use a contact pressure corresponding as nearly as practical to the maximum supporting value of the earthwork or base. A minimum of two coverages of the proof roller will be required. Each succeeding trip of the proof roller shall be offset by not greater than one tire width. Rollers shall be operated at speeds directed by the Engineer which shall be between three (3) and ten (10) kilometers per hour.

Where the operation of the proof roller unit shows an area to be unstable or non-uniform, it shall be corrected in accordance with the applicable Item of Work.

216.4. Measurement. This Item will be measured by the actual hours the heavy pneumatic tire proof roller unit works as directed by the Engineer.

216.5. Payment. The equipment furnished and operated in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Rolling (Proof)". This price shall be full compensation for furnishing and operating all equipment; for all labor, tools, fuel, and incidentals necessary to satisfactorily perform the work.

Unless otherwise provided on the plans, payment for reworking unstable or non-uniform areas, removing and replacing materials, addition of stabilizing materials, and all compaction and incidentals necessary to correct all irregularities will not be made directly but will be considered as subsidiary to the various bid items.

ITEM 217

ROLLING
(Vibratory)

217.1. Description. This Item shall govern for the compaction of embankments and all pavement structure courses except surface treatments or portland cement concrete pavement by the operation of approved vibratory rollers as herein specified and as approved by the Engineer.

217.2. Equipment. Vibratory rollers shall be maintained in a satisfactory working condition and will be approved by the Engineer.

(1) General. Vibratory rollers shall:

	Earth & Base	Asph Stab Base & Asphaltic Conc Pavement
Be self propelled with at least one drum equipped to vibrate.	X	X
Be equipped with separate frequency and amplitude control for each vibrating drum.	X	X
Have the capability of automatically reversing the direction of the rotating eccentric mass.		X
Automatically stop vibration before the motion of the rollers stop.		X

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Have the capability of starting and stopping the vibration manually.	X	X
Have the capability of keeping the drum thoroughly moistened with water.		X
Have the capability to continuously clean the face of the drum.	X	X

(2) Type. The equipment to be used shall be of the type shown on the plans and shall conform to the requirements as follows:

(a) Type A. Static mass shall be less than 5.4 megagrams and the vibratory drum shall be not less than 0.5 meter wide.

(b) Type B. Static mass shall be equal to or more than 5.4 megagrams and the vibratory drum shall be not less than 0.5 meter wide.

(c) Type C. Static mass, vibratory drum width and drum surface configuration will be shown on the plans.

(3) Alternate Equipment. In lieu of the equipment specified, the Contractor may, upon written permission from the Engineer, operate other compacting equipment that will produce equivalent relative compaction in the same period of time as the specified equipment. If the substituted compaction equipment fails to produce the desired compaction within the same period of time as would be expected of the specified equipment, as determined by the Engineer, its use shall be discontinued and the Contractor will be required to furnish the specified equipment.

217.3. Construction Methods. This work shall be done only when directed by the Engineer. Sufficient rollers shall be provided to compact the material in a satisfactory manner. When operations are so isolated from one another that one roller unit cannot perform the required compaction satisfactorily, additional roller units shall be provided.

The Contractor shall furnish the Engineer the equipment Manufacturer's specifications concerning operating amplitude and frequency controls and settings.

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The vibratory roller shall be operated in such a manner so as to produce the necessary compaction as specified in the pertinent bid items, together with the following requirements:

(1) The vibration unit shall not be operated when the roller is stationary or when it is in contact with compacted finished embankment or pavement structure layer.

(2) In case of over vibration resulting in disruption of the compacted material, the Contractor shall rework and recompact or replace the damaged material at his own expense.

(3) When compacting asphaltic concrete pavement, the vibrating roller shall be operated at a speed that will produce not less than 30 impacts (blows) per meter, unless otherwise shown on the plans or approved by the Engineer.

(4) When compacting asphaltic concrete pavement, the drum(s) shall be kept in a moist condition with water.

217.4. Measurement. When shown on the plans to be a pay item, this Item will be measured by the actual hours the roller works as directed by the Engineer.

217.5. Payment. The cost of furnishing and operating the equipment in accordance with this Item will not be paid for directly but will be considered subsidiary to the various bid items of the contract, unless this Item is specified as a pay item in the contract.

When vibratory rolling is specified as a pay item, the rollers furnished and operated in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Rolling (Vibratory)", of the type specified. This price shall be full compensation for furnishing and operating all equipment; and for all labor, fuel, tools and incidentals necessary to satisfactorily perform the work.

ITEM 247

FLEXIBLE BASE

247.1. Description. This Item shall govern for the delivery, stockpiling and/or the construction of foundation or base courses as herein specified and in conformity with the typical sections and to the lines and grades shown on the plans or established by the Engineer.

247.2. Materials. The flexible base material shall be crushed or uncrushed as necessary to meet the requirements herein, and shall consist of durable coarse aggregate particles and binding materials.

(1) General. When off right of way sources are involved, the Contractor's attention is directed to Item 7, "Legal Relations and Responsibilities to the Public".

(2) Physical Requirements.

(a) General. All types shall meet the physical requirements for the specified grade(s) as set forth in Table 1.

Additives, such as, but not limited to, lime, cement or fly ash, shall not be used to alter the soil constants or strengths shown in Table 1, unless otherwise shown on the plans.

Unless otherwise shown on the plans, the base material shall have a minimum Bar Linear Shrinkage of 2 percent as determined by Test Method Tex-107-E, Part II.

The flexible base shall be one of the following types, as follows:

(b) Type A. Type A material shall be crushed stone produced from oversize quarried aggregate, sized by crushing and produced from a naturally occurring single source. Crushed gravel or uncrushed gravel shall not be acceptable for Type A material. No blending of sources and/or additive materials will be allowed in Type A material.

(c) Type B. Type B material shall be crushed or uncrushed gravel.

(d) Type C. Type C material shall be crushed gravel. Unless otherwise shown on the plans, crushed gravel shall have a minimum of 60 percent of the particles retained on the 4.75 millimeter sieve with two (2) or more crushed faces as determined by Test Method Tex-460-A, Part I.

(e) Type D. As shown on the plans.

TABLE 1
PHYSICAL REQUIREMENTS

GRADE 1	GRADE 2	GRADE 3
Triaxial Class 1: Min. compressive strength, kPa: 310 at 0 kPa lateral pressure and 1206 at 103 kPa lateral pressure	Triaxial Class 1 to 2.3: Min. compressive strength, kPa: 241 at 0 kPa lateral pressure and 1206 at 103 kPa lateral pressure	Triaxial Class - Unspecified
Master Grading	Master Grading	Master Grading
45 mm 0	63 mm 0	63 mm 0
22.4 mm 10-35	45 mm 0-10	45 mm 0-10
9.5 mm 30-50	4.75 mm 45-75	4.75 mm 30-75
4.75 mm 45-65	425 µm 60-85	425 µm 50-85
425 µm 70-85		
Max LL.....35	Max LL.....40	Max LL 40
Max PI.....10	Max PI.....12	Max PI 12
Wet Ball Mill Max.....40	Wet Ball Mill Max 45	Wet Ball Mill Max 50
Max increase in passing 425 µm.....20	Max increase in passing 425 µm 20	Max increase in passing 425 µm..... 20

GRADE 4	GRADE 5	GRADE 6
Triaxial Class Unspecified Master Grading 45 mm.....0 4.75 mm.....45-75 425 µm.....50-85 Max LL .....40 Max PI.....12	Triaxial Class Unspecified Master Grading 45 mm.....0 425 µm.....50-85 Max LL .....40 Max PI 12	As Shown on the Plans

Notes:
1. Gradation requirements are percent retained on square sieves.
2. When a magnesium soundness value is shown on the plans the material will be tested in accordance with Test Method Tex-411-A.
3. When lightweight aggregates are used, the wet ball mill requirements will not apply and the lightweight aggregate shall meet the Los Angeles Abrasion, Pressure Slaking and Freeze Thaw requirements of Item 303, "Aggregate for Surface Treatment (Lightweight)".

(3) Pilot Grading. When pilot grading is required on the plans, the flexible base shall not vary from the designated pilot grading of each sieve size by more than five (5) percentage points. However, the flexible base grading shall be within the master grading limits as shown in Table 1. The pilot grading may be varied by the Engineer as necessary to insure that the base material produced will meet the physical requirements shown in Table 1.

(4) Testing. Testing of flexible base materials shall be in accordance with the following Department standard laboratory test procedures:

Moisture Content	Tex-103-E
Liquid Limit	Tex-104-E
Plasticity Index	Tex-106-E
Bar Linear Shrinkage	Tex-107-E, Part II

Sieve Analysis	Tex-110-E
Moisture-Density Determination	Tex-113-E
Roadway Density	Tex-115-E
Wet Ball Mill	Tex-116-E
Triaxial Tests (Part I or II as selected by the Engineer)	Tex-117-E
Particle Count	Tex-460-A, Part I

Samples for testing the base material for triaxial class, soil constants, gradation and wet ball mill will be taken prior to the compaction operations.

(5) Tolerances. Unless otherwise shown on the plans, the limits establishing reasonably close conformity with the specified gradation and plasticity index are defined by the following:

(a) Gradation. The Engineer may accept the material, providing not more than one (1) out of the most recent five (5) consecutive gradation tests performed are outside the specified limits for master grading or pilot grading, as applicable, on any individual sieve by no more than five (5) percentage points.

(b) Plasticity Index. The Engineer may accept the material providing not more than one (1) out of the most recent five (5) consecutive plasticity index samples tested are outside the specified limit by no more than two (2) percentage points.

(6) Material Sources. The flexible base material shall be furnished by the Contractor. When a non-commercial source is utilized, it shall be opened in such manner as to immediately expose the vertical faces of all the various strata of acceptable material. Unless otherwise approved by the Engineer, the material shall be secured and processed by successive vertical cuts extending through all of the exposed strata.

Unless otherwise shown on the plans, the flexible base material shall be temporarily stockpiled prior to delivery to the roadway. Unless other- wise shown on the plans, the stockpile shall not be less than three (3) meters in height and shall be made up of layers not greater than 600 millimeters in thickness. After a sufficient stockpile has been constructed the Contractor may proceed with loading from the stockpile for

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delivery. In loading from the stockpile for delivery, the material shall be loaded by making successive vertical cuts through the entire depth of the stockpile.

When temporary stockpiles are to be tested for acceptance prior to delivery to its intended use, any stockpile that has been sampled and accepted shall not have material added or removed unless otherwise approved by the Engineer. The Contractor will be charged for additional sampling and testing required as a result of material being removed from a previously approved stockpile without the approval of the Engineer. Such charges will be deducted from the Contractor's estimates.

Blending of materials from more than one (1) source to produce Type B, C or D flexible base will be allowed when approved by the Engineer.

247.3. Construction Methods.

(1) Complete In Place

(a) Preparation of Subgrade or Existing Roadbed. Prior to de- livery of the base material, the subgrade or existing roadbed shall be shaped to conform to the typical sections, shown on the plans or established by the Engineer. This work shall be done in accordance with the provision of the applicable bid items.

When shown on the plans and directed by the Engineer, the Contractor shall proof roll the roadbed in accordance with Item 216, "Rolling (Proof)". Soft spots shall be corrected as directed by the Engineer.

(b) First Course. It shall be the responsibility of the Contractor to deliver the required amount of base material to each 30 meters. Base material shall be spread uniformly and shaped the same day as delivered. In the event inclement weather or other unforeseen circumstances render this impractical, the material shall be shaped as soon as practical.

Prior to compacting the flexible base, the flexible base material shall be bladed and shaped to conform to the typical sections as shown on the plans. All areas of segregated coarse or fine material shall be corrected or removed and replaced with well graded material, as directed by the Engineer and at the Contractor's expense.

The Contractor shall sprinkle for dust control as directed by the

Engineer.

(c) Succeeding or Finish Courses. Construction methods shall be the same as required for the first course. Throughout this entire operation, the shape of each course shall be maintained by blading. Upon completion, the surface shall be smooth and in conformity with the typical section as shown on the plans and the established lines and grades. Prior to placing the surfacing on the completed base, the base shall be cured to the extent directed by the Engineer.

(d) Compaction Method. The flexible base shall be compacted by "Density Control". Water used for compaction shall conform to the material requirements of Item 204, "Sprinkling".

The flexible base shall be sprinkled as required and compacted to the extent necessary to provide not less than 100 percent density as determined by Test Method Tex-113-E, unless otherwise shown on the plans. After each section of flexible base is completed, tests as necessary will be made by the Engineer in accordance with Test Method Tex-115-E. When the material fails to meet the density requirements, or it loses the required stability, density or finish before the next course is placed or the project is completed, it shall be reworked and retested in accordance with Section
247.3.(1)(e).

(e) Reworking a Section. Should the base course, due to any reason or cause, lose the required stability, density or finish before the surfacing is complete, it shall be reworked, recompacted and refinished at the sole expense of the Contractor.

(f) Tolerances. Tolerances shall conform to the following:

(i) Density Tolerances. The Engineer may accept the work providing not more than one (1) out of the most recent five (5) consecutive density tests performed is below the specified density, and providing that the failing test is no more than 50 kilograms per cubic meter below the specified density.

(ii) Grade Tolerances. In areas on which surfacing is to be placed, any deviation in excess of six (6) millimeters in cross section or six (6)

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millimeters in a length of five (5) meters measured longitudinally shall be corrected by loosening, adding or removing material, reshaping and

recompacting by sprinkling and rolling.

(g) Thickness Measurement. When the measurement is by the square meter, the flexible base will be measured for depth in units of 3300 square meters, or fraction thereof. The measurements will be at location(s) determined by the Engineer and performed in accordance with Test Method Tex-140-E. In any unit where flexible base is deficient by more than 13 millimeters in thickness, the deficiency shall be corrected by scarifying, adding material as required, reshaping, recompacting and refinishing at the Contractor's expense.

(2) Roadway Delivery. It shall be the responsibility of the Contractor to deliver the required amount of base material to each 30 meters. All processing or manipulations will be in accordance with the applicable bid items.

(3) Stockpile Delivery. It shall be the responsibility of the Contractor to prepare the stockpile site, to provide and deliver the required amount of base material to the designated stockpile site and to construct the stockpile. Unless otherwise shown on the plans, the stockpile shall not be less than three (3) meters in height and shall be made up of layers not to exceed 0.6 meter in thickness.

247.4. Measurement. This Item will be measured by either Measurement Class 1, 2, 3, 4, or 5 as shown on the plans:

(1) Measurement Class 1. Measurement will be by the cubic meter in vehicles of uniform capacity.

(2) Measurement Class 2. Measurement will be by the megagrams of dry mass in vehicles as delivered. A set of standard platform truck scales conforming to the requirements of Item 520, "Weighing and Measuring Equipment", shall be furnished by the Contractor and placed at a location approved by the Engineer. When the material is weighed during mixing or batching, reweighing will not be necessary. The dry mass will be determined by deducting the mass of the moisture in the material at the time of weighing from the gross mass of the material. The moisture in the material will be determined in accordance with Test Method Tex-103-E at least once each day and more often if conditions warrant.

(3) Measurement Class 3. Measurement will be by the cubic meter in the final stockpile position. The volume of flexible base will be computed in

place between the natural ground and the top of the stockpile by the method of average end areas.

(4) Measurement Class 4. Measurement will be by the cubic meter in the completed and accepted final position. The volume of base course will be computed in place between the original subgrade or subbase surfaces, and the lines, grades and slopes of the accepted base course as shown on the plans by the method of average end areas.

Measurement Class 4 is plan quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment is required, additional measurements or calculations will not be required. No payment will be made for thickness or width exceeding that shown on the typical section or provided on the plans.

(5) Measurement Class 5. Measurement will be by the square meter of surface area in the completed and accepted position. The surface area of the base course will be based on the width of flexible base as shown on the plans.

Measurement Class 5 is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment is required, additional measurements or calculations will not be required. No payment will be made for thickness or width exceeding that shown on the typical section or provided on the plans.

247.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Flexible Base (Complete in Place)" of the type, grade, measurement class specified and depth specified (for measurement Class 5); for "Flexible Base (Roadway Delivery)" of the type, grade, measurement class specified and depth specified (for measurement Class 5); and for "Flexible Base (Stockpile Delivery)" of the type, grade, measurement class specified and depth specified (for measurement Class 5). This price shall be full compensation for securing and furnishing all

251.1

materials, including royalty and freight involved; for furnishing scales and labor involved in weighing the material when required; for loosening, blasting, excavating, screening, crushing and temporary stockpiling when required; for loading all materials; for all hauling and delivering and for all manipulations; sprinkling; for rolling, except for proof rolling; sprinkling for dust control, for

labor, tools and incidentals necessary to complete the work except as follows:

When the plans specify "Flexible Base (Complete in Place)", the unit price bid shall be full compensation for shaping and fine grading the roadbed; and for spreading, mixing, blading, compacting, shaping, finishing, and curing the base material.

When the plans specify "Flexible Base (Roadway Delivery)", the unit price bid will not include processing at the roadway. Measurement will be only by Measurement Class 1 or 2.

When the plans specify "Flexible Base (Stockpile Delivery)", the unit price bid also will be full compensation for preparing the stockpile area and for spreading and shaping the material in the stockpile. Measurement will be only by Measurement Class 1, 2, or 3.

When proof rolling is shown on the plans, and when directed by the Engineer, it will be paid for in accordance with Item 216, "Rolling (Proof)".

When subgrade is constructed under this project, correction of soft spots will be at the Contractor's expense. When subgrade is not constructed under this project, correction of soft spots in the subgrade or existing roadbed will be in accordance with Article 4.3.

ITEM 251

REWORKING BASE MATERIAL

251.1. Description. This Item shall govern for reworking existing base material (with or without an asphaltic concrete pavement) in accordance with the requirements as herein specified and as shown on the plans. This Item shall also govern for incorporation of new base material when shown on the plans.

251.2 to 251.4

251.2. Types of Work. Reworking base material shall consist of one (1) of the following types of work.

Type A. Scarifying only.

Type B. Scarifying, Salvaging and Replacing.

Type C. Scarifying, Salvaging and Stockpiling.

Type D. Scarifying and Reshaping.

Scarifying shall consist of loosening and breaking the existing base material.

Salvaging shall consist of removing, saving and temporarily stockpiling, if necessary, the existing base material.

Stockpiling shall consist of final storage of the salvaged base material at the location shown on the plans or as directed by the Engineer.

Replacing shall consist of returning and reworking the salvaged base material, with or without additional new base material, on the prepared roadbed.

Reshaping shall consist of reworking the in-place base material with or without additional new base material.

251.3. Materials.

(1) Flexible Base. New base material shall meet the material requirements of Article 247.2 for the type and grade as shown on the plans.

(2) Water. Water shall meet the material requirements of Item 204, "Sprinkling".

251.4. Construction Methods.

(1) General. The work shall be performed to the width and depth shown on the typical sections and as specified below for the type of work shown on the plans:

251.4

(2) Removal of Asphaltic Concrete Pavement. When shown on the plans, any asphaltic concrete pavement, including any accompanying surface treatment, plant-mix seal and micro-surfacing, shall be removed prior to scarifying the existing base material. The Contractor shall make any necessary provision to prevent contamination of the asphaltic material during and after

removal of the asphaltic material. Removal of the asphaltic material shall be in accordance with the applicable bid items. When the existing pavement consists only of a surface treatment, it will not be removed before scarifying.

(3) Type of Work.

(a) Type A (Scarifying only). The existing base, with or without existing asphaltic concrete pavement, shall be scarified for its full width and depth, unless otherwise shown on the plans. All material shall be broken into particles of a maximum size as approved by the Engineer, or as shown on the plans.

(b) Type B (Scarifying, Salvaging and Replacing).

(i) Scarifying. The existing base, with or without existing asphaltic concrete pavement, shall be cleaned of all objectionable materials by blading, brooming or other approved methods, prior to scarifying. After cleaning, the existing material shall be scarified for its full width and depth, unless otherwise shown on the plans. However, in no case shall the underlying subgrade be disturbed. Unless otherwise shown on the plans, the material shall be broken into particles of not more than 63 millimeters in size.

(ii) Salvaging. All salvaging operations, including temporary stockpiling or windrowing, shall be conducted in such a manner as not to interfere with traffic, proper drainage or the general requirements of the work. All material shown on the plans to be salvaged shall be kept reasonably free of soil from the subgrade or roadbed during the salvaging operation. The scarified material shall be removed from the roadbed using equipment approved by the Engineer. The salvaged material may be placed in temporary stockpiles or windrows until sufficient subgrade has been prepared to receive the material.

(iii) Replacing.

(*) Preparation of Subgrade. Prior to replacing the salvaged material, the subgrade shall be constructed and shaped to conform to the typical sections as shown on the plans or as established by the Engineer. This work shall be done in accordance with the provisions of applicable bid items.

Prior to replacing the salvaged material, when shown on the plans and when directed by the Engineer, the Contractor shall proof roll the roadbed in accordance with Item 216, "Rolling (Proof)". Soft spots shall be corrected as directed by the Engineer.

(*) Replacement of Salvaged Material. The salvaged material shall be deposited on the prepared subgrade, sprinkled if directed, bladed, and shaped to conform to the typical sections shown on the plans or as directed by the Engineer.

New base material, when shown on the plans to be mixed with the salvaged base material, shall be placed and uniformly incorporated with the salvaged material.

All areas and nests of segregated material shall be corrected or removed and replaced with satisfactory and/or new material as directed by the Engineer. All salvaged material shall be kept reasonably free of objectionable materials during the replacing operations.

The replaced material shall conform to the compaction requirements of Article 251.5 and the grade tolerances of Article 251.6.

(4) Type C (Scarifying, Salvaging and Stockpiling).

(a) Scarifying. The existing base, with or without existing asphaltic concrete pavement, shall be cleaned of all objectionable materials by blading, brooming or other approved methods, prior to scarifying. After cleaning, the existing material shall be scarified for its full width and depth, unless otherwise shown on the plans. However, in no case shall the underlying subgrade be disturbed. Unless otherwise shown on the plans, the material shall be broken into particles of not more than 63 millimeters in size.

(b) Salvaging. All salvaging operations, including temporary stockpiling or windrowing, shall be conducted in such a manner as not to interfere with traffic, proper drainage or the general requirements of the work. All material shown on the plans to be salvaged shall be kept reasonably free of soil from the subgrade or roadbed during the salvaging operation. The scarified material shall be removed from the roadbed using equipment approved by the Engineer. Scarified material may be placed in temporary stockpiles or windrows prior to loading into approved equipment

for hauling to the final stockpile site.

(c) Stockpiling. Trash, wood, brush, stumps and other objection- able materials at the final storage (stockpile) site shall be removed and disposed of as shown on the plans or as approved by the Engineer prior to the stockpiling of salvaged base material. The Contractor shall prepare the stockpile site and shall deliver the salvaged material to the prepared final stockpile area. The material shall be worked into a neat stockpile as shown on the plans or as approved by the Engineer.

(5) Type D (Scarifying and Reshaping).

(a) Preparation of Subgrade. Prior to scarifying the existing base, if required, any new subgrade shall be constructed and shaped to conform to the typical sections as shown on the plans or as established by the Engineer. This work shall be done in accordance with the provisions of applicable bid items.

(b) Scarifying. The existing base, with or without existing asphaltic concrete pavement, shall be cleaned of all objectionable materials by blading, brooming or other approved methods, prior to scarifying. After cleaning, the existing material shall be scarified for its full width and depth, unless otherwise shown on the plans. However, in no case shall the underlying subgrade be disturbed. Unless otherwise shown on the plans, the material shall be broken into particles of not more than 63 millimeters in size.

(c) Reshaping. After completion of scarifying, the existing base shall be mixed and shaped to conform to the typical sections shown on the plans. However, in no case, shall the underlying subgrade be disturbed.

New base material, when shown on the plans to be mixed with the scarified material, shall be placed on the existing scarified material, and uniformly incorporated.

The reshaped material shall conform to the compaction requirements of Article 251.5 and the grade tolerances of Article 251.6.

251.5. Compaction Methods.

(1) General. The base material shall be compacted either by "Ordinary Compaction" or "Density Control" as shown on the plans.

(2) Ordinary Compaction. When "Ordinary Compaction" is shown on the plans, the following provisions shall apply:

The material shall be sprinkled and rolled as directed by the Engineer. Compaction equipment shall be approved by the Engineer. All irregularities, depressions or weak spots which develop shall be corrected immediately by scarifying the areas and recompacting by sprinkling and rolling.

Should the material lose the required stability, compaction or finish before the next course is placed, or the project is accepted, it shall be reworked in accordance with Subarticle 251.5.(4). However, compaction shall be in accordance with "Ordinary Compaction".

(3) Density Control. When "Density Control" is shown on the plans the following provisions shall apply:

Unless otherwise shown on the plans, each course shall be sprinkled as required and compacted to the extent necessary to provide not less than 98 percent of the optimum density as determined by Test Method Tex-113-E. Roadway density testing will be as outlined in Test Method Tex-115-E.

When the material fails to meet the density requirements, or should the material lose the required stability, density or finish before the next course is placed, or the project is accepted, it shall be reworked in accordance with Subarticle 251.5.(4).

(4) Reworking a Section. Should the reworked base material, due to any reason or cause, lose the required stability, density or finish before

the next course is placed or the project is accepted, it shall be recompacted and refinished at the Contractor's expense.

251.6. Tolerances. Tolerances shall conform to the following:

(1) Density Tolerances. The Engineer may accept the work providing not more than one (1) out of the most recent five (5) density tests performed is below the specified density provided the failing test is no more

than 50 kilograms per cubic meter below the specified density.

(2) Grade Tolerances. In areas on which pavement is to be placed, any deviation in excess of six (6) millimeters in cross section or six (6) millimeters in a length of five (5) meters measured longitudinally shall be corrected by loosening, adding or removing material, reshaping and recompacting by sprinkling and rolling.

251.7. Measurement. This Item will be measured by one (1) of the following methods:

Class 1. Measurement will be by the 1-kilometer, or portion of, measured along the centerline of each roadbed as defined in Item 1, "Definition of Terms".

Class 2. Measurement will be by the square meter of the existing base or pavement in its original position. When Class 2 measurement is used, the limits of measurement will be as shown on the plans.

This class is a plans quantity measurement and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required. No payment will be made for thickness or width exceeding that shown on the typical sections or provided on the plans.

Class 3. Measurement will be by the cubic meter of salvaged material in vehicles as delivered at the stockpile.

Class 4. Measurement will be by the cubic meter of salvaged material measured by the average-end-area method in the stockpile.

Class 5. Measurement will be by the cubic meter in its original position measured by the average-end-area method.

This class is a plans quantity measurement and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required. No payment will be made for thickness or width exceeding that shown on the typical sections or provided on the plans.

Class 6. Measurement will be by the megagram, dry mass as delivered at the stockpile. When the plans indicate that measurement of the material is to be by the megagram, a set of standard platform truck scales conforming to the requirements of Item 520, "Weighing and Measuring Equipment", shall be furnished by the Contractor and placed at a location approved by the Engineer. The dry mass will be determined by deducting the mass of the moisture from the gross mass. The moisture content in the material will be determined by Test Method Tex-103-E, from samples taken at the time of truck weighing, at least once each day and more often if conditions warrant.

251.8. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Reworking Base Material" of the type, class, scarified depth, and compaction method shown on the plans, together with the following conditions.

Measurement and payment for "Reworking Base Material (Type A)" will be restricted to Class 1, 2.

Measurement and payment for "Reworking Base Material (Type B)" will be restricted to Class 1, 2, or 5.

Measurement and payment for "Reworking Base Material (Type C)" will not be restricted to any Class.

Measurement and payment for "Reworking Base Material (Type D)" will be restricted to Class 1, 2, or 5.

260.1

The unit price bid shall be full compensation for furnishing all labor, tools, equipment, materials, supplies, and incidentals necessary to complete the work, except as follows:

When new base material is mixed with the existing base material, furnishing and delivery of the new base will be paid for as "Flexible Base (Roadway Delivery)" for the type, grade, and class shown on the plans, in accordance with Article 247.5. All manipulation including mixing, spreading, blading, shaping and finishing of the new and existing base material will not be paid for directly, but will be considered subsidiary to this Item.

When "Ordinary Compaction" is shown on the plans, all sprinkling and

rolling, except proof rolling, will not be paid for directly but will be considered subsidiary to this Item, unless otherwise shown on the plans.

When "Density Control" is shown on the plans, all sprinkling and rolling, except proof rolling, will not be paid for directly but will be considered subsidiary to this Item.

When proof rolling is shown on the plans and when directed by the Engineer, it will be paid for in accordance with Item 216, "Rolling (Proof)".

When subgrade is constructed under this project, correction of soft spots will be at the Contractor's expense. When subgrade is not constructed under this project, correction of soft spots will be in accordance with Article 9.3.

Removal of any asphaltic material will be paid for in accordance with the applicable bid items.

ITEM 260

LIME TREATMENT FOR MATERIALS USED AS SUBGRADE (ROAD MIXED)

260.1. Description. This Item shall govern for treating the new or existing subgrade, the existing pavement structure or a combination thereof to be used as subgrade by pulverizing, adding lime, mixing, and compacting the mixed material as specified in this Item.

260.2. Materials.

(1) Lime. The lime shall meet the requirements of Item 264, "Lime and Lime Slurry", for the type of lime specified.

The Contractor shall have the option of selecting from the types shown on the plans, the type of lime to be used. The Engineer shall be notified in writing before changing the source or type.

All lime slurries used in "Slurry Placing" shall be furnished at or above the minimum "Dry Solids" content as approved by the Engineer.

(2) Water. Water shall meet the material requirements of Item 204, "Sprinkling".

(3) Asphalt. Asphalt shall conform to the requirements of Item 300, "Asphalts, Oils and Emulsions".

260.3. Equipment.

(1) General. The machinery, tools and equipment necessary for proper prosecution of the work on this Item shall be on the project and approved by the Engineer prior to beginning this Item.

All machinery, tools and equipment used shall be maintained in a satisfactory working condition.

(2) Lime Storage. Both quicklime and hydrated lime in dry form shall be suitably stored in closed, weatherproof containers until immediately before use. Storage bins, when used, shall be completely enclosed. Hydrated lime in bags shall be stored in weatherproof buildings with adequate protection from ground dampness. Type C Quicklime, when permitted by the Engineer, shall be shipped only in bulk; bagged material will not be acceptable.

(3) Lime Mass Verification. When lime is furnished in trucks, the mass of lime shall be determined on certified scales or the Contractor shall provide a set of standard platform truck scales at a location approved by the Engineer. Scales shall conform to the requirements of Item 520, "Weighing and Measuring Equipment".

260.4

When Type A Hydrated Lime is furnished in bags, each bag shall bear the manufacturer's certified mass. Bags varying more than five (5) percent from that mass may be rejected and the average mass of bags in any shipment, as shown by weighing 10 bags taken at random, shall not be less than the manufacturer's certified mass.

(4) Slurry Equipment. Type C Quicklime of Grade "DS" or "S", when used to manufacture slurry on the project, or other location approved by the Engineer shall be slurried in agitated slurry tanks. The slurrying of Type C Quicklime must be handled in such a way as not to generate any dust hazardous to job personnel or to the public or be potentially damaging to any adjacent property.

The distributor truck used for slurry placing need not necessarily be

equipped with an agitator; however, the slurry at the time of distribution must meet the consistency requirements specified. The Contractor shall, if necessary, use appropriate equipment to achieve the consistency requirements under Section 260.4.(4)(b).

For Type B Commercial Lime Slurry, the distributor truck shall be equipped with a sampling device in accordance with Test Method Tex-600-J, Part I.

260.4. Construction Methods.

(1) General. The completed course shall be uniformly treated, free from loose or segregated areas, of uniform density and moisture content, well bound for its full depth and shall have a smooth surface.

(2) Preparation of Subgrade or Existing Base. Prior to treating existing material, it shall be shaped to conform to the typical sections, as shown on the plans or as established by the Engineer. This work shall be done in accordance with the provisions of applicable bid items. When shown on the plans, any existing asphaltic concrete pavement shall be removed and will be paid for in accordance with applicable bid items.

Before pulverizing or scarifying an existing material, when shown on the plans and when directed by the Engineer, the Contractor shall proof roll the roadbed in accordance with Item 216, "Rolling (Proof)". Soft spots shall be corrected as directed by the Engineer.

When the Contractor elects to use a cutting and pulverizing machine that will process the material to the plan depth, the Contractor will not be required to excavate to the secondary grade or windrow the material. This method will be permitted only if a machine is provided which will insure that the material is cut uniformly to the proper depth and which has cutters that will plane the secondary grade to a uniform surface over the entire width of the cut. The machine shall provide a visible indication of the depth of cut at all times.

In lieu of using the cutting and pulverizing machine, the Contractor shall excavate and windrow the material to expose the secondary grade to the typical sections, lines and grades as shown on the plans or as established by the Engineer.

(3) Pulverization. The existing pavement or base material shall be

pulverized or scarified so that 100 percent shall pass the 50 millimeter sieve.

(4) Application. The percentage by mass or kilograms per square meter of lime to be added will be as shown on the plans and may be varied by the Engineer if conditions warrant.

Lime shall be spread only on that area where the mixing operations can be completed during the same working day, except as required for quicklime in Subarticle 260.4.(5).

Unless otherwise approved by the Engineer, the lime operation shall not be started when the air temperature is below 5 °C and falling, but may be started when the air temperature is above 2 °C and rising. The temperature will be taken in the shade and away from artificial heat. Lime shall not be placed when weather conditions in the opinion of the Engineer are unsuitable.

CAUTION: Use of quicklime can be dangerous. Users should be informed of the recommended precautions in handling, storage and use of quicklime.

The application and mixing of lime with the material shall be accomplished by the methods herein described as "Dry Placing" or "Slurry

Placing". Type A Hydrated Lime shall be applied by "Slurry Placing" unless otherwise shown on the plans or approved by the Engineer. Type B Commercial Lime Slurry shall be applied by "Slurry Placing". Type C Quicklime shall be applied by "Slurry Placing" or "Dry Placing" as shown on the plans. The method of applying Type C Quicklime may be changed if approved in writing by the Engineer. When Type C Quicklime is used for dry placement, it shall be Grade "DS". When Type C Quicklime is used for slurry placement, it shall be either Grade "DS" or Grade "S". Grade "S" shall be used in slurry placement only.

(a) Dry Placing. The lime shall be distributed by a spreader approved by the Engineer or by bag distribution for Type A Hydrated Lime at the rate shown on the plans or as directed by the Engineer.

The lime shall be distributed at a uniform rate and in such a manner as to reduce the scattering of lime by wind. Lime shall not be applied when wind conditions, in the opinion of the Engineer, are such that blowing lime becomes objectionable to adjacent property owners or dangerous to traffic.

A motor grader shall not be used to spread Type A Hydrated Lime, but may be used to spread Type C Quicklime, Grade "DS".

The material shall be sprinkled as approved by the Engineer.

(b) Slurry Placing. When Type A Hydrated Lime is specified and slurry placement is to be used, the Type A Hydrated Lime shall be mixed with water to form a slurry with a solids content approved by the Engineer.

Type B Commercial Lime Slurry shall be delivered to the project in slurry form at or above the minimum dry solids content approved by the Engineer. The distribution of lime at the rate(s) shown on the plans or approved by the Engineer shall be attained by successive passes over a measured section of roadway until the proper lime content has been secured.

When Type C Quicklime is applied as a slurry, the amount of dry quicklime shall be 80 percent of the amount shown on the plans. The slurry shall contain at least the minimum dry solids content approved by the Engineer. The residue from the slurrying procedure shall be spread uniformly over the length of the roadway currently being processed unless otherwise approved by the Engineer. This residue is primarily inert material with little stabilizing value, but may contain a small amount of

quicklime particles that slake slowly. A concentration of these particles could cause the compacted stabilized material to swell during slaking.

Slurry Consistency Requirements

Slurry shall be of such consistency that it can be applied uniformly without difficulty.

When the distributor truck is not equipped with an agitator, the Contractor shall have a standby pump available on the project for agitating the lime and water as required by the Engineer in case of undue delays in dispersing the slurry.

(5) Mixing. The mixing procedure shall be the same for "Dry Placing" or "Slurry Placing" as herein described.

During the interval between application and mixing, hydrated lime that has been exposed to the open air for a period of six (6) hours or more or to excessive loss due to washing or blowing will not be accepted for payment.

The material and lime shall be thoroughly mixed by equipment approved by the Engineer. The material and lime shall be brought to the proper moisture content and may be left to cure one (1) to four (4) days as approved by the Engineer or the mixing continued until a homogeneous friable mixture of material and lime is obtained.

In addition to the above, when Type C Quicklime, Grade "DS", is used under "Dry Placing", the material and lime shall be mixed as thoroughly as possible at the time of the lime application. Sufficient moisture shall be added during the mixing to hydrate the quicklime. After mixing, and prior to compaction, the mixture of material, quicklime and water shall be moist cured for two (2) to seven (7) days, as approved by the Engineer. After curing, mixing shall continue until the pulverization requirements are met.

When shown on the plans or approved by the Engineer, the pulverization requirement may be waived when the material contains a substantial quantity of aggregate.

Following mixing, a sample of the material at roadway moisture will be obtained for pulverization testing. All nonslaking aggregates retained on the 19.0 millimeter sieve will be removed from the sample. The remainder of the material shall meet the following pulverization requirement when tested by Test Method Tex-101-E, Part III:

	Percent
Minimum passing 45 mm sieve	100
Minimum passing 19.0 mm sieve	85

(6) Compaction Methods. Prior to compaction, the material shall be aerated or sprinkled as necessary to provide the optimum moisture. Compaction of the mixture shall begin immediately after the pulverization requirement is met.

Compaction shall continue until the entire depth of the mixture is uniformly compacted by "Ordinary Compaction" or "Density Control" as shown on the plans. Throughout this entire operation the shape of the course shall be maintained by blading, and the surface upon completion shall be smooth and in conformity with the typical sections, lines and grades as shown on the plans or as established by the Engineer.

When shown on the plans or approved by the Engineer, multiple lifts will be permitted.

(a) Ordinary Compaction. When "Ordinary Compaction" is shown on the plans the following provisions shall apply:

The material shall be sprinkled and rolled as directed by the Engineer. All irregularities, depressions or weak spots which develop shall be corrected immediately by scarifying the areas affected, adding or removing material as required, reshaping and recompacting by sprinkling and rolling.

Should the material lose the required stability, compaction or finish before the next course is placed or the project is accepted, it shall be reworked in accordance with Subarticle 260.4.(7). However, compaction shall be in accordance with "Ordinary Compaction".

(b) Density Control. When "Density Control" is shown on the plans the following provisions shall apply:

Unless otherwise shown on the plans, each course shall be sprinkled as required and compacted to the extent necessary to provide not less than 95 percent of the optimum density as determined by Test Method Tex-121-E, Part II. Roadway density testing will be as outlined in Test Method Tex-115-E.

When the material fails to meet the density requirements, or should the material lose the required stability, density or finish before the next course is placed, or the project is accepted, it shall be reworked in accordance with Subarticle 260.4.(7).

(7) Reworking a Section. When a section is reworked within 72 hours after completion of compaction, the Contractor shall rework the section to provide the required compaction. When a section is reworked more than 72 hours after completion of compaction, the Contractor shall add 25 percent of the specified rate of lime. Reworking shall include loosening, road mixing as approved by the Engineer, compacting, and finishing. When a section is reworked, a new optimum density will be determined from the reworked material in accordance with Test Method Tex-121-E, Part II.

(8) Finishing and Curing. After the final layer or course of the lime treated material has been compacted, it shall be brought to the required lines and grades in accordance with the typical sections.

The completed section shall then be finished by rolling with a pneumatic tire or other suitable roller as approved by the Engineer. The completed section shall be moist cured or prevented from drying by addition of an asphalt material at the rate of 0.2 to 0.9 liter per square meter as determined by the Engineer. This material shall be the type shown on the plans. Curing shall continue for seven (7) days before further courses are added or traffic is permitted, unless otherwise approved by the Engineer.

However, the lime treated material may be covered by other courses, the day following finishing, when approved by the Engineer. When the plans provide for the treated material to be covered by other courses of material, the next course shall be applied within 14 calendar days after final compaction is completed, unless otherwise approved by the Engineer.

260.5 to 260.6

260.5. Tolerances. Tolerances shall conform to the following:

(1) Density Tolerances. The Engineer may accept the work providing not more than one (1) out of the most recent five (5) density tests performed is below the specified density, provided the failing test is no more than 50 kilograms per cubic meter below the specified density.

(2) Grade Tolerances. Finished grade tolerances shall be in accordance with Subarticle 132.4.(1).

260.6. Measurement. This Item will be measured as follows:

(1) Lime.
(a) Type A.

(i) Hydrated Lime (Dry). When **Type A** Hydrated Lime is used under **"Dry Placing"**, the quantity of lime will be measured by the megagram, dry mass.

(ii) Hydrated Lime (Slurry). When **Type A** Hydrated Lime is used under **"Slurry Placing"**, the quantity of lime will be measured by the megagram, dry mass of the hydrated lime used to prepare the lime slurry at the job site.

(b) Type B.

Commercial Lime Slurry. When **Type B** Commercial Lime **Slurry** is used, the quantity of lime will be calculated from the **minimum** percent "Dry Solids Content" of the slurry previously agreed upon for the project by the Contractor and the Engineer. This figure will be multiplied by the mass of the slurry in megagrams delivered, which must be at or above the required minimum "Dry Solids Content".

(c) Type C.

(i) Quicklime (Dry). When **Type C** Quicklime is used under **"Dry Placing"**, the quantity of lime will be measured by the megagram, dry mass of the quicklime actually delivered on the road.

260.7

(ii) Quicklime (Slurry). When **Type C** Quicklime is used under **"Slurry Placing"**, the quantity will be measured by the megagram, dry mass of the quicklime used to prepare the hydrated lime slurry. The measured megagrams of Type C Quicklime will be multiplied by a conversion factor of 1.28 to give the quantity of equivalent hydrated lime, which will be the basis of payment.

(2) Lime Treatment. Lime treatment will be measured by the square meter of the depth specified to the lines and grades shown on the typical sections.

260.7. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for as follows:

(1) Lime. Lime will be paid for at the unit price bid for "Lime" of one of the following specified types, which price will be full compensation for furnishing all lime.

(a) Type A (Dry)
(b) Type A (Slurry)
(c) Type B
(d) Type C (Dry)
(e) Type C (Slurry)

Lime for reworking a section in accordance with Subarticle 260.4.(7) will not be paid for directly but will be subsidiary to this Item.

(2) Lime Treatment. "Lime Treated Subgrade (Ordinary Compaction)" or "Lime Treated Subgrade (Density Control)" of the depth specified will be paid for at the unit price bid per square meter. This price shall be full compensation for shaping existing material, loosening, mixing, pulverizing, spreading, drying, applying lime, water content of the slurry, compacting, curing including curing materials, shaping and maintaining, processing, hauling, reworking if required, preparing secondary subgrade, and for all mixing water, tools, equipment, labor, and incidentals necessary to complete the work.

When proof rolling is shown on the plans and directed by the Engineer, it will be paid for in accordance with Item 216, "Rolling (Proof)".

262.1 to 262.2

When "Ordinary Compaction" is shown on the plans, all sprinkling and

rolling, except proof rolling, will not be paid for directly but will be considered subsidiary to this Item, unless otherwise shown on the plans.

When "Density Control" is shown on the plans, all sprinkling and rolling, except proof rolling, will not be paid for directly but will be considered subsidiary to this Item.

When subgrade is constructed under this project, correction of soft spots will be at the Contractor's expense. When subgrade is not constructed under this project, correction of soft spots will be in accordance with Article 9.3.

ITEM 262

LIME TREATMENT FOR BASE COURSES (ROAD MIXED)

262.1. Description. This Item shall govern for treating new and/or existing base and surfacing [with or without asphaltic concrete pavement (ACP)], if shown, by pulverizing, adding lime, mixing and compacting the treated material to the required density as specified herein and in conformity with the typical sections, lines, grades and depths as shown on the plans or as established by the Engineer.

262.2. Materials.

(1) Lime. The lime shall meet the requirements of Item 264, "Lime and Lime Slurry", for the type of lime specified.

The Contractor shall have the option of selecting from the types shown on the plans the type of lime to be used. The Engineer shall be notified in writing before changing source or type.

All lime slurries used in "Slurry Placing" shall be furnished at or above the minimum "Dry Solids Content" as approved by the Engineer.

(2) Flexible Base. New base material shall meet the material requirements of Item 247, "Flexible Base", and shall be of the type and grade shown on the plans.

(3) Water. Water shall meet the material requirements of Item 204,

"Sprinkling".

(4) Asphalt. Asphalt shall conform to the requirements of Item 300, "Asphalts, Oils and Emulsions".

262.3. Equipment.

Equipment shall conform to the requirements of Article 260.3.

262.4. Construction Methods.

(1) General. The completed course shall be uniformly treated, free from loose or segregated areas, of uniform density and moisture content, well bound for its full depth and shall have a smooth surface.

(2) Preparation of Subgrade or Base. Prior to treating existing material and/or placing any new material, the existing material shall be shaped to conform to the typical sections as shown on the plans or as established by the Engineer. This work shall be done in accordance with the applicable bid items. When shown on the plans, any existing ACP shall be removed and will be paid for in accordance with applicable bid items.

Before pulverizing or scarifying an existing material, when shown on the plans, and when directed by the Engineer, the Contractor shall proof roll the roadbed in accordance with Item 216, "Rolling (Proof)". Soft spots shall be corrected as directed by the Engineer.

When the Contractor elects to use a cutting and pulverizing machine that will process the material to the plan depth, the Contractor will not be required to excavate to the secondary grade or windrow the material. This method will be permitted only if a machine is provided which will insure that the material is cut uniformly to the proper depth and which has cutters that will plane the secondary grade to a smooth surface over the entire width of the cut. The machine shall provide a visible indication of the depth of cut at all times.

In lieu of using the cutting and pulverizing machine, the Contractor shall excavate and windrow the material to expose the secondary grade to the typical sections, lines and grades as shown on the plans or as established by the Engineer.

262.4

When new base material is required by this Item, it shall be delivered, placed and spread in the required quantity per 30 meters. The material shall

be manipulated as specified for the base course or as directed by the Engineer and thoroughly mixed to provide a uniform gradation prior to the addition of lime.

(3) Pulverization. The existing pavement or base material shall be pulverized or scarified so that 100 percent will pass the 63 millimeter sieve.

(4) Application. The percentage by mass or kilograms per square meter of lime to be added will be as shown on the plans and may be varied by the Engineer if conditions warrant.

Lime shall be spread only on the area where the mixing operations can be completed during the same working day, except as required for quicklime in Subarticle 262.4.(5).

Unless otherwise approved by the Engineer, the lime operation shall not be started when the air temperature is below 5 °C and falling, but may be started when the air temperature is above 2 °C and rising. The temperature will be taken in the shade and away from artificial heat. Lime shall not be placed when weather conditions in the opinion of the Engineer are unsuitable.

CAUTION: Use of quicklime can be dangerous. Users should be informed of the recommended precautions in the handling, storage and use of quicklime.

The application and mixing of lime with the material shall be accomplished by the methods herein described as "Dry Placing" or "Slurry Placing". Type A Hydrated Lime shall be applied by "Slurry Placing" unless otherwise shown on the plans or approved by the Engineer. Type B Commercial Lime Slurry shall be applied by "Slurry Placing". Type C Quicklime shall be applied by "Slurry Placing" or "Dry Placing" as shown on the plans. The method of applying Type C Quicklime may be changed if approved in writing by the Engineer. When Type C Quicklime is used for dry placement, it shall be Grade "DS". When Type C Quicklime is used for slurry placement, it shall be either Grade "DS" or Grade "S". Grade "S" shall be used in slurry placement only.

262.4

(a) Dry Placing. The lime shall be distributed by a spreader approved by the Engineer or by bag distribution for Type A Hydrated Lime at the rate shown on the plans or as directed by the Engineer.

The lime shall be distributed at a uniform rate and in such a manner as to reduce the scattering of lime by wind. Lime shall not be applied when wind conditions, in the opinion of the Engineer, are such that blowing lime becomes objectionable to adjacent property owners or dangerous to traffic.

A motor grader shall not be used to spread Type A Hydrated Lime, but may be used to spread Type C Quicklime Grade "DS".

The material shall be sprinkled as approved by the Engineer.

(b) Slurry Placing. When Type A Hydrated Lime is specified and slurry placement is used, the Type A hydrate shall be mixed with water to form a slurry with a solids content approved by the Engineer.

Type B Commercial Lime Slurry shall be delivered to the project in slurry form at or above the minimum dry solids content approved by the Engineer. The distribution of lime at the rate(s) shown on the plans or approved by the Engineer shall be attained by successive passes over a measured section of roadway until the proper lime content has been secured.

When Type C Quicklime is applied as slurry, the amount of dry quicklime shall be 80 percent of the amount shown on the plans. The slurry shall contain at least the minimum dry solids content approved by the Engineer. The residue from the slurrying procedure shall be spread uniformly over the length of the roadway currently being processed unless otherwise approved by the Engineer. This residue is primarily inert material with little stabilizing value, but may contain a small amount of particles that slake slowly. A concentration of these particles could cause the compacted stabilized material to swell during slaking.

Slurry Consistency Requirements

Slurry shall be of such consistency that it can be applied uniformly without difficulty.

When the distributor truck is not equipped with an agitator, the Contractor shall have a standby pump **262.4**

available on the project for agitating the lime and water as required by the Engineer, in case of undue delays in dispersing the slurry.

(5) Mixing. The mixing procedure shall be the same for "Dry Placing"

or "Slurry Placing" as herein described.

During the interval between application and mixing, hydrated lime that has been exposed to the open air for a period of six (6) hours or more or to excessive loss due to washing or blowing will not be accepted for payment.

The material and lime shall be thoroughly mixed by equipment approved by the Engineer. The material and lime shall be brought to the proper moisture content. The mixing shall be continued until, in the opinion of the Engineer, a homogeneous mixture is obtained.

In addition to the above, when Type C Quicklime, Grade "DS", is used under "Dry Placing", the material and lime shall be mixed as thoroughly as possible at the time of the lime application. Sufficient moisture shall be added during the mixing to hydrate the quicklime. After mixing, and prior to compaction, the mixture of material, quicklime and water, shall be moist cured for two (2) to seven (7) days, as approved by the Engineer. After curing, mixing shall continue until the material and lime are thoroughly blended to the satisfaction of the Engineer.

(6) Compaction Methods. Prior to compaction, the material shall be aerated or sprinkled as necessary to provide the optimum moisture. Compaction of the mixture shall begin immediately after the material and lime are thoroughly blended.

Compaction shall continue until the entire depth of mixture is uniformly compacted by "Ordinary Compaction" or "Density Control" as shown on the plans. Throughout this entire operation the shape of the course shall be maintained by blading, and the surface upon completion shall be smooth and in conformity with the typical sections, lines and grades as shown on the plans or as established by the Engineer.

When shown on the plans or approved by the Engineer, multiple lifts will be permitted.

262.4

(a) Ordinary Compaction. When "Ordinary Compaction" is shown on the plans the following provisions shall apply:

The material shall be sprinkled and rolled as directed by the Engineer. All irregularities, depressions or weak spots which develop shall be corrected immediately by scarifying the areas affected, adding or removing material as

required, reshaping and recompacting by sprinkling and rolling.

Should the material lose the required stability, compaction or finish before the next course is placed or the project is accepted, it shall be reworked in accordance with Subarticle 262.4.(7). However, compaction shall be in accordance with "Ordinary Compaction".

(b) Density Control. When "Density Control" is shown on the plans the following provisions shall apply:

Unless otherwise shown on the plans, the bottom course shall be sprinkled as required and compacted to the extent necessary to provide not less than 95 percent of the optimum density as determined by Test Method Tex-121-E, Part II. Unless otherwise shown on the plans, all other subsequent courses treated under this item shall be compacted to a minimum of 98 percent of the optimum density. Roadway density testing will be as outlined in Test Method Tex-115-E.

When the material fails to meet the density requirements, or should the material lose the required stability, density or finish before the next course is placed or the project is accepted, it shall be reworked in accordance with Subarticle 262.4.(7).

(7) Reworking a Section. When a section is reworked within 72 hours after completion of compaction, the Contractor shall rework the section to provide the required compaction. When a section is reworked more than 72 hours after completion of compaction, the Contractor shall add 25 percent of the specified rate of lime. Reworking shall include loosening, roadmixing as approved by the Engineer, compacting and finishing. When a section is reworked, a new optimum density will be determined from the reworked material in accordance with Test Method Tex-121-E, Part II.

(8) Finishing and Curing. After the final layer or course of the lime treated base has been compacted, it shall be brought to the required lines and grades in accordance with the typical sections.

The completed section shall then be finished by rolling with a pneumatic tire or other suitable roller as approved by the Engineer. The completed section shall be moist cured or prevented from drying by addition of an asphalt material at the rate of 0.2 to 0.9 liter per square meter as determined by the Engineer. This material shall be the type shown on the plans. Curing shall continue for seven (7) days before further courses are added or traffic is permitted, unless otherwise approved by the Engineer.

However, the lime treated base material may be covered by other courses the day following finishing, when approved by the Engineer. When the plans provide for the treated material to be sealed or covered by other courses of material, the seal or next course shall be applied within 14 calendar days after final compaction is completed, unless otherwise approved by the Engineer.

262.5. Tolerances. Tolerances shall conform to the following:

(1) Density Tolerances. The Engineer may accept the work providing not more than one (l) out of the most recent five (5) density tests performed is below the specified density, provided the failing test is no more than 50 kilograms per cubic meter below the specified density.

(2) Grade Tolerances. Finished grade tolerance shall be in accordance with Subsection 247.3.(1)(f)(ii).

262.6. Measurement. This Item will be measured as follows:

(1) Lime.

(a) Type A.

(i) Hydrated Lime (Dry). When **Type A** Hydrated Lime is used under **"Dry Placing"**, the quantity of lime will be measured by the megagram, dry mass.

(ii) Hydrated Lime (Slurry). When **Type A** Hydrated Lime is used under **"Slurry Placing"**, the quantity of lime will be measured by the

megagram, dry mass of the powdered bulk hydrated lime used to prepare the hydrated lime slurry.

(b) Type B.

Commercial Lime Slurry. When **Type B** Commercial Lime Slurry is used, the quantity of lime will be calculated from the **minimum** percent "Dry Solids Content" of the slurry previously agreed upon for the project by the Contractor and the Engineer. This figure will be multiplied by the mass of the slurry in megagrams delivered, which must be at or above the required minimum "Dry Solids Content".

(c) Type C.

(i) Quicklime (Dry). When **Type C** Quicklime is used under **"Dry Placing"**, the quantity of lime will be measured by the megagram, dry mass of the quicklime actually delivered on the road.

(ii) Quicklime (Slurry). When **Type C** Quicklime is used under **"Slurry Placing"**, the quantity will be measured by the megagram, dry mass of the quicklime used to prepare the hydrated lime slurry. The measured megagrams of Type C Quicklime will be multiplied by a conversion factor of 1.28 to give the quantity of equivalent hydrated lime, which will be the basis of payment.

(2) Lime Treatment. Lime treatment will be measured by the square meter of the depth specified to the lines and grades shown on the typical sections.

262.7. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for as follows:

(1) Lime. Lime will be paid for at the unit price bid for "Lime" of one of the following specified types, which price will be full compensation for furnishing all lime.

(a) Type A (Dry)
(b) Type A (Slurry)
(c) Type B

(d) Type C (Dry)
(e) Type C (Slurry)

Lime for reworking a section in accordance with Subarticle 262.4.(7) will not be paid for directly but will be subsidiary to this Item.

(2) Lime Treatment. "Lime Treatment For Base Courses (Existing Base)", "Lime Treatment For Base Courses (New Base)" or "Lime Treatment For Base Courses (New and Existing Base)" of the type compaction and depth specified will be paid for at the unit price bid per square meter. This price shall be full compensation for shaping existing material, loosening, mixing, pulverizing or scarifying, spreading, drying, applying lime, water content of the slurry, compacting, curing including curing materials, shaping and maintaining, processing, hauling, reworking if required, preparing secondary subgrade, for all mixing water, tools, equipment, labor and incidentals necessary to complete the work.

Furnishing and delivery of new base will be paid for as "Flexible Base (Roadway Delivery)", in accordance with Subarticle 247.5. All manipulation including mixing, spreading, blading, shaping, compacting, and finishing of the new and/or existing base material will be paid for under this Item.

When "Ordinary Compaction" is shown on the plans, all sprinkling and rolling, except proof rolling, will not be paid for directly, but will be considered subsidiary to this Item, unless otherwise shown on the plans.

When "Density Control" is shown on the plans, all sprinkling and rolling, except proof rolling, will not be paid for directly, but will be considered subsidiary to this Item.

When proof rolling is shown on the plans and directed by the Engineer, it will be paid for in accordance with Item 216, "Rolling (Proof)".

When the existing section is constructed under this project, correction of soft spots will be at the Contractor's expense.

When the existing section is not constructed under this project, correction of soft spots will be in accordance with Article 9.3.

ITEM 263

LIME TREATED BASE
(PLANT MIXED)

263.1. Description. This Item shall govern for the construction of a foundation for surface course or for other base courses consisting of a mixture of base material, hydrated lime and water, in conformity with the typical sections, and to the lines, grades and depths shown on the plans or established by the Engineer.

263.2. Materials.

(1) Lime. The lime shall meet the requirements of Item 264, "Lime and Lime Slurry". Type A Hydrated Lime shall be used.

(2) Water. Water shall meet the material requirements of Item 204, "Sprinkling".

(3) Asphalt. Asphalt shall conform to the requirements of Item 300, "Asphalts, Oils and Emulsions".

(4) Flexible Base. The base material prior to the addition of lime shall meet the requirements of Article 247.2 and shall be the type and grade shown on the plans.

263.3. Equipment.

(1) General. The machinery, tools and equipment necessary for proper prosecution of the work on this Item shall be on the project and approved by the Engineer prior to beginning this Item.

(2) Lime Storage. Hydrated lime shall be suitably stored in closed, weatherproof containers until immediately before use. Storage bins, when used, shall be completely enclosed.

(3) Lime Mass Verification. The mass of lime shall be determined on certified scales or the Contractor shall provide a set of standard platform truck scales at a location approved by the Engineer. Scales shall conform to the requirements of Item 520, "Weighing and Measuring Equipment".

(4) Mixing Equipment. Equipment shall be a stationary mixing and weighing plant conforming to the requirements of Item 520, "Weighing and Measuring Equipment". Equipment shall be in good operating condition.

The mixer shall be a stationary pugmill; however, batch or continuous mixers which will produce a uniform material may be approved by the Engineer. The plant shall be equipped with feeding and metering devices which will add the base material, lime and water into the mixer in the specified proportions.

263.4. Proportioning of Mixes. The percentage by mass of lime to be added will be as shown on the plans and may be varied by the Engineer if conditions warrant.

263.5. Construction Methods.

(1) General. The completed course shall be uniformly mixed, free from loose or segregated areas, of uniform density and moisture content, well bound for its full depth and shall have a smooth surface.

(2) Preparation of Subgrade/Subbase. Prior to placing lime treated base, the subgrade or existing roadbed shall be shaped to conform to the typical sections shown on the plans or established by the Engineer. This work shall be done in accordance with the provisions of applicable bid items.

(3) Mixing. The lime, base material and water shall be thoroughly mixed in an approved plant. The moisture content of the mixture shall be at optimum or within the range established by the Engineer.

(4) Placing. The lime treated base shall be placed on the prepared subgrade/subbase to produce the depth specified on the plans. Unless otherwise shown on the plans, the maximum depth of a lift shall not exceed 200 millimeters compacted. The spreading operations shall be done in such a manner as to eliminate nests or pockets of material of non-uniform gradation and in such a manner as to eliminate planes of weakness. Construction joints shall be approximately vertical.

Unless otherwise approved by the Engineer, the lime operation shall not be started when the air temperature is below 5 °C and falling, but may

be started when the air temperature is above 2 °C and rising. The temperature will be taken in the shade and away from artificial heat. Base shall not be placed when weather conditions, in the opinion of the Engineer, are unsuitable.

(5) Compaction Methods. Compaction shall be by "Density Control". After mixing, the material shall be hauled to the roadway and compaction begun immediately after placement. Throughout this entire operation, the shape of the course shall be maintained by blading and the surface upon completion shall be smooth and in conformity with the typical sections, lines and grades as shown on the plans or as established by the Engineer. Unless otherwise shown on the plans, the material shall be sprinkled as required and compacted to the extent necessary to provide not less than 95 percent of the optimum density as determined by Test Method Tex-121-E, Part II. Roadway density testing will be as outlined in Test Method Tex-115-E. Should the material lose stability, density or finish before the next course is placed or the work is accepted, it shall be reworked in accordance with Subarticle 263.5.(8).

(6) Finishing. All placing, compacting and finishing operations shall be completed within a period of three (3) days after the lime is added to the base materials. The time limit does not apply to the final finishing such as tight blading, rolling and other finishing operations required just prior to applying the surface course except that any loosening, reworking, and recompacting of base material shall be subject to the application of additional lime as hereinafter specified.

After the lime treated base is compacted, the surface shall be finished to grade and section by blading and shall be sealed with approved pneumatic or other suitable roller as approved by the Engineer. When approved by the Engineer, surface finishing methods may be varied from this procedure provided a dense uniform surface is produced and further provided that laminated layers are avoided.

A flat wheel roller, or other suitable roller, may be required by the Engineer to finish the roadway surface.

(7) Curing. The completed section shall be moist-cured for seven days or prevented from drying by addition of an asphalt material at a rate of 0.2 to 0.9 liter per square meter as determined by the Engineer. This material shall be the type as specified on the plans. Curing shall continue

until further courses are added or traffic is permitted, unless otherwise approved by the Engineer. Seals or additional courses shall be applied within 14 calendar days after finishing unless otherwise approved by the Engineer.

(8) Reworking a Section. When a section is reworked within 72 hours after completion of compaction, the Contractor shall rework the section to provide the required compaction. When a section is reworked, more than 72 hours after completion of compaction, the Contractor shall add 25 percent of the specified rate of lime. Reworking shall include loosening by disking or harrowing, adding material if necessary, road mixing as approved, compacting and finishing. When a section is reworked, a new optimum density will be determined from the reworked material. The Contractor has the option of removing the failing material and replacing it with acceptable lime treated mix.

263.6. Tolerances.

(1) Density Tolerances. The Engineer may accept the work providing not more than one (1) out of the most recent five (5) density tests performed is below the specified density, provided the failing test is no more than 50 kilograms per cubic meter below the specified density.

(2) Grade Tolerances. Finished grade tolerances shall be in accordance with Subsection 247.3.(1)(f)(ii).

263.7. Deficient Base Thickness. The adjustment in unit prices provided for in this article will apply only when measurement for payment is by the square meter. The following requirements will govern for determining treated base thickness, and for adjustment of unit prices.

(1) Location and Measurement of Deficient Areas. The treated base depth will be measured by the Engineer prior to final acceptance. Locations of tests within each unit will be selected by the Engineer. The thickness of the treated base will be determined by measurement of the base in a finished condition in accordance with Test Method Tex-140-E.

For the purpose of establishing an adjusted unit price for payment, roadways, ramps and units to be considered separately are defined as 300 meters of treated base in each uniform placement width starting at the beginning of the treated base bearing the smaller kilometer station number

of each contiguous placement. The last unit in each lane will be 300 meters plus the fractional part of 300 meters remaining.

Placement width will be considered as the width between longitudinal construction joints. For widening, the placement width will be considered as the average width placed of the widened section that is deficient in thickness.

For the purpose of establishing an adjusted unit price for intersections, irregular sections, crossovers, entrances, segmental construction, transition to but not including ramps and other areas designated by the Engineer, units are defined as 1700 square meters or fraction thereof.

One (1) measurement will be taken at the location selected by the Engineer in each unit. When the measurement from any unit is not deficient more than 13.0 millimeters from the plan thickness, full payment will be made. When the measurement from any unit is deficient more than 13.0 millimeters from the plan thickness, two (2) additional measurements will be taken from the unit and the average of the three measurements determined. The two (2) additional measurements from any 300-meter unit will be taken at intervals of not less than 90 meters apart. The two (2) additional measurements from any 1700-square meters unit will be taken at locations such that the treated base in the unit will be well represented. If the average of these three (3) measurements is not deficient by more than 13.0 millimeters from the plan thickness, full payment will be made. If the average thickness of the three (3) measurements is deficient more than 13.0 millimeters but not more than 25.0 millimeters from the plan thickness, an adjusted unit price as provided in Subarticle 263.7.(2) will be paid for the areas represented by these measurements.

In calculating the average thickness of the treated base, measurements which are in excess of the specified thickness by more than 13.0 millimeters will be considered as the specified thickness plus 13.0 millimeters, and measurements which are less than the specified thickness by more than 25.0 millimeters will be considered as the specified thickness less 25.0 millimeters.

In addition, when any measurement is less than the specified thickness by more than 25.0 millimeters, the actual thickness of the treated base in this area will be determined by taking exploratory measurements at 15-meter intervals parallel to the centerline in each direction from the

deficient measurement until, in each direction, a measurement is taken which is not deficient by more than 25.0 millimeters. Exploratory measurements may extend into adjacent units. Exploratory measurements for deficient thickness will not be used in averages for adjusted unit price. Exploratory measurements are to be used only to determine the length of treated base in a unit that is to be left in place without pay and/or removed and replaced as provided in Subarticle 263.7.(2).

(2) Price Adjustments. Where the average thickness of lime treated base is deficient in thickness by more than 13.0 millimeters, but not more than 25.0 millimeters, payment will be made at an adjusted price as specified in the following table:

Lime Treated Base Deficiency

Deficiency in Thickness (Millimeters)	Proportional Part of Unit Bid Price Allowed
0.0 through 13.0	100 percent
greater than 13.0 through 20.0	75 percent
greater than 20.0 through 25.0	50 percent

Any area of treated base found deficient in thickness by more than 25.0 millimeters will be evaluated by the Engineer. If, in the judgment of the Engineer, the area of such deficiency should not be reworked, there will be no payment for the area retained. If, in the judgment of the Engineer, the area of such deficiency warrants reworking, the area shall be reworked in accordance with Subarticle 263.5.(8) to the thickness of adjacent sections. In lieu of reworking a deficient thickness section, asphaltic concrete pavement (ACP) conforming to Item 340 may be permitted by the Engineer.

Payment for the corrected sections will be at 50 percent of the unit bid price. The minimum limit of non-pay for reworked sections will be 30 meters.

(3) Excess Thickness. No additional payment over the unit bid price will be made for any treated base of a thickness exceeding that required by the plans.

263.8 to 263.9

263.8. Measurement. This Item will be measured for payment by one of the following units as shown on the plans:

(1) Lime treated base will be measured by the square meter of completed work. This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment is required in accordance with Article 263.7, additional measurements or calculations will not be required.

(2) Lime treated base will be measured by the megagram, dry mass in vehicles as delivered. A set of standard platform truck scales conforming to the requirements of Item 520, "Weighing and Measuring Equipment", shall be furnished by the Contractor and placed at a location approved by the Engineer. When the material is weighed during mixing or batching, reweighing will not be necessary. The dry mass will be determined by deducting the mass of the moisture in the material at the time of weighing from the gross mass of the material. The moisture in the material will be determined in accordance with Test Method Tex-103-E at least one time each day and more often if conditions warrant.

(3) Lime treated base will be measured by the cubic meter in its completed and accepted final position. The volume of base course will be computed in place between the original subgrade or subbase surfaces and the lines, grades and slopes of the accepted base course as shown on the plans and calculated by the method of average-end-areas.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment is required, additional measurements or calculations will not be required. No payment will be made for thickness or width exceeding that shown on the typical section or provided on the plans.

263.9. Payment. The work performed and material furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Lime Treated Base (Plant Mix) (Density Control)" of the specified depth. This price shall be full compensation for securing and furnishing all materials; for furnishing scales and labor involved in weighing the material when required; for all storing, mixing, hauling; for loading all materials; and delivering, sprinkling,

rolling, compacting, finishing, curing, maintaining and reworking of the treated base; and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work.

When used to correct deficient thickness, hot mix asphaltic concrete will not be paid for directly but will be subsidiary to this Item.

When shown on the plans, the excavation required in the preparation and shaping of the subgrade for the completion of shoulders and slopes and for finishing roadway shall be performed, measured, and paid for in accordance with the pertinent bid items.

When subgrade is constructed under this project, correction of soft spots will be at the Contractor's expense. When subgrade is not constructed under this project, correction of soft spots will be in accordance with Article 9.3.

ITEM 264

LIME AND LIME SLURRY

264.1. Description. This Item establishes the requirements for hydrated lime, quicklime and commercial lime slurry.

CAUTION: Use of quicklime can be dangerous. Users should become informed of the recommended precautions in the handling, storage and use of quicklime.

264.2. Types. The various types and grades are defined and identified as follows:

(1) **Type A, Hydrated Lime**, a dry powdered material consisting essentially of calcium hydroxide.

(2) **Type B, Commercial Lime Slurry**, a liquid mixture of essentially hydrated lime solids and water in slurry form.

(3) **Type C, Quicklime**, a dry material consisting essentially of calcium oxide. It shall be furnished in either of two grades which differ in sizing.

264.3

Grade DS, "pebble" quicklime of a gradation suitable for either "Dry Placing" or for use in the preparation of a slurry for "Wet Placing".

Grade S, finely-graded quicklime for use in the preparation of a slurry for wet placing. (Note: Due to the possibility of appreciable amounts of finely divided, powdered quicklime being present in this product, the use of Type C, Grade S Quicklime is restricted to "Slurry Placing" only. It is considered to be unsuitable for "Dry Placing".)

264.3. General. Lime shall be applied as provided for in the governing specifications, as a dry material or as a mixture of lime solids and water in the form of lime slurry.

For dry application, Type A, Hydrated Lime or Type C, Quicklime of **Grade DS only** may be used where specifications permit.

For wet application, lime slurry may be delivered to the job site as Type B, Commercial Lime Slurry or a lime slurry may be prepared at the job site or other location approved by the Engineer, by using Type A Hydrated Lime or Type C Quicklime as specified.

The lime and lime slurry being furnished under the terms of this specification shall, in addition to all other requirements, also meet the following chemical and physical requirements.

Chemical:

	TYPE		
	A	**B**	**C**
Total "active" lime content, % by mass - - - - - - - - - - (i.e., % by mass $Ca(OH)_2$ + % by mass CaO, if present)	90.0 min[1]	87.0 min[2]	-
Unhydrated lime content, % by mass CaO: - - - - - - -	5.0 max	-	87.0 min
"Free Water" content, % by mass H_2O: - - - - - - -	5.0 max	-	-

Physical:

Wet sieve requirement, as % by mass residue:

Retained on 3.35 mm sieve: - - - - - - - - -	0.2 max	0.2 max[2]	8.0 max[3]
Retained on 600 µm sieve: - - - - - - - - -	4.0 max	4.0 max[2]	-
Dry sieve requirement, as % by mass residue:			
Retained on a 25.0 mm sieve: - - - - - - - - -	-	-	0.0
Retained on a 19.0 mm sieve: - - - - - - - - -	-	-	10.0 max
Retained on a 150 µm sieve: - - - - - - - - -			-

Note 1: No more than 5.0 percent by mass CaO (unhydrated lime) will be allowed in determining the total "active" lime content.

Note 2: In "solids content" of the slurry.

Note 3: The amount of total "active" lime content, as CaO, in the material retained on the 3.35 mm sieve must not exceed 2.0 percent by mass of the original Type C lime.

Type B, Commercial Lime Slurry or a slurry prepared at the job site from Type A Hydrated Lime or Type C Quicklime shall be furnished at or above the minimum "Dry Solids" content as approved by the Engineer and must be of a consistency that can be handled and uniformly applied without difficulty. The slurry shall be free of liquids other than water and any materials of a nature injurious or objectionable for the purpose intended.

264.4. Sampling and Testing. The sampling and testing of lime shall be as determined by Test Method Tex-600-J, "Lime Testing Procedure".

264.5. Measurement and Payment. Lime will be measured and paid for in accordance with the governing specifications for the items of construction in which lime is used.

ITEM 265

LIME-FLY ASH (LFA) TREATMENT FOR MATERIALS USED AS SUBGRADE

265.1. Description. This Item shall govern for treating new or existing subgrade, existing pavement structure or combination thereof to be used as subgrade by pulverizing, adding lime and fly ash, mixing and compacting the mixed material as specified in this Item.

265.2. Materials.

(1) Lime. Lime shall meet the requirements of Item 264, "Lime and Lime Slurry", for the type of lime specified.

The Contractor shall have the option of selecting from the types shown on the plans, the type of lime to be used. The Engineer shall be notified in writing before changing source or type.

All lime slurries used in "Slurry Placing" shall be furnished at or above the minimum "Dry Solids Content" as approved by the Engineer.

(2) Fly Ash. Fly ash may be either Type A or B and shall meet the requirements of "Departmental Materials Specification: D-9-8900, Fly Ash".

(3) Water. Water shall meet the material requirements of Item 204, "Sprinkling".

(4) Asphalt. Asphalt shall conform to the requirements of Item 300, "Asphalts, Oils and Emulsions".

265.3. Equipment.

(1) General. The machinery, tools and equipment necessary for proper prosecution of the work on this Item shall be on the project and approved by the Engineer prior to beginning this Item.

All machinery, tools and equipment used shall be maintained in a satisfactory working condition.

(2) Material Storage. Quicklime, hydrated lime in dry form and fly ash shall be suitably stored in closed, weatherproof containers until immediately before use. Storage bins, when used, shall be completely enclosed. Hydrated lime in bags shall be stored in weatherproof buildings with adequate protection from ground dampness. When Type C Quicklime is permitted, it shall be shipped only in bulk; bagged material will not be acceptable.

(3) Material Mass Verification. When lime and/or fly ash is furnished in trucks, the mass of lime and fly ash shall be determined on certified scales or the Contractor shall provide a set of standard platform truck scales at a location approved by the Engineer. Scales shall conform to the requirements of Item 520, "Weighing and Measuring Equipment".

When Type A Hydrated lime or fly ash is furnished in bags, each bag shall bear the manufacturer's certified mass. Bags varying more than five (5) percent from that mass may be rejected and the average mass of bags in any shipment, as shown by weighing 10 bags taken at random, shall not be less than the manufacturer's certified mass.

(4) Slurry Equipment. Type C Quicklime of Grade "DS" or "S" when used to manufacture slurry on the project or other location approved by the Engineer, shall be slurried in agitated slurry tanks. The slurrying of Type C Quicklime must be handled in such a way as to not generate any dust hazardous to job personnel or to the public or be potentially damaging to any adjacent property.

The distributor truck used for slurry placing need not necessarily be equipped with an agitator; however, the slurry at the time of distribution must meet the consistency requirements specified. The Contractor shall, if necessary, use appropriate equipment to achieve compliance with the consistency requirements.

For Type B Commercial Lime Slurry, the distributor truck shall be equipped with a sampling device in accordance with Test Method Tex-600-J, Part I.

265.4. Construction Methods.

(1) General. The completed course shall be uniformly treated, free from loose or segregated areas, of uniform density and moisture content, well bound for its full depth and shall have a smooth surface.

(2) Preparation of Subgrade or Existing Base. Prior to treating existing material, the subgrade or existing base shall be shaped to conform to the typical sections as shown on the plans or as established by the Engineer. This work shall be done in accordance with the provisions of applicable bid items. When shown on the plans, any existing asphaltic concrete pavement shall be removed and will be paid for in accordance with the applicable bid items.

Before pulverizing or scarifying an existing material, when shown on the plans and when directed by the Engineer, the Contractor shall proof roll the roadbed in accordance with Item 216, "Rolling (Proof)". Soft spots shall be corrected as directed by the Engineer.

When the Contractor elects to use a cutting and pulverizing machine that will process the material to the plan depth, the Contractor will not be required to excavate to the secondary grade or windrow the material. This method will be permitted only if a machine is provided which will insure that the material is cut uniformly to the proper depth and which has cutters that will plane the secondary grade to a uniform surface over the entire width of the cut. The machine shall provide a visible indication of the depth of cut at all times.

In lieu of using the cutting and pulverizing machine, the Contractor shall excavate and windrow the material to expose the secondary grade to the typical sections, lines and grades as shown on the plans or as established by the Engineer.

(3) Pulverization. The existing pavement or base material shall be pulverized or scarified so that 100 percent shall pass the 63 millimeter sieve.

(4) Application and Mixing of Lime and Fly Ash.

(a) General. The percentages by mass or kilograms per square meter of lime and fly ash to be added will be shown on the plans and may be varied by the Engineer if conditions warrant.

Lime or fly ash shall be spread only on that area where the mixing operation can be completed during the same working day, except as required for Quicklime in Section 265.4.(4)(c).

Unless otherwise approved in writing by the Engineer, the LFA operation shall not be started when the air temperature is below 5 °C and falling, but may be started when the air temperature is above 2 °C and rising. The temperature will be taken in the shade and away from artificial heat. LFA shall not be placed when weather conditions, in the opinion of the Engineer, are unsuitable.

CAUTION: Use of quicklime can be dangerous. Users should be informed of the recommended precautions in handling, storage and use of quicklime.

(b) Application of Lime. Lime shall be added and mixed first, unless otherwise approved by the Engineer.

The application and mixing of lime with the material shall be accomplished by the methods herein described as "Dry Placing" or "Slurry Placing". Type A Hydrated Lime shall be applied by "Slurry Placing" unless otherwise shown on the plans or approved by the Engineer. Type B Commercial Lime Slurry shall be applied by "Slurry Placing". Type C Quicklime shall be applied by "Slurry Placing" or "Dry Placing" as shown on the plans. The method of applying Type C Quicklime may be changed if approved in writing by the Engineer. When Type C Quicklime is used for dry placement, it shall be Grade "DS". When Type C Quicklime is used for slurry placement, it shall be either Grade "DS" or Grade "S". Grade "S" is for use in slurry placement only.

(i) Dry Placing. The lime shall be distributed by a spreader approved by the Engineer or by bag distribution for Type A Hydrated Lime at the rate shown on the plans or as approved by the Engineer. Distribution rates shall be as shown on the plans or as directed by the Engineer.

The lime shall be distributed at a uniform rate and in such manner as to reduce the scattering of lime by wind. Lime shall not be applied when wind conditions, in the opinion of the Engineer, are such that blowing lime becomes objectionable to adjacent property owners or dangerous to traffic.

A motor grader shall not be used to spread Type A Hydrated Lime, but may be used to spread Type C Quicklime of Grade "DS".

(ii) Slurry Placing. Where Type A Hydrated Lime is shown on the plans and slurry placement is to be used, the Type A hydrate shall be mixed with water to form a slurry with a solids content approved by the Engineer.

Type B Commercial Lime Slurry shall be delivered to the project in slurry form at or above the minimum dry solids content approved by the Engineer. The distribution of lime at the rate(s) shown on the plans or approved by the Engineer shall be attained by successive passes over a measured section of roadway until the proper lime content has been secured.

When Type C Quicklime is applied as a slurry, the amount of dry quicklime shall be 80 percent of the amount required by the plans. The slurry shall contain at least the minimum dry solids content approved by the Engineer. The residue from the slurrying procedure shall be spread uniformly over the length of the roadway currently being processed unless otherwise approved by the Engineer. This residue is primarily inert material with little stabilizing value, but may contain a small amount of quicklime particles that slake slowly. A concentration of these particles could cause the compacted stabilized material to swell during slaking.

Slurry Consistency Requirements

Slurry shall be of such consistency that it can be applied uniformly without difficulty.

When the distributor truck is not equipped with an agitator, the Contractor shall have a stand-by pump available on the project for agitating the lime and water as required by the Engineer in case of undue delays in dispersing the slurry.

(c) Mixing of Lime. The mixing procedure shall be the same for "Dry Placing" or "Slurry Placing" as herein described.

During the interval between application and mixing, hydrated lime that has been exposed to the open air for a period of six (6) hours or more or to excessive loss due to washing or blowing will not be accepted for payment.

The material and lime shall be thoroughly mixed by equipment approved by the Engineer. The material and lime may be brought to the proper moisture content and may be left to cure one (1) to four (4) days as approved by the Engineer or the mixing continued until a homogeneous friable mixture of material and lime is obtained.

Following mixing, a sample of the material at roadway moisture will be obtained for pulverization testing. All non-slaking aggregates retained on the 19.0 millimeter sieve will be removed from the sample. The remainder of the material shall meet the following requirements when tested by Test Method Tex-101-E, Part III:

	Percent
Minimum passing 45 mm sieve	100
Minimum passing 19.0 mm sieve	85

When shown on the plans or approved by the Engineer, this pulverization requirement may be waived when the material contains a substantial quantity of aggregate.

The treated materials shall be sprinkled during the mixing operation as approved by the Engineer to provide optimum mixing moisture.

In addition to the above, when Type C Quicklime, Grade "DS", is used under Dry Placing, the material and lime shall be mixed as thoroughly as possible at the time of the lime application. Sufficient moisture shall be added during the mixing to hydrate the quicklime. After mixing, and prior to compaction, the mixture of the material, quicklime and water shall be moist cured for two (2) to seven (7) days, as approved by the Engineer. After curing, mixing shall continue until the pulverization requirements are met.

(d) Application of Fly Ash. Unless otherwise approved by the Engineer, fly ash shall be distributed in the dry form only by a distributor approved by the Engineer. Application of fly ash shall begin within four

(4) calendar days after the lime mixing operation has been completed, unless approved by the Engineer. Fly ash shall not be applied when wind conditions, in the opinion of the Engineer, are such that blowing fly ash becomes objectionable to adjacent property owners or dangerous to traffic. The mixture shall be sprinkled as approved by the Engineer. Fly ash shall be uniformly spread only on that area where the mixing and compacting operations can be completed during the same working day. A motor grader shall not be used to spread fly ash. Initial mixing after the addition of fly ash shall be accomplished dry or with a minimum of water to prevent fly ash balls.

(e) Mixing of Fly Ash. The mixing shall be continued until, in the opinion of the Engineer, a homogeneous mixture of lime, fly ash and material is obtained.

(5) Compaction Methods. Prior to compaction, the material shall be aerated or sprinkled as necessary to provide the optimum moisture. Compaction shall begin immediately after mixing of the last stabilizing agent. All compaction operations shall be completed within six (6) hours.

Compaction shall continue until the entire depth of mixture is uniformly compacted by "Ordinary Compaction" or "Density Control" as shown on the plans. Throughout this entire operation the shape of the course shall be maintained by blading, and the surface upon completion shall be smooth and in conformity with the typical sections, lines and grades as shown on the plans or as established by the Engineer.

When shown on the plans or approved by the Engineer, multiple lifts will be permitted.

(a) Ordinary Compaction. When "Ordinary Compaction" is shown on the plans, the following provisions shall apply:

The material shall be sprinkled and rolled as directed by the Engineer. All irregularities, depressions or weak spots which develop shall be corrected immediately by scarifying the areas affected, adding or removing material as required and reshaping and recompacting by sprinkling and rolling. The surface of the course shall be maintained in a smooth condition, free from undulations and ruts, until the next course is placed.

Should the material lose the required stability, compaction or finish before the next course is placed, or the project is accepted, it shall be reworked in accordance with Subarticle 265.4.(6). However, compaction shall be in accordance with "Ordinary Compaction".

(b) Density Control. When "Density Control" is shown on the plans, the following provisions shall apply:

Unless otherwise shown on the plans, each course shall be sprinkled as required and compacted to the extent necessary to provide not less than 95 percent of the optimum density as determined by Test Method Tex-121-E, Part II. Roadway density testing will be as outlined in Test Method Tex-115-E.

When the material fails to meet the density requirements, or should the material lose the required stability, density or finish before the next course is placed or the project is accepted, it shall be reworked in accordance with Subarticle 265.4.(6).

(6) Reworking a Section. When a section is reworked within 72 hours after placement, the Contractor shall rework the section to provide the required compaction. When a section is reworked more than 72 hours after placement, the Contractor shall add 25 percent of the specified rate of lime and fly ash. Reworking shall include loosening, road mixing as approved by the Engineer, compacting and finishing. When a section is reworked, a new optimum density will be determined from the reworked material in accordance with Test Method Tex-121-E, Part II.

(5) Finishing and Curing. After the final layer or course of the LFA treated material has been compacted, it shall be brought to the required lines and grades in accordance with the typical sections, within two (2) hours.

The completed section shall then be finished by rolling with a pneumatic tire or other suitable roller approved by the Engineer. The completed section shall be moist-cured or prevented from drying by addition of an asphalt material at the rate of 0.2 to 0.9 liter per square meter as determined by the Engineer. This material shall be the type shown on the plans. Curing shall continue for seven (7) days before further courses are added or traffic is permitted, unless otherwise approved by the Engineer.

However, the LFA treated material may be covered by other courses, the day following finishing, when approved by the Engineer. When the plans provide for the treated material to be covered by other courses of material, the next course shall be applied within 14 calendar days after final compaction is completed, unless otherwise approved by the Engineer.

265.5. Tolerances. Tolerances shall conform to the following:

(1) Density Tolerances. The Engineer may accept the work providing not more than one (1) out of the most recent five (5) density tests performed is below the specified density, provided the failing test is not more than 50 kilograms per cubic meter below the specified density.

(2) Grade Tolerances. Finished grade tolerances shall be in accordance with Subarticle 132.4.(1).

265.6. Measurement. This Item will be measured as follows:

(1) Lime.

(a) Type A.

(i) Hydrated Lime (Dry). When Type A Hydrated Lime is used under "Dry Placing", the quantity of lime will be measured by the megagram, dry mass.

(ii) Hydrated Lime (Slurry). When Type A Hydrated Lime is used under "Slurry Placing", the quantity of lime will be measured by the megagram, dry mass of powdered bulk hydrated lime used to prepare the hydrated lime slurry at the job site.

(b) Type B.

Commercial Lime Slurry. When Type B Commercial Lime Slurry is used, the quantity of lime will be calculated from the minimum percent "Dry Solids Content" of the slurry previously agreed upon for the project by the Contractor and the Engineer. This figure will be multiplied by the mass of the slurry in megagrams delivered, which must be at or above the required minimum "Dry Solids Content".

(c) **Type C.**

(i) **Quicklime (Dry).** When Type C Quicklime is used under "Dry Placing", the quantity of lime will be measured by the megagram, dry mass of the quicklime actually delivered on the road.

(ii) **Quicklime (Slurry).** When Type C Quicklime is used under "Slurry Placing", the quantity will be measured by the megagram, dry mass of the quicklime used to prepare the hydrated lime slurry at the job site. The measured megagrams of Type C quicklime will be multiplied by a conversion factor of 1.28 to give the quantity of equivalent hydrated lime, which will be the basis of payment.

(2) **Fly Ash.** Fly ash will be measured by the megagram, dry mass as delivered on the road.

(3) **LFA Treatment.** LFA treatment will be measured by the square meter of the depth specified to the line and grades shown on the typical sections.

265.7. **Payment.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for as follows:

(1) **Lime.** Lime will be paid for at the unit price bid for "Lime" of one of the following specified types, which price will be full compensation for furnishing all lime.

(a) Type A (Dry)
(b) Type A (Slurry)
(c) Type B
(d) Type C (Dry)
(e) Type C (Slurry)

Lime for reworking a section in accordance with Subarticle 265.4.(6) will not be paid for directly but will be subsidiary to this Item.

(2) **Fly Ash.** Fly ash will be paid for at the unit price bid for "Fly Ash" which price will be full compensation for furnishing all fly ash.

Fly ash for reworking a section in accordance with Subarticle 265.4.(6) will not be paid for directly but will be subsidiary to this Item.

(3) LFA Treatment. "LFA Treated Subgrade" of the compaction method and depth specified will be paid for at the unit price bid per square meter. This price shall be full compensation for shaping existing material, loosening, mixing, pulverizing, spreading, drying, applying lime and fly ash, water content of the slurry, compacting, curing including curing materials, shaping and maintaining, processing, hauling, reworking if required, preparing secondary subgrade and for all mixing water, tools, equipment, labor and incidentals necessary to complete the work.

When proof rolling is shown on the plans and directed by the Engineer, it will be paid for in accordance with Item 216, "Rolling (Proof)".

When "Ordinary Compaction" is shown on the plans, all sprinkling and rolling, except proof rolling, will not be paid for directly, but will be considered subsidiary to this Item, unless otherwise shown on the plans.

When "Density Control" is shown on the plans, all sprinkling and rolling, except proof rolling, will not be paid for directly but will be considered subsidiary to this Item.

When subgrade is constructed under this project, correction of soft spots in the subgrade will be at the Contractor's expense. When subgrade is not constructed under this project, correction of soft spots in the subgrade will be in accordance with Article 9.3.

ITEM 266

LIME-FLY ASH (LFA) TREATMENT FOR BASE COURSES (ROAD MIXED)

266.1. Description. This Item shall govern for treating of new and/or existing base and surfacing, if shown, by pulverizing, adding lime and fly ash, mixing and compacting the treated material to the required density as specified herein and in conformity with the typical sections, lines, grades and depths as shown on the plans or as established by the Engineer.

266.2. Materials.

(1) Lime. Lime shall meet the requirements of Item 264, "Lime and Lime Slurry", for the type of lime specified.

The Contractor shall have the option of selecting from the types shown on the plans, the type of lime to be used. The Engineer shall be notified in writing before changing source or type.

All lime slurries used in "Slurry Placing" shall be furnished at or above the minimum "Dry Solids Content" as approved by the Engineer.

(2) Fly Ash. Fly ash shall meet the requirements of "Departmental Materials Specification: D-9-8900, Fly Ash".

(3) Flexible Base. New base material shall meet the material requirements of Item 247, "Flexible Base", and shall be of the type and grade as shown on the plans.

(4) Water. Water shall meet the material requirements of Item 204, "Sprinkling".

(5) Asphalt. Asphalt shall conform to the requirements of Item 300, "Asphalts, Oils and Emulsions".

266.3. Equipment. Equipment shall conform to the equipment requirements of Item 265, "Lime Fly Ash (LFA) Treatment for Materials Used as Subgrade".

266.4. Construction Methods.

(1) General. The completed course shall be uniformly treated, free from loose or segregated areas, of uniform density and moisture content, well bound for its full depth and shall have a smooth surface.

(2) Preparation of Subgrade or Base. Prior to treating existing material and/or placing any new material, the existing material shall be shaped to conform to the typical sections as shown on the plans or as established by the Engineer. This work shall be done in accordance with the applicable bid items. When shown on the plans, any existing asphaltic concrete pavement shall be removed and paid for in accordance with the applicable bid items.

When shown on the plans and when directed by the Engineer, the Contractor shall proof roll the roadbed in accordance with Item 216, "Rolling (Proof)", before pulverizing or scarifying an existing material. Soft spots shall be corrected as directed by the Engineer.

When the Contractor elects to use a cutting and pulverizing machine that will process the material to the plan depth, the Contractor will not be required to excavate to the secondary grade or windrow the material. This method will be permitted only if a machine is provided which will insure that the material is cut uniformly to the proper depth and which has cutters that will plane the secondary grade to a uniform surface over the entire width of the cut. The machine shall provide a visible indication of the depth of cut at all times.

In lieu of using the cutting and pulverizing machine, the Contractor shall excavate and windrow the material to expose the secondary grade to the typical sections, lines and grades as shown on the plans or as established by the Engineer.

When new base material is required by this Item, it shall be delivered, placed and spread in the required amount per 30 meters. The material shall be manipulated as specified for the base course or as directed by the Engineer and thoroughly mixed to provide a uniform gradation prior to the addition of lime or fly ash.

(3) Pulverization. The existing pavement or base material shall be pulverized or scarified so that a minimum of 100 percent will pass the 63 millimeter sieve.

(4) Application and Mixing of Lime and Fly Ash.

(a) General. General Requirements shall conform to the requirements of Section 265.4.(4)(a).

(b) Application of Lime. Application of lime shall conform to the requirements of Section 265.4.(4)(b).

(c) Mixing of Lime. The mixing procedure shall be the same for "Dry Placing" or "Slurry Placing" as herein described.

During the interval of time between application and mixing, hydrated lime that has been exposed to the open air for a period of six (6) hours or more or to excessive loss due to washing or blowing will not be accepted for payment.

The material and lime shall be thoroughly mixed by equipment approved by the Engineer. The material and lime shall be brought to the proper moisture content. The mixing shall be continued until, in the opinion of the Engineer, a homogeneous mixture is obtained.

The treated materials shall be sprinkled during the mixing operation as approved by the Engineer to provide optimum mixing moisture.

In addition to the above, when Type C Quicklime, Grade "DS", is used under "Dry Placing", the material and lime shall be mixed as thoroughly as possible at the time of the lime application. Sufficient moisture shall be added during the mixing to hydrate the quicklime. After mixing, and prior to compaction, the mixture of material, quicklime and water shall be moist cured for two (2) to seven (7) days, as approved by the Engineer. After curing, mixing shall continue until the material and lime are thoroughly blended to the satisfaction of the Engineer.

(d) Application of Fly Ash. Unless otherwise approved by the Engineer, fly ash shall be distributed in the dry form only by a distributor approved by the Engineer. Application shall begin within four (4) calendar days after the lime mixing operation has been completed, unless approved by the Engineer. Fly ash shall not be applied when wind conditions, in the opinion of the Engineer, are such that blowing fly ash becomes objectionable to adjacent property owners or dangerous to traffic. The mixture shall be sprinkled as approved by the Engineer. Fly ash shall be uniformly spread only on that area where the mixing and compacting operations can be completed during the same working day. A motor grader shall not be used to spread fly ash. Initial mixing after the addition of fly ash shall be accomplished dry or with a minimum of water to prevent fly ash balls.

(e) Mixing of Fly Ash. The mixing shall be continued until, in the opinion of the Engineer, a homogenous mixture of lime, fly ash and material is obtained.

(5) Compaction Methods. Prior to compaction, the material shall be aerated or sprinkled as necessary to provide the optimum moisture. Compaction shall begin immediately after mixing of the last stabilizing agent. All compaction operations shall be completed within six (6) hours.

Compaction shall continue until the entire depth of the mixture is uniformly compacted by "Ordinary Compaction" or "Density Control" as shown on the plans. Throughout this entire operation the shape of the course shall be maintained by blading, and the surface upon completion shall be smooth and in conformity with the typical sections, lines and grades as shown on the plans or as established by the Engineer.

When shown on the plans or approved by the Engineer, multiple lifts will be permitted.

(a) Ordinary Compaction. When "Ordinary Compaction" is shown on the plans, the following provisions shall apply:

The material shall be sprinkled and rolled as directed by the Engineer. All irregularities, depressions or weak spots which develop shall be corrected immediately by scarifying the areas affected, adding or removing material as required and reshaping, recompacting by sprinkling and rolling. The surface of the course shall be maintained in a smooth condition, free from undulations and ruts, until the next course is placed.

Should the material lose the required stability, compaction or finish before the next course is placed, or the project is accepted, it shall be reworked in accordance with Subarticle 265.4.(6). However, compaction shall be in accordance with "Ordinary Compaction".

(b) Density Control. When "Density Control" is shown on the plans the following provisions shall apply:

Unless otherwise shown on the plans, the bottom course shall be sprinkled as required and compacted to the extent necessary to provide not less than 95 percent of the density determined by Test Method Tex-121-E, Part II. Unless otherwise shown on the plans, all other subsequent courses treated under this Item shall be compacted to a minimum of 98 percent of the density. The optimum density will be determined by Test Method Tex-121-E, Part II. Roadway density testing will be in accordance with Test Method Tex-115-E.

When the material fails to meet the density requirements, or should the material lose the required stability, density or finish before the next course is placed or the project is accepted, it shall be reworked in accordance with Subarticle 265.4.(6).

(6) Finishing and Curing. After the final layer or course of the LFA treated base has been compacted, it shall be brought to the required lines and grades in accordance with the typical sections, within two (2) hours.

The completed section shall then be finished by rolling with an approved pneumatic tire or other suitable roller as approved by the Engineer. The completed section shall be moist cured or prevented from drying by addition of an asphalt material at the rate of 0.2 to 0.9 liter per square meter as determined by the Engineer. This material shall be the type shown on the plans. Curing shall continue for seven (7) days before further courses are added or traffic is permitted, unless otherwise approved by the Engineer.

However, the LFA treated base material may be covered by other courses the day following finishing, when approved by the Engineer. When the plans provide for the treated base to be sealed or covered by other courses of material, the seal or next course shall be applied within 14 calendar days after final compaction is completed, unless otherwise approved by the Engineer.

266.5. Tolerances. Tolerances shall conform to the following:

(1) Density Tolerances. The Engineer may accept the work providing not more than one (1) out of the most recent five (5) density tests performed is below the specified density, provided the failing test is no more than 50 kilograms per cubic meter below the specified density.

(2) Grade Tolerances. Finished grade tolerances shall be in accordance with Subsection 247.3.(1)(f)(ii).

266.6. Measurement. This Item will be measured as follows:

(1) Lime.

(a) Type A.

(i) Hydrated Lime (Dry). When Type A Hydrated Lime is used under "Dry Placing", the quantity of lime will be measured by the megagram, dry mass.

(ii) Hydrated Lime (Slurry). When Type A Hydrated Lime is used under "Slurry Placing", the quantity of lime will be measured by the megagram, dry mass of the powdered bulk hydrated lime used to prepare the hydrated lime slurry at the job site.

(b) Type B.

Commercial Lime Slurry. When Type B Commercial Lime Slurry is used, the quantity of lime will be calculated from the minimum percent "Dry Solids Content" of the slurry previously agreed upon for the project by the Contractor and the Engineer. This figure will be multiplied by the mass of the slurry in megagrams delivered, which must be at or above the required minimum "Dry Solids Content".

(c) Type C.

(i) Quicklime (Dry). When Type C Quicklime is used under "Dry Placing", the quantity of lime will be measured by the megagram, dry mass of the quicklime actually delivered on the road.

(ii) Quicklime (Slurry). When Type C Quicklime is used under "Slurry Placing", the quantity will be measured by the megagram, dry mass of the quicklime used to prepare the hydrated lime slurry at the job site. The measured megagrams of Type C Quicklime will be multiplied by a conversion factor of 1.28 to give the quantity of equivalent hydrated lime, which will be the basis of payment.

(2) Fly Ash. Fly ash will be measured by the megagram, dry mass as delivered on the road.

(3) LFA Treatment. LFA treatment of base will be measured by the square meter of the depth specified to the line and grades shown on the typical sections.

266.7. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for as follows:

(1) Lime. Lime will be paid for at the unit price bid for "Lime" of one of the following specified types, which price will be full compensation for furnishing all lime.

(a) Type A (Dry)
(b) Type A (Slurry)
(c) Type B
(d) Type C (Dry)
(e) Type C (Slurry)

Lime for reworking a section in accordance with Subarticle 265.4.(6) will not be paid for directly but will be subsidiary to this Item.

(2) Fly Ash. Fly ash will be paid for at the unit price bid for "Fly Ash", which price will be full compensation for furnishing all fly ash.

Fly ash for reworking a section in accordance with Subarticle 265.4.(6) will not be paid for directly but will be subsidiary to this Item.

(3) LFA Treatment. "LFA Treatment For Base Courses (Existing Base)", "LFA Treatment For Base Courses (New Base)" or "LFA Treatment For Base Courses (New and Existing Base)" of the type compaction and depth specified will be paid for at the unit price bid per square meter. This price shall be full compensation for shaping existing material, loosening, mixing, pulverizing or scarifying, spreading, drying, applying lime and fly ash, water content of the slurry, compacting, curing including curing materials, shaping and maintaining, processing, hauling, reworking if required, preparing secondary subgrade, for all mixing water, tools, equipment, labor and incidentals necessary to complete the work.

Furnishing and delivery of the new base to the project will be paid for as "Flexible Base (Roadway Delivery)", in accordance with Article 247.5. All manipulation including mixing, spreading, blading, shaping, compacting

and finishing of the new and/or existing base material will be paid for under this Item.

When proof rolling is shown on the plans and directed by the Engineer, it will be paid for in accordance with Item 216, "Rolling (Proof)".

When "Ordinary Compaction" is shown on the plans, all sprinkling and rolling, except proof rolling, will not be paid for directly but will be considered subsidiary to this Item, unless otherwise shown on the plans.

When "Density Control" is shown on the plans, all sprinkling and rolling, except proof rolling, will not be paid for directly but will be considered subsidiary to this Item.

When the existing section is constructed under this project, correction of soft spots in the subgrade or base will be at the Contractor's expense. When the existing section is not constructed under this project, correction of soft spots will be in accordance with Article 9.3.

ITEM 275

PORTLAND CEMENT TREATED MATERIALS (ROAD MIXED)

275.1. Description. This Item shall govern for treating subgrade, new and/or existing base [with or without asphaltic concrete pavement (ACP)], or combinations as shown on the plans, by the addition of portland cement and for road mixing and compacting the treated material to the required density, as herein specified and in conformity with the typical sections, lines, grades and thickness as shown on the plans or as established by the Engineer.

275.2. Materials. Materials shall conform to the requirements shown on the plans and to the following requirements.

(1) Flexible Base. New base material shall conform to the material requirements of Item 247, "Flexible Base" and shall be of the type and grade as shown on the plans.

(2) Portland Cement. Portland cement shall be either Type I, IP, or II conforming to the requirements of Item 524, "Hydraulic Cement".

(3) Water. Water shall conform to the material requirements for Item 421, "Portland Cement Concrete".

(4) Asphalt. Asphalt shall conform to the material requirements of Item 300, "Asphalts, Oils and Emulsions".

275.3. Equipment.

(1) General. The machinery, tools, and equipment necessary for proper prosecution of the work shall be on the project and approved by the Engineer prior to beginning work on this Item.

All machinery, tools, and equipment used shall be maintained in a satisfactory working condition.

(2) Weighing and Measuring Equipment. Weighing and measuring equipment shall conform to Subarticle 520.3.(5) second paragraph.

275.4. Mix Design. Cement content will be selected by the Engineer based on compressive strength tests provided by the Contractor so as to meet the strength as shown on the plans. When Strength L, M or N is shown on the plans, compressive strength conforming to the requirements in Table 1 will be determined by mix design tests provided by the Contractor on laboratory prepared samples in accordance with Test Method Tex-120-E.

When material properties or sources change, the Engineer may require the Contractor to provide additional mix design tests and adjust the cement content as required.

TABLE 1

STRENGTH REQUIREMENTS

Strength	Minimum Design Compressive Strength	Allowable Cement Content %
Strength L	5170 kPa	4-9
Strength M	3450 kPa	3-9
Strength N	As shown on plans	---
Strength O	No strength specified	As shown on the plans

275.5. Construction Methods

(1) General. The completed course shall be uniformly treated, free from loose or segregated areas, of uniform density and moisture content, well bound for its full depth and shall have a smooth surface.

(2) Preparation of Subgrade or Existing Base. Prior to scarifying or pulverizing existing material, the subgrade or existing base shall be shaped to conform to the typical sections as shown on the plans or as established by the Engineer. This work shall be done in accordance with the provisions of the applicable bid Items. When shown on the plans, any existing asphaltic concrete pavement shall be removed and paid for in accordance with the applicable bid Items.

When shown on the plans and when directed by the Engineer, the Contractor shall proof roll the roadbed in accordance with Item 216, "Rolling (Proof)", before pulverizing or scarifying existing material. Soft spots shall be corrected as directed by the Engineer.

When the Contractor elects to use a cutting and pulverizing machine that will process the material to the plan depth, the Contractor will not be required to excavate to the secondary grade or windrow the material. This

method will be permitted only if a machine is provided which will insure that the material is cut uniformly to the proper depth and which has cutters that will plane the secondary grade to a smooth surface over the entire width of the cut. The machine shall be of such design that a visible indication is given at all times that the machine is cutting to the proper depth.

In lieu of using the cutting and pulverizing machine, the Contractor shall excavate and windrow the material to expose the secondary grade to the typical sections, lines and grades as shown on the plans or as established by the Engineer. Then the windrowed material shall be uniformly replaced before cement is applied.

(3) Pulverization. The existing material as shown on the typical section, shall be pulverized or scarified as follows:

(a) Existing Subgrade. A minimum of 80 percent shall pass the 4.75 millimeter sieve.

NOTE: When shown on the plans or approved by the Engineer, this pulverization requirement may be w

(b) Subbase, Base and/or Surfacing. A minimum of 100 percent shall pass the 50 millimeter sieve.

(4) Application of Cement. The percent of cement to be added will be as shown on the plans or determined in accordance with Article 275.4.

Cement shall be spread only in that area where the mixing, compacting, and finishing operations can be completed during the same working day.

Unless otherwise approved by the Engineer, the cement treatment operation shall not be started when the air temperature is below 5 °C and falling, but may be placed when the air temperature is above 2 °C and rising. The temperature will be taken in the shade and away from artificial heat. Cement shall not be placed when weather conditions in the opinion of the Engineer are unsuitable.

The cement shall be spread by an approved spreader or by bag

distribution. It shall be distributed at a uniform rate and in such a manner as to reduce to a minimum the scattering of cement by wind. Cement shall not be applied when wind conditions, in the opinion of the Engineer, are such that blowing cement becomes objectionable to adjacent property owners or dangerous to traffic.

(5) Mixing. Only single or multiple soil stabilizer mixers shall be used.

When delivered flexible base is shown on the plans, the base materials shall be uniformly spread and premixed prior to the addition of cement or water, unless otherwise approved by the Engineer.

After any required mixing of the material(s), the cement shall be dry mixed with the material(s) prior to the addition of water. Immediately after dry mixing, water shall be uniformly applied. After mixing, the mixture shall be in a loose, evenly spread state ready for compaction. The mixture shall be mixed and compacted in one (1) lift.

(6) Compaction Methods. Compaction shall continue until the entire thickness of the mixture is uniformly compacted by "Ordinary Compaction" or "Density Control" as shown on the plans.

Compaction shall be completed within two (2) hours of the addition of water to the dry mixed material.

(a) Ordinary Compaction. When "Ordinary Compaction" is shown on the plans, the following provisions shall apply:

The treated material shall be sprinkled and rolled as directed by the Engineer. All irregularities, depressions or weak spots which develop shall be corrected immediately by scarifying the areas affected, adding or removing treated material as required, reshaping, and recompacting at the Contractor's expense.

Should the material lose the required stability, compaction or finish before the next course is placed or the project is accepted, it shall be removed and replaced, unless otherwise approved by the Engineer. Removal and replacement will be at the Contractor's expense.

275.6

(b) Density Control. When "Density Control" is shown on the plans, the following provisions shall apply.

Unless otherwise shown on the plans, the course shall be sprinkled as required herein and compacted to the extent necessary to provide not less than 95 percent of the density as determined by Test Method Tex-120-E, Part II. Roadway density will be determined by Test Method Tex-115-E.

When the material fails to meet the density requirements or should the material lose the required stability, density or finish before the next course is placed or the project is accepted, the treated material shall be removed and replaced, unless otherwise approved by the Engineer. Removal and replacement with acceptable treated material will be at the Contractor's expense.

(7) Finishing. Immediately after compaction, the surface of the mixture shall be clipped, skinned, or tight bladed by a maintainer or subgrade trimmer to a depth of approximately six (6) millimeters, removing all loosened materials. The loosened materials shall be disposed of at the Contractor's expense and at a location approved by the Engineer. The surface shall then be rolled with a pneumatic tire roller, adding small increments of moisture as needed during rolling.

Throughout this operation, the shape of the course shall be maintained and the surface upon completion shall be smooth and in conformity with the typical sections, lines and grades as shown on the plans or as established by the Engineer.

(8) Curing. The completed section shall be moist cured for three (3) days or prevented from drying by addition of an asphalt material at the rate of 0.2 to 0.9 liter per square meter as determined by the Engineer. The asphalt used shall be of the type and grade shown as on the plans or as approved by the Engineer.

275.6. Tolerances. Tolerances shall conform to the following:

(1) Density Tolerances. The Engineer may accept the work providing not more than one (1) out of the most recent five (5) density tests performed is below the specified density, provided the failing test is no more than 50 kilograms per cubic meter below the specified density.

275.7 to 275.8

(2) Moisture Tolerances. The percentage of moisture in the mixture at the beginning of compaction shall be within ± two (2.0) percentage points of optimum as determined by Test Method Tex-120-E, Part II, unless otherwise approved by the Engineer. The percent of moisture will be determined in accordance with Test Method Tex-103-E. If the percentage of moisture is outside the allowable tolerance, the Contractor shall adjust operations to meet this requirement.

(3) Grade Tolerances. In areas on which pavement is to be placed, any deviation in excess of six (6) millimeters in cross section and six (6) millimeters in five (5) meters measured longitudinally shall be corrected by loosening, adding, or removing material, reshaping, and compacting by sprinkling and rolling.

275.7. Measurement. This Item will be measured as follows:

Cement Treatment will be measured by the square meter of the surface area to the lines and grades shown on the typical sections.

Cement will be measured by the megagram, dry mass.

275.8. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Cement Treatment (Existing Material)", "Cement Treatment (New Base)", or "Cement Treatment (Mixing Existing Material and New Base)" of the strength, thickness and compaction method specified and for "Cement" at the unit price bid per megagram, dry mass. These prices shall be full compensation for shaping existing material, loosening, pulverizing, providing cement, spreading, road mixing, compacting, blading, shaping, finishing, curing including curing materials, replacing if required, and for all mixing water, labor, tools and incidentals necessary to complete the work except as otherwise provided for in this specification.

When new base material is shown on the plans, furnishing and delivery of the new base will be paid for as "Flexible Base (Roadway Delivery)", of the type, grade and class shown on the plans in accordance with Article 247.5.

When "Ordinary Compaction" is shown on the plans, all sprinkling and rolling, except proof rolling, will not be paid for directly but will be

considered subsidiary to this Item, unless otherwise shown on the plans.

When "Density Control" is shown on the plans, all sprinkling and rolling, except proof rolling, will not be paid for directly but will be considered subsidiary to this Item.

When proof rolling is specified by the Engineer and shown on the plans, it will be paid for in accordance with Item 216, "Rolling (Proof)".

When subgrade is constructed under this project, correction of soft spots in the subgrade or existing base will be at the Contractor's expense.

When subgrade is not constructed under this project, correction of soft spots in the subgrade or existing base will be in accordance with Article 9.3.

ITEM 276

PORTLAND CEMENT TREATED BASE (PLANT MIXED)

276.1. Description. This Item shall govern for the construction of a portland cement treated base course, composed of new flexible base material, cement and water, mixed at a central mixing plant, and constructed in accordance with the typical sections, lines, grades and thickness as shown on the plans or as established by the Engineer and with the requirements herein.

276.2. Materials. Materials shall conform to the requirements shown on the plans and to the following requirements.

(1) Flexible Base. New base material shall conform to the material requirements of Item 247, "Flexible Base" and shall be of the type and grade as shown on the plans.

(2) Portland Cement. Portland cement shall be either Type I, IP, or II conforming to the requirements of Item 524, "Hydraulic Cement".

(3). Water. Water shall conform to the material requirements for Item 421, "Portland Cement Concrete".

(4). Asphalt. Asphalt shall meet the requirements of Item 300,

"Asphalts, Oils, and Emulsions".

276.3. Equipment.

(1) General. The machinery, tools and equipment necessary for proper prosecution of the work shall be on the project and approved by the Engineer prior to beginning work on this Item.

All machinery, tools and equipment used shall be maintained in satisfactory working condition.

(2) Mixer. The stationary mixing plant shall be capable of producing a uniform mixture and shall be equipped with feeding and/or weighing devices that are capable of proportioning the mixture as specified.

(3) Spreader. The material spreader shall be capable of placing the material in a uniform layer and shall be approved by the Engineer. When shown on the plans, the spreader shall be equipped with electronic grade controls.

(4) Weighing and Measuring Equipment. The equipment shall conform to the requirements of Item 520, "Weighing and Measuring Equipment".

276.4. Mix Design. Cement content will be selected by the Engineer based on compressive strength tests provided by the Contractor so as to meet the strength as shown on the plans. When Strength L, M or N is shown on the plans, compressive strength conforming to the requirements in Table 1 will be determined by mix design tests provided by the Contractor on laboratory prepared samples in accordance with Test Method Tex-120-E.

When material properties or sources change, the Engineer may require the Contractor to provide additional mix design tests and adjust the cement content as required.

TABLE 1

STRENGTH REQUIREMENTS

Strength	Minimum Design Compressive Strength	Allowable Cement Content %
Strength L	5170 kPa	4 - 9
Strength M	3450 kPa	3 - 9
Strength N	As shown on plans	
Strength O	No strength specified	As shown on the plans

276.5. Construction Methods

(1) **General.** A completed course shall be uniformly treated, free from loose or segregated areas, of uniform density and moisture content, well bound for its full depth and with a smooth surface. This work shall be done in accordance with the applicable bid Items.

(2) **Preparation of Subgrade or Existing Subbase.** Prior to placing the cement treated base, the subgrade or existing subbase shall be shaped to conform to the typical sections, as shown on the plans or as established by the Engineer.

When shown on the plans and when directed by the Engineer, the Contractor shall proof roll the roadbed in accordance with Item 216, "Rolling (Proof)", before placing treated material. Soft spots shall be corrected as directed by the Engineer.

(3) **Mixing and Placing.** The cement, base material, and water shall be thoroughly mixed in a stationary plant. After mixing is completed, no additional water shall be added to the mixture unless otherwise approved by the Engineer.

Cement treated material shall be placed only on that area where the compacting and finishing operations can be completed during the same working day.

Unless otherwise approved by the Engineer, the cement treated base operation shall not be started when the air temperature is below 5 °C and falling, but may be placed when the air temperature is above 2 °C and rising. The temperature will be taken in the shade and away from artificial heat. Cement treated base shall not be placed when weather conditions in the opinion of the Engineer are unsuitable.

The cement treated base shall be placed with an approved spreader in uniform layers to produce the depth shown on the plans. The thickness of the layers shall be as shown on the plans. Construction joints between new cement treated base and cement treated base that has been in place four (4) hours or longer shall be approximately vertical. The vertical face may be created by using a header or cutting back the face to approximately vertical.

(4) Compaction Method. Compaction shall continue until the entire depth of mixture is uniformly compacted by "Density Control".

Compaction shall be completed within two (2) hours of the addition of water to the dry mixed material. However, when multiple lifts are permitted, compaction of all lifts shall be completed within five (5) hours after the addition of water to the treated base used in the first lift.

After mixing, the cement treated material shall be hauled to the roadway and compaction begun immediately after placement. Throughout this entire operation, the shape of the course shall be maintained by blading and the surface upon completion shall be smooth and in conformity with the typical sections, lines and grades as shown on the plans or as established by the Engineer.

Unless otherwise shown on the plans, each course shall be compacted to the extent necessary to provide not less than 95 percent of the density as determined by Test Method Tex-120-E, Part II. Roadway density will be determined by Test Method Tex-115-E.

When the material fails to meet the density requirements or should the material lose the required stability, density or finish before the next course is placed or the project is accepted, the treated material shall be removed and replaced, unless otherwise approved by the Engineer. Removal and replacement will be at the Contractor's expense.

(5) Finishing. Immediately after compaction, the final course shall be clipped, skinned, or tight bladed by a maintainer or subgrade trimmer to a depth of approximately six (6) millimeters, removing all loosened materials. The loosened material shall be disposed of at the Contractor's expense and at a location approved by the Engineer. The surface shall be rolled immediately with a pneumatic tire roller, adding small increments of moisture as needed during rolling.

(6) Curing. The cement treated base shall be kept wet for a period of 72 hours after completion of compaction. This may be done by preventing the evaporation of water by sprinkling or by placing an approved asphaltic membrane. Either curing method may be used unless otherwise shown on the plans. The asphalt used shall be of the type and grade as shown on the plans or as approved by the Engineer in writing. The asphalt shall be applied at the rate of approximately 0.2 to 0.9 liter per square meter, unless otherwise shown on the plans or as approved by the Engineer.

276.6. Tolerances. Tolerances shall conform to the following:

(1) Density Tolerances. The Engineer may accept the work providing not more than one (1) out of the most recent five (5) density tests performed is below the specified density, provided the failing test is no more than 50 kilograms per cubic meter below the specified density.

(2) Moisture Tolerances. At the beginning of compaction, the percentage of moisture in the mixture shall be within ± two (2.0) percent of optimum as determined by Test Method Tex-120-E, unless otherwise approved by the Engineer. The percent of moisture will be determined in accordance with Test Method Tex-103-E. If the percentage of moisture is outside the allowable tolerance, the Contractor shall adjust operations to meet this requirement.

(3) Grade Tolerances. In areas in which pavement is to be placed, any deviation in excess of six (6) millimeters in cross section and six (6) millimeters in five (5) meters measured longitudinally shall be corrected by loosening, adding, or removing material, reshaping, and compacting by sprinkling and rolling.

276.7. Deficient Base Thickness. The adjustment in unit prices provided for in this Article will apply only when measurement for cement

treated base is by the square meter. The following requirements will govern for determining treated base thickness, and for adjustment of unit prices.

(1) Location and Measurement of Deficient Areas. The cement treated base will be measured for thickness by the Department prior to acceptance. The thickness of the base will be determined in accordance with Test Method Tex-140-E. Locations of tests will be selected by the Engineer; however, the spacing interval for tests, as specified herein, is to be maintained. The thickness of the treated base will be determined by measurement of the base in a finished condition.

For the purpose of establishing an adjusted unit price for payment, the following procedures will be followed:

(a) Segmental/Sequential Construction as Shown on the Plans. Units to be considered separately are defined as 300 meters or fraction thereof of cement treated base in each placement width starting at the beginning of each day's placement of each separate treated base section.

(b) No Segmental Construction Required. Units to be considered separately as 300 meters of cement treated base in each placement width starting at the beginning of the treated base bearing the smaller kilometer station number. The last unit in each placement width will be 300 meters plus the fractional part of 300 meters remaining.

Placement width will be considered as the width between longitudinal construction joints. For widening, the width will be considered as the average width placed of the widened section that is deficient in thickness.

For the purpose of establishing an adjusted unit price for intersections, irregular sections, crossovers, entrances, segmental construction, transition to but not including ramps and other areas designated by the Engineer, units are defined as 1700 square meters or fraction thereof.

One (1) measurement will be taken at the location selected by the Engineer or at random in each unit. When the measurement from any unit is not deficient more than 13.0 millimeters from the plan thickness, full payment will be made. When the measurement from any unit is deficient more than 13.0 millimeters but not more than 25.0 millimeters from the plan thickness, two (2) additional measurements will be taken from the unit

and the average of the three (3) measurements determined. The two (2) additional measurements from any 300-meter unit will be taken at intervals of not less than 90 meters apart. The two (2) additional measurements from any 1700-square meter unit will be taken at locations such that the treated base in the unit will be well represented. If the average of these three (3) measurements is not deficient by more than 13.0 millimeters from the plan thickness, full payment will be made. If the average thickness of the three (3) measurements is deficient more than 13.0 millimeters but not more than 25.0 millimeters from the plan thickness, an adjusted unit price as provided in Subarticle (2) of this Article will be paid for the areas represented by these measurements.

In calculating the average thickness of the treated base, measurements which are in excess of the specified thickness by more than six (6) millimeters will be considered as the specified thickness plus six (6) millimeters, and measurements which are less than the specified thickness by more than 25.0 millimeters will be considered as the specified thickness less 25.0 millimeters.

When any measurement is less than the specified thickness by more than 25.0 millimeters, the actual thickness of the treated base in this area will be determined by taking exploratory measurements at 15-meter intervals parallel to the centerline in each direction from the deficient measurement until, in each direction, a measurement is taken which is not deficient by more than 25.0 millimeters. Exploratory measurement may extend into adjacent units and will be included. Exploratory measurements for deficient thickness will not be used in averages for adjusted unit price. Exploratory measurements are to be used only to determine the length of the treated base in a unit that is to be left in place without pay and/or removed and replaced or corrected as provided in Subarticle 276.7.(2).

(2) Price Adjustments. When the average thickness of the treated base is deficient in thickness by more than 13.0 millimeters, but not more than 25.0 millimeters, payment will be made at an adjusted price as specified in Table 2.

TABLE 2
Cement Treated Base Deficiency

Deficiency in Thickness (Millimeters)	Proportional Part of Unit Bid Price Allowed
0.0 to 13.0	100 percent
greater than 13.0 through 20.0	75 percent
greater than 20.0 through 25.0	50 percent

Any area of treated base found deficient in thickness by more than 25.0 millimeters will be evaluated by the Engineer. If, in the judgement of the Engineer, the area of such deficiency should not be removed and replaced or corrected, there will be no payment for the area retained. If, in the judgement of the Engineer, the area of such deficiency warrants replacement, the area shall be replaced by the Contractor to the thickness of the adjacent sections. In lieu of reworking a deficient thickness section with new treated base, a hot mix asphaltic concrete overlay conforming to the requirements of Item 340, "Hot Mix Asphaltic Concrete Pavement", may be permitted by the Engineer.

Payment for the replaced/corrected sections will be at 50 percent of the unit bid price. The minimum limit of non-pay will be 30 meters.

(3) Excess Thickness. No additional payment over the unit bid price will be made for any treated base of a thickness exceeding that required by the plans.

276.8. Measurement. This Item will be measured by the method described as either Class 1, 2, 3, 4 or 5 as follows and as specified on the plans.

(1) Class 1. Cement treated base will be measured by the cubic meter in vehicles as delivered on the road.

(2) Class 2. Cement treated base will be measured by the megagram, dry mass in vehicles as delivered on the road.

(3) **Class 3.**

(a) Flexible base will be measured by the megagram, dry mass, excluding the mass of cement, in vehicles as delivered on the road.

(b) Cement will be measured by the megagram, dry mass, excluding mass of flexible base, in vehicles as delivered on the road based on the calculated or specified percentage.

(4) **Class 4.** Flexible base and cement will be measured as follows:

(a) Flexible base will be measured by the square meter of surface area of completed and accepted work, based on the width of cement treated base as shown on the plans.

(b) Cement will be measured by the megagram, dry mass based on the square meters of flexible base. Cement content will be based on the calculated or specified percentage.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment is required, additional measurements or calculations will not be required. No payment will be made for thickness or width exceeding that shown on the typical section or provided on the plans.

(5) **Class 5.** Cement treated base will be measured by the square meter of surface area of completed and accepted work, based on the width of cement treated base as shown on the plans.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment is required, additional measurements or calculations will not be required. No payment will be made for thickness or width exceeding that shown on the typical section or provided on the plans.

NOTE: For Class 2 and 3, the moisture in the material will be determined at least one (1) time each day and more often if conditions warrant. Dry mass will be determined in accordance with Test Method Tex-103-E.

276.9. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid as follows:

(1) Measurement Class 1 will be paid for at the unit price bid per cubic meter for "Cement Treated Base" of the strength, flexible base type and grade specified.

(2) Measurement Class 2 will be paid for at the unit price bid per megagram, dry mass for "Cement Treated Base" of the strength, flexible base type and grade specified.

(3) Measurement Class 3 will be paid for at the unit price bid per megagram, dry mass for "Flexible Base" of the strength, flexible base type and grade specified, and for "Cement" at the unit price bid per megagram, dry mass.

(4) Measurement Class 4 will be paid for at the unit price bid per square meter for "Flexible Base" of the strength, flexible base type, grade, and thickness specified, and at the unit price bid per megagram, dry mass for "Cement".

(5) Measurement Class 5 will be paid for at the unit price bid per square meter for "Cement Treated Base" of the strength, flexible base type, grade and thickness specified.

(6) General.

For Measurement Classes 1, 2, and 5, the unit price bid will be full compensation for furnishing all materials, mixing, placing, compaction, finishing, curing, tools, equipment, and all incidentals necessary to complete the work.

For Measurement Classes 3 and 4, the unit price bid for "Flexible Base" will be full compensation for mixing, placing, compaction, finishing, curing, tools, equipment, and all incidentals necessary to complete the work and furnishing all materials except cement.

For Measurement Classes 3 and 4, the unit price bid for "Cement" will be full compensation for furnishing cement.

For Measurement Classes 4 and 5, an adjusted unit price for deficient thickness base as provided under Article 276.7 will be paid.

All sprinkling and rolling except proof rolling will not be paid for directly but will be considered subsidiary to this Item.

When Proof Rolling is specified, it will be paid for in accordance with Item 216, "Rolling (Proof)".

When Hot Mix Asphaltic Concrete is used to correct deficient thickness, it will not be paid for directly but will be considered subsidiary to this Item.

When subgrade or subbase is constructed under this project, correction of soft spots in the subgrade or subbase will be at the Contractor's expense. When subgrade or subbase is not constructed under this project, correction of soft spots in the subgrade or subbase will be in accordance with Article 9.3.

PART II, CONSTRUCTION DETAILS

DIVISION III
SURFACE COURSES OR PAVEMENT

ITEM 300

ASPHALTS, OILS AND EMULSIONS

300.1. Description. This Item shall govern for asphalt cement, cutback asphalts, emulsified asphalts, other miscellaneous asphaltic materials and latex additives.

300.2. Materials. When tested according to Texas Department of Transportation Test Methods, the various materials shall meet the applicable requirements of this specification.

(1) Asphalt Cement. The asphalt cement shall be homogeneous, shall be free from water, shall not foam when heated to 175 °C and shall meet the requirements in Table 1.

TABLE 1

Viscosity Grade	AC-1.5		AC-3		AC-5		AC-10		AC-20		AC-30	
Property	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Viscosity,												
60 °C, Pa·s	10.0	20.0	25.0	35.0	40.0	60.0	80.0	120.0	160.0	240.0	240.0	360.0
135 °C, Pa·s	0.07	-	0.11	-	0.14	-	0.19	-	0.25	-	0.30	-
Penetration, 25 °C												
100 g, 5 s, (0.1 mm)	250	-	210	-	135	-	85	-	55	-	45	-
Flash Point, C.O.C.,°C	218	-	218	-	218	-	232	-	232	-	232	-
Solubility in												
Trichloroethylene, %	99.0	-	99.0	-	99.0	-	99.0	-	99.0	-	99.0	-
Spot Test	Negative for all grades											
Tests on Residue from												
Thin Film Oven Test:												
Viscosity, 60 °C,												
Pa·s	-	45.0	-	90.0	-	150.0	-	300.0	-	600.0	-	900.0
Ductility, 25 °C,												
50 mm per min, mm	1000*	-	1000	-	1000	-	1000	-	700	-	500	-

* If the ductility at 25 °C is less than 1000 mm, the material will be acceptable if its ductility at 16 °C is more than 1000 mm.

(2) Latex Modified Asphalt.

(a) Latex Additive. The latex additive shall be an emulsion of styrene-butadiene low-temperature copolymer in water. The emulsion shall have good storage stability and possess the following properties.

Monomer Ratio of Latex, butadiene to styrene	-	$\frac{73 \pm 5}{27 \pm 5}$
Minimum Solids Content, percent by mass	-	45
Viscosity of Emulsion at 25 ± 1 °C, cps, max (No. 3 spindle, 20 rpm, Brookfield RVT Viscometer)	-	2000

The manufacturer shall furnish the actual styrene-butadiene rubber (SBR) content for each batch of latex emulsion. This information shall accompany all shipments to facilitate proper addition rates.

(b) Latex Modified Asphalt Cement. The latex modified asphalt cement shall consist of an AC-5 or AC-10 asphalt cement in accordance with Subarticle 300.2.(1) to which a styrene-butadiene rubber latex has been added. The amount shown is based on latex solids in the finished asphalt cement-latex additive blend. Possible combinations and their intended uses are as follows:

Material	Use
AC-5 + 2% latex solids	Surface treatments
AC-10 + 2% latex solids	Surface treatments or asphaltic concrete
AC-10 + 3% latex solids	Asphaltic concrete
AC-10 + 3% latex solids (High viscosity blend)	Asphaltic concrete where maximum high temperature toughness is needed.

The finished asphalt cement-latex additive blend shall be smooth, homogeneous, and comply with the requirements in Table 2.

TABLE 2

Type - Grade Property	AC-5 + 2% Latex Solids	AC-10 + 2% Latex Solids	AC-10 + 3% Latex Solids	AC-10 + 3% Latex Solids (High Viscosity Blend)
Minimum SBR content, percent by mass solids (IR determination) *	2.0	2.0	3.0	3.0
Penetration, 100 g, 5 s, 25 °C, min, (0.1 mm)	120	80	75	75
Viscosity, 60 °C, Pa·s, minimum	70.0	130.0	160.0	230.0
Viscosity, 135 °C, Pa·s, maximum	0.70	0.80	1.20	1.20
Ductility, 4 °C, 10 mm/min mm, minimum	-	-	1000	1000
Ductility, 4 °C, 50 mm/min mm, minimum	700	600	-	-
Separation of Polymer after 48 hours at 163 °C	None	None	None	None
Separation of Polymer after 5 hours at 163 °C **	None	None	None	None

* The asphalt supplier shall furnish the Department samples of the asphalt cement and latex emulsion used in making the finished product.

** Applies in lieu of the 48 hour requirement when the latex modified asphalt is to be used in asphaltic concrete and the latex additive is introduced separately at the mix plant, either by injection into the asphalt line or into the mixer.

(c) Latex Modified Cutback Asphalt. The latex modified cutback asphalt shall be a medium curing cutback produced from an asphalt cement to which has been added a styrene-butadiene rubber latex. The latex modified cutback asphalt shall comply with the requirements in Table 3.

TABLE 3

Type - Grade	MC-2400 Latex	
Property	Min	Max
Kinematic Viscosity @ 60 °C, mm^2/s	2400	4800
Water, percent	-	0.2
Flash Point, T.O.C., °C	65	-
Distillation Test:		
Distillate, percentage by volume of total distillate to 360 °C		
to 260 °C	-	35
to 316 °C	35	80
Residue from Distillation, volume %	78	-
Tests on Distillation Residue:		
Minimum SBR Content percent by mass solids (IR determination) *	2.0	-
Penetration, 100 g, 5 s, 25 °C, (0.1 mm)	150	300
Ductility, 50 mm/min, 25 °C, mm	500	-
Solubility in Trichloroethylene, %	99.0	-

* The asphalt supplier shall furnish the Department samples of the asphalt cement and latex emulsin used in making the finished product.

(3) Cutback Asphalt. Cutback asphalt shall meet the requirements indicated in Tables 4 and 5 for the specified type and grade.

TABLE 4
RAPID CURING TYPE CUTBACK ASPHALT

Type - Grade	RC-250		RC-800		RC-3000	
Property	Min	Max	Min	Max	Min	Max
Kinematic Viscosity @ 60 °C, mm^2/s	250	400	800	1600	3000	6000
Water, percent	-	0.2	-	0.2	-	0.2
Flash Point, T.O.C., °C	27	-	27	-	27	-
Distillation Test:						
Distillate, percentage by volume of total distillate to 360 °C						
to 225 °C	40	75	35	70	20	55
to 260 °C	65	90	55	85	45	75
to 316 °C	85	-	80	-	70	-
Residue from distillation, volume %	70	-	75	-	82	-
Tests on Distillation Residue:						
Penetration, 100 g, 5 s, 25 °C, (0.1 mm)	80	120	80	120	80	120
Ductility, 50 mm/min, 25 °C, mm	1000	-	1000	-	1000	-
Solubility in Trichloroethylene, %	99.0	-	99.0	-	99.0	-
Spot Test	Negative for all grades					

TABLE 5
MEDIUM CURING TYPE CUTBACK ASPHALT

Type - Grade	MC-30		MC-70		MC-250		MC-800		MC-3000	
Property	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Kinematic Viscosity @ 60 °C, mm^2/s	30	60	70	140	250	500	800	1600	3000	6000
Water, Percent	-	0.2	-	0.2	-	0.2	-	0.2	-	0.2
Flash Point, T.O.C., °C	38	-	38	-	65	-	65	-	65	-
Distillation Test:										
Distillate, percentage by volume of total distillate to 360 °C										
to 225 °C	-	25	-	20	-	10	-	-	-	-
to 260 °C	40	70	20	60	15	55	-	35	-	15
to 316 °C	75	93	65	90	60	87	45	80	15	75
Residue from Distillation, volume %	50	-	55	-	67	-	75	-	80	-
Tests on Distillation Residue:										
Penetration, 100 g, 5 s, 25 °C, (0.1 mm)	120	250	120	250	120	250	120	250	120	250
Ductility, 50 mm/min, 25 °C, mm	1000*	-	1000*	-	1000*	-	1000*	-	1000*	-
Solubility in Trichloroethylene, %	99.0	-	99.0	-	99.0	-	99.0	-	99.0	-
Spot Test	Negative for all grades									

* If the penetration of residue is more than 200 and the ductility at 25 °C is less that 1000 mm, the material will be acceptable if its ductility at 16 °C is more than 1000 mm.

(4) Emulsified Asphalt. Emulsified asphalt shall be homogeneous, shall show no separation of asphalt after thorough mixing and shall meet the requirements for the specified type and grade shown in Tables 6 through 9.

TABLE 6
ANIONIC EMULSIONS

	Rapid Setting				Medium Setting		Slow Setting			
Type - Grade	**RS-2**		**RS-2h**		**MS-2**		**SS-1**		**SS-1h**	
Property	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
Viscosity, Saybolt Furol at 25 °C, s	-	-	-	-	-	-	20	100	20	100
at 50 °C, s	150	400	150	400	100	300	-	-	-	-
Sieve Test, %	-	0.10	-	0.10	-	0.10	-	0.10	-	0.10
Miscibility (Standard Test)	-	-	-	-	-	-	Passing		Passing	
Cement Mixing, %	-	-	-	-	-	-	-	2.0	-	2.0
Demulsibility, 35 ml of 0.02 N $CaCl_2$, %	60	-	60	-	-	30	-	-	-	-
Storage Stability, 1 day, %	-	1	-	1	-	1	-	1	-	1
Freezing Test, 3 cycles *	-	-	-	-	Passing		Passing		Passing	
Distillation Test:										
Residue by Distillation, % by mass	65	-	65	-	65	-	60	-	60	-
Oil Distillate, % by volume of emulsion	-	1/2	-	1/2	-	1/2	-	1/2	-	1/2
Tests on Residue from Distillation:										
Penetration at 25 °C, 100 g, 5 s, (0.1 mm)	120	160	80	110	120	160	120		70	100
Solubility in Trichloroethylene, %	97.5	-	97.5	-	97.5	-	160		97.5	-
Ductility at 25 °C, 50 mm/min, mm	1000	-	800	-	1000	-	97.5	-	800	-
							1000	-		

* Applies only when the Engineer designates material for winter use.

TABLE 7
HIGH FLOAT ANIONIC EMULSIONS

	Rapid Setting		Medium Setting	
Type - Grade	HFRS-2		AES-300	
Property	Min	Max	Min	Max
Viscosity, Saybolt Furol				
at 25 °C, s	-	-	75	400
at 50 °C, s	150	400	-	-
Sieve Test, %	-	0.10	-	0.10
Coating Ability and Water Resistance:				
Coating, dry aggregate	-	-	good	
Coating, after spraying	-	-	fair	
Coating, wet aggregate	-	-	fair	
Coating, after spraying	-	-	fair	
Demulsibility 35 ml of 0.02 N $CaCl_2$, %	50	-	-	-
Storage Stability Test, 1 day, %	-	1	-	1
Distillation Test:				
Residue by Distillation, % by mass	65	-	65	-
Oil Distillate, by volume of emulsion, %	-	1/2	-	5
Tests on Residue from Distillation:				
Penetration at 25 °C, 100 g, 5 s, (0.1 mm)	100	140	300	-
Solubility in Trichloroethylene, %	97.5	-	97.5	-
Ductility at 25 °C, 50 mm/min, mm	1000	-	-	-
Float Test at 60 °C, s	1200	-	1200	-

TABLE 8
CATIONIC EMULSIONS

	Rapid Setting				Medium Setting				Slow Setting			
Type - Grade	CRS-2		CRS-2h		CMS-2		CMS-2s		CSS-1		CSS-1h	
Property	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol												
at 25 °C, s	-	-	-	-	-	-	-	-	20	100	20	100
at 50 °C, s	150	400	150	400	100	300	100	300	-	-	-	-
Sieve Test, %	-	0.10	-	0.10	-	0.10	-	0.10	-	0.10	-	0.10
Cement Mixing, %	-	-	-	-	-	-	-	-	-	2.0	-	2.0
Demulsibility, 35 ml 0.8 percent sodium dioctyl sulfosuccinate, %	40	-	40	-	-	-	-	-	-	-	-	-
Storage Stability, 1 day, %	-	1	-	1	-	1	-	1	-	1	-	1
Coating Ability and Water Resistance:												
Coating, dry aggregate	-	-	-	-	good		good		-	-	-	-
Coating, after spraying	-	-	-	-	fair		fair		-	-	-	-
Coating, wet aggregate	-	-	-	-	fair		fair		-	-	-	-
Coating, after spraying	-	-	-	-	fair		fair		-	-	-	-
Particle Charge Test	positive		positive		positive		positive		positive		positive	
Distillation Test:												
Residue by Distillation, % by mass	65	-	65	-	65	-	65	-	60	-	60	-
Oil Distillate, % by volume of emulsion	-	1/2	-	1/2	-	7	-	5	-	1/2	-	1/2
Tests on Residue from Distillation:												
Penetration at 25 °C, 100 g, 5 s, (0.1 mm)	120	160	80	110	120	200	300	-	120	160	80	110
Solubility in Trichloroethylene, %	97.5	-	97.5	-	97.5	-	97.5	-	97.5	-	97.5	-
Ductility at 25 °C, 50 mm/min, mm	1000	-	800	-	1000	-	-	-	1000	-	800	-

TABLE 9
POLYMER MODIFIED EMULSIONS

	High Float Anionic Rapid Setting		Cationic Rapid Setting	
Type - Grade	HFRS-2P		CRS-2P	
Property	Min	Max	Min	Max
Polymer Content, percent by mass of the distillation residue *	3.0	-	3.0	-
Viscosity, Saybolt Furol at 50 °C, s	150	400	150	400
Storage Stability Test, 1 day, %	-	1	-	1
Demulsibility, 35 ml of 0.02 N $CaCl_2$, %	40	-	-	-
Demulsibility, 35 ml 0.8 percent sodium dioctyl sulfosuccinate, %	-	-	40	-
Sieve Test, %	-	0.10	-	0.10
Particle Charge Test	-		Positive	
**Distillation Test:				
Oil distillate, by volume of emulsion, %	-	1/2	-	1/2
Residue, % by mass	65	-	65	-
Tests on Residue from Distillation:				
Float Value at 60 °C, s	1200	-	-	-
Penetration, 25 °C, 100 g, 5 s, (0.1 mm)	100	140	110	150
Ductility, 4 °C, 50 mm/min, mm	500	-	500	-
Viscosity at 60 °C, Pa·s	150.0	-	130.0	-
Solubility in Trichloroethylene, %	97	-	97	-

* The emulsion supplier shall furnish the Department samples of the asphalt cement and polymer used in making the finished emulsion.

**The temperature on the lower thermometer shall be brought slowly to 177 °C plus or minus 5 °C and maintained at this temperature for 20 minutes. The total distillation shall be completed in 60 plus or minus minutes from the first application of heat.

(5) Fluxing Material. Fluxing material shall be free from foreign matter and shall be comprised of flux oil or a blend of flux oil and aromatic oil. The materials, when tested separately, shall meet the following requirements:

(a) Flux Oil.

Properties	Minimum	Maximum
Water, mass percent.....	-	0.2
Kinematic Viscosity, 60 °C, mm^2/s.....	60	200
Flash Point, C.O.C., °C.....	93	-
Loss on Heating, 50 g, 5 h at 163 °C, mass percent.....	-	10
Asphalt Content (100 to 200 Penetration residue by vacuum distillation), mass percent.....	25	-
Pour Point, °C.....	-	15

(b) Aromatic Oil.

Properties	Minimum	Maximum
Water, mass percent.....	-	0.2
Kinematic Viscosity, 60 °C, mm^2/s.....	-	150
Flash Point, C.O.C., °C.....	121	-
Loss on Heating, 50 g, 5 h at 163 °C, mass percent.....	-	12
Pour Point, °C.....	-	15

The aromatic oil, when blended with a maximum of 30 percent by mass of bitumen recovered from limestone rock asphalt by Test Method Tex-211-F, shall produce a material with a minimum penetration at 25 °C of 85.

(6) Special Precoat Material. Special precoat material shall meet the following requirements:

Properties	Minimum	Maximum
Water, %.....	-	0.2
Flash Point, C.O.C., °C.....	93	-
Kinematic Viscosity at 60 °C, mm^2/s.....	300	500
Distillation to 360 °C:		
Initial Boiling Point, °C.....	260	-
Residue by mass, %.....	70	-
Residue Penetration, 25 °C, 100 g, 5 s, (0.1 mm).....	200	300

(7) Cracked Fuel Oil. Cracked fuel oil shall meet the following requirements:

Properties	Minimum	Maximum
Asphalt Content of 100 Penetration @ 25 °C, %.....	65	80
Flash Point, C.O.C., °C.....	121	-
Kinematic Viscosity at 60 °C, mm^2/s.....	-	550
Loss at 100 °C, 20 g, 5 h, %.....	-	3.0
Water and Sediment, %.....	-	2.0

(8) Crack Sealer. This section sets forth the requirements for SS-1P polymer modified emulsion suitable for sealing fine cracks, and a rubber asphalt compound suitable for sealing cracks three (3) millimeters greater width. For cracks on the order of three (3) millimeters width, HFRS-2P polymer modified emulsion as described in Section (4), Table 9 of this item may be used. Requirements for SS-1P and rubber-asphalt crack sealing compound are as follows:

(a) SS-1P Polymer Modified Emulsion. Specific requirements are as follows:

Properties	Minimum	Maximum
Polymer Content, percent by mass of the distillation residue¨.....	3.0	-
Viscosity, Saybolt Furol at 25 °C, s.....	30	100
Storage Stability Test, one day, %.....	-	1
Cement Mixing, %.....	-	2.0
Sieve Test, %.....	-	0.10
Miscibility (Standard Test).....	Passing	
¨Distillation:		
Oil distillate, by volume of emulsion, %.....	-	1/2
Residue, %.....	60	-
Requirements on Residue from Distillation:		
Penetration, 25 °C, 100 g, 5 s, (0.1 mm)....	100	140
Ductility, 4 °C, 50 mm/min, mm.....	500	-
Solubility in trichloroethylene, %.....	97	-
Viscosity at 60 °C, Pa·s.....	130.0	-

* The emulsion supplier shall furnish the Department samples of the asphalt cement and polymer used in making the finished emulsion.

** The temperature on the lower thermometer shall be brought slowly to 177 °C plus or minus 5 °C and maintained at this temperature for 20 minutes. The total distillation shall be completed in 60 plus or minus five (5) minutes from the first application of heat.

(b) Rubber-Asphalt Crack Sealing Compound. This may be a proprietary material. The compound shall be capable of being melted and applied at a temperature of 200 °C or less by a suitable oil jacketed kettle equipped with a pressure pump, a hose and a nozzle. It shall contain no water or highly-volatile matter. It shall not be tracked by traffic when cooled to road temperature.

The rubber-asphalt crack sealing compound shall meet the following requirements:

Properties	Minimum	Maximum
Rubber Content, percent by mass.....	22	26
Flash Point, Modified C.O.C., °C *.....	200	-
Penetration at 25 °C, 150 g, 5 s, (0.1 mm)**..	30	50
Penetration at 0 °C, 200 g, 60 s, (0.1 mm)**..	12	-

* The equipment and procedure shall be as specified in ASTM D 92 with the following modification. Prior to passing the test flame over the cup, agitate the sealing compound with a nine (9) millimeter to 13 millimeter wide square-end metal spatula in a manner so as to bring the material on the bottom of the cup to the surface, i.e., turn the material over. This shall be done, starting at one side of the thermometer, moving around to the other, then returning to the starting point, using eight (8) to ten (10) rapid circular strokes. The agitation shall be accomplished in three (3) to four (4) seconds. The test flame shall be passed over the cup immediately after the stirring is completed. This procedure shall be repeated at each successive 5 °C interval until the flash point is reached.

** The penetration shall be determined by ASTM D 5 except that the cone specified in ASTM D 217 shall be substituted for the penetration needle.

Properties of Rubber Used in Sealer. The rubber shall be one of the following types:

Type I - Ground tire rubber.

Type II - Mixture of ground tire rubber and high natural reclaimed scrap rubber. The natural rubber content, determined by ASTM D 297, shall be a minimum of 25 percent.

The ground rubber shall comply with the following gradation requirements when tested by Test Method Tex-200-F, Part I.

U.S. Standard Sieve Size	Percent Retained Type I	Type II
2.36 mm	0	-
2.00 mm	0-5	0
600 µm	90-100	50-70
300 µm	95-100	70-95
150 µm	-	95-100

The ground rubber shall be free from fabric, wire, cord or other contaminating materials.

Packaging. The rubber-asphalt crack sealing compound shall be packaged in boxes which contain two (2) 14-16 kilogram blocks that are individually packaged in a liner made of polyethylene, or other packaging approved by the Engineer.

(9) Asphalt Recycling Agent. The asphalt recycling agent shall be either a petroleum oil, referred to as recycling agent, or a petroleum oil emulsion, referred to as emulsified recycling agent. These agents may be used alone or the emulsified recycling agent may be used in conjunction with emulsified asphalt having the same particle charge, i.e., a cationic emulsified asphalt must be used with a cationic emulsified recycling agent and an anionic emulsified asphalt with an anionic emulsified recycling agent. The supplier must clearly state whether the emulsified recycling agent being furnished is cationic or anionic. Specific requirements are as follows:

(a) Emulsified Recycling Agent.

Properties	Minimum	Maximum
Viscosity, Saybolt Furol at 25 °C, s.....	15	100
Sieve Test, %	-	0.10
Miscibility *	No Coagulation	
Residue, % by mass **	60	-
Test on Residue from Evaporation Test:		
Flash Point, C.O.C., °C.....	200	-
Viscosity at 60 °C, mm^2/s.....	75	250
Viscosity at 135 °C, mm^2/s.....	-	10.0

* Performed according to Test Method Tex-521-C except that 0.02 N calcium chloride solution shall be used in place of water.

** Residue shall be determined by the evaporation method set forth in ASTM D 244, except that the sample shall be maintained at 150 °C until foaming ceases, then cooled and weighed.

The ability of the residue from the evaporation test to restore the original properties of an aged asphalt cement shall be determined as follows. The residue shall be blended uniformly in the laboratory with a standard 14 to 16 penetration asphalt at a maximum rate of 20 percent by mass of the asphalt. The resulting blend must comply with all the requirements of Subarticle 300.2.(1) for AC-20 asphalt cement.

The standard asphalt cement for the above blend shall be obtained by subjecting an AC-20 produced by Fina Oil and Chemical, Big Spring, Texas, meeting all requirements of this Item, to the thin film oven test as specified in Test Method Tex-510-C except that the test period shall be increased so as to obtain the required penetration.

(b) Recycling Agent. When recycling agent (petroleum oil) is specified, it shall meet the same requirements indicated above for the Residue from Evaporation Test on emulsified recycling agent.

300.3. Storage, Heating and Application Temperatures. Asphaltic materials should be applied at the temperature which provides proper and uniform distribution and within practical limits avoiding higher temperatures than necessary. Satisfactory application should usually be obtained within the recommended ranges shown below. No material shall be heated above the maximum temperatures shown in Table 10.

300.3

TABLE 10

TYPE - GRADE	Application		Storage Maximum, °C
	Recommended Range, °C	Maximum Allowable, °C	
AC-1.5 and AC-3	105-150	180	180
AC-5, 10, 20, 30	135-180	190	205
AC-5 or AC-10 + 2% SBR	145-190	200*	190
AC-10 + 3% SBR	150-180	180	185
RC-250	50-85	95	95
RC-800	75-110	130	130
RC-3000	100-135	140	140
MC-30	20-65	80	80
MC-70	50-80	95	95
MC-250	50-100	115	115
MC-800	80-130	135	135
MC-3000 & MC-2400 Latex	105-135	145	145
SS-1, SS-1h, SS-1P, CSS-1, CSS-1h, recycling agent, emulsified recycling agent	10-55	60	60
RS-2, RS-2h, MS-2, CRS-2, CRS2h, CRS-2P, CMS-2, CMS-2s, HFRS-2, HFRS-2P, AES-300	45-70	80	80
Special Precoat Material	50-120	135	135
Flux Oil	-	135	135
Aromatic Oil	-	135	135
Cracked Fuel Oil	70-105	130	130
Rubber-Asphalt Crack Sealer	175-190	205	-

* AC-5 + 2% SBR and AC-10 + 2% SBR which is designated for surface treatment work may be heated to a maximum temperature of 200 °C by the supplier loading through an in-line heater, or, with the Engineer's permission, these materials may be heated to a maximum of 200 °C by the Contractor just prior to application. When any of the SBR-modified asphalt cements are used in asphaltic concrete, the storage temperature at the mix plant should not exceed 180 °C.

CAUTION: Heating of asphaltic materials (except emulsions) constitutes a fire hazard. Proper precautions should be used in all cases, especially with RC cutbacks. The utmost care shall be taken to prevent open flames from coming in contact with the asphaltic material or the gases of same. The Contractor shall be responsible for damage from any fires or accidents which may result from heating the asphaltic materials.

300.4. Measurement and Payment. Asphaltic materials described in this specification will be measured and paid for in accordance with the governing specifications for the Items of construction in which these materials are used.

ITEM 301

ASPHALT ANTISTRIPPING AGENTS

301.1. Description. This Item shall govern for furnishing and

incorporating lime or liquid antistripping agents in the production of asphaltic concrete pavement mixtures and/or asphalt stabilized base mixtures.

301.2. Materials.

(1) Lime. The lime shall meet the requirements of Item 264, "Lime and Lime Slurry".

(2) Liquid Antistripping Agent. The antistripping agent shall be a uniform liquid with no evidence of crystallization, settling or separation of components. Prior to delivery, a sample of the antistripping agent proposed for use shall be furnished to the Engineer. Information to be provided with the sample includes the material safety data sheet, the specific gravity of the agent at the manufacturer's recommended addition temperature, the manufacturer's recommended dosage range and handling and storage instructions. The liquid antistripping agent shall be delivered in properly labeled containers, unopened as shipped from the manufacturer, or in sealed tank trucks properly invoiced.

301.3. Mixture Design Evaluation. Laboratory mixtures of the proposed asphaltic pavement or base will be evaluated during mixture designing.

Hot-placed mixtures, except for Item 342, "Plant Mix Seal" surfacing mixture, will be evaluated for moisture susceptibility as follows, unless otherwise shown on the plans. Test Method Tex-531-C will be the evaluation procedure, and a minimum tensile strength ratio of 0.70 is required. Laboratory mixture meeting this requirement will be tested in accordance with Test Method Tex-530-C to establish the maximum stripping to be allowed during production verification testing.

Cold-placed mixtures and Item 342, "Plant Mix Seal", surfacing mixture will be evaluated as follows, unless otherwise shown on the plans. Test Method Tex-530-C will be the evaluation procedure, and a maximum stripping of ten (10) percent is allowed.

If the proposed mixture does not comply with the specified resistance to moisture damage, the Contractor shall make changes in the combination of materials or add an antistripping agent in order to provide a mixture that will comply with the specified resistance to moisture damage.

When lime is used as an antistripping agent, the selected amount shall be in the range of 0.5 to 2.0 percent by mass of the individual aggregate or aggregates being treated.

When a liquid antistripping agent is used, the selected amount of agent shall be from 0.3 to 1.0 percent by mass of the asphalt in the mixture but shall not exceed the amount recommended by the manufacturer.

When shown on the plans, a limited number of addition rates will be evaluated for a given antistripping agent.

301.4. Construction Methods.

(1) General. The Contractor shall provide all the necessary equipment for mixing, handling, metering and dispensing the asphalt antistripping agent.

The produced asphaltic mixture will be evaluated to verify resistance to moisture damage in accordance with Test Method Tex-530-C, unless otherwise shown on the plans. When Test Method Tex-531-C is the required evaluation procedure during mixture design, the produced mixture shall not strip more than the percentage established during mixture design correlation testing with Test Method Tex-530-C. When Test Method Tex-530-C is the required evaluation procedure during mixture design, a maximum stripping of ten (10) percent is allowed in the produced mixture, unless otherwise shown on the plans. If testing indicates that the required level of resistance to moisture damage is not being achieved in the plant mixture, production shall cease until trial production indicates that the problem has been corrected.

(2) Lime. Lime shall be added in slurry or dry form. It shall be added between the plant cold feeds and the dryer during mixture production, unless otherwise shown on the plans. Whether added in slurry or dry form,

the method of application shall be such that the lime is thoroughly mixed with the aggregates being treated.

The lime shall be applied to the aggregate at the required rate by means of a metering device. The Contractor shall demonstrate that the metering equipment will properly deliver the required rate of lime. The metering equipment and location of lime application must be approved by the Engineer.

When lime is added in dry form, Type A hydrated lime shall be used. It shall be mixed with wet aggregate in a suitable pugmill mixer. Additional water shall be introduced into the mixer, if necessary, to insure that the aggregate contains at least two (2) percent by mass moisture above the saturated surface dry condition.

(3) Liquid Antistripping Agent. Handling of liquid antistripping agent shall at all times be in accordance with the manufacturer's recommendations. The agent shall not show evidence of any separation or nonuniformity at time of use. For agents which have a high viscosity at normal ambient temperatures, the Contractor shall warm the material by suitable means to the application temperature recommended by the additive manufacturer so that proper consistency for accurate metering is assured. The agent shall be added to the asphalt line at the required rate by means of an in-line metering device just prior to introduction of the asphalt into the mixing plant. The Contractor shall demonstrate that the meter meets the requirements of Item 520, "Weighing and Measuring Equipment". A blending device is required to disperse the additive in the asphaltic material. The metering and blending equipment and location must be approved by the Engineer.

301.5. Measurement and Payment. The work performed, materials furnished and all labor, tools, equipment and incidentals necessary to complete the work under this Item will not be measured or paid for directly, but will be considered subsidiary to the appropriate construction Item of the contract.

ITEM 302

AGGREGATES FOR SURFACE TREATMENTS

302.1. Description. This Item shall govern for aggregates and precoated aggregates used in the construction of surface treatments.

302.2

302.2. Materials.

(1) Aggregates. Aggregates shall be composed of gravel, crushed gravel, crushed stone, crushed slag or natural limestone rock asphalt. When

specified on the plans, other aggregate types may be permitted or required. Aggregate from each source shall meet the requirements specified herein. Source is defined as a geographical location of naturally occurring material that can be mined or quarried from the original in-situ deposit.

The aggregate shall not contain more than 2.0 percent by mass of soft particles and other deleterious material as determined by Test Method Tex-217-F, Part I.

The aggregate shall not contain more than 1.0 percent loss from fine dust, clay-like particles and/or silt when tested in accordance with Test Method Tex-217-F, Part II.

The flakiness index for the aggregate, as determined by Test Method Tex-224-F, shall not exceed 17 unless otherwise shown on the plans.

The percent wear, as determined by Test Method Tex-410-A, for each of the materials shall not exceed 35 percent.

Crushed gravel shall have a minimum of 85 percent of the particles retained on the 4.75 millimeter sieve with two (2) or more mechanically induced crushed faces, as determined by Test Method Tex-460-A, Part I.

The aggregate will be subjected to five (5) cycles of magnesium sulfate soundness testing in accordance with Test Method Tex-411-A. The loss shall not exceed 25 percent, unless otherwise shown on the plans.

The polish value for the aggregate used in the surface or finish course shall not be less than the value shown on the plans, when tested in accordance with Test Method Tex-438-A. Unless otherwise shown on the plans, the polish-value requirement will apply only to aggregate used on travel lanes. When aggregates requiring polish value are supplied from a source that is rated by the Materials and Tests Division, the Rated Source Polish Value (RSPV) for that source will be used to meet this requirement. When aggregates are supplied from a source that is not rated, the aggregate will be sampled and tested prior to use. The procedures will be in accordance with Test Methods Tex-400-A and Tex-438-A, Part I.

Blending of aggregates to achieve polish value will not be permitted, unless otherwise shown on the plans. If blending is allowed, Test Method Tex-438-A, Part II, Method B will be used to determine the required blend percentages. However, a minimum of 50 percent by volume of non-polishing aggregate is required.

(2) Natural Limestone Rock Asphalt. In addition to the above requirements, natural limestone rock asphalt aggregate shall have an average bitumen content of up to 7.0 percent, by mass, of naturally impregnated asphalt, as determined by Test Method Tex-215-F. Except for Grade 5 aggregate, the portion of the material retained on the 4.75 millimeter sieve shall contain a minimum of 20 percent by mass of material with a naturally impregnated asphalt content of less than 1.0 percent. The percentage of material with less than 1.0 percent naturally impregnated asphalt shall be determined according to Test Method Tex-220-F, and the asphalt content of this separated material shall be determined according to Test Method Tex-215-F.

Natural limestone rock asphalt aggregate shall contain not more than 2.0 percent by mass of any one of or any combination of, iron pyrites, or other objectionable matter, as determined by Test Method Tex-217-F, Part I.

The percent wear on natural limestone rock asphalt aggregate, as determined by Test Method Tex-410-A, shall be made on that portion of the material retained on the 4.75 millimeter sieve, having a naturally impregnated asphalt content of less than 1.0 percent.

(3) Precoated Aggregate. Precoated aggregate shall be aggregate of the type and grade specified, coated with 0.5 to 1.5 percent, by mass, of residual bitumen from a precoating material.

When limestone rock asphalt is used, it shall be fluxed with 0.5 to 1.5 percent by mass of fluxing material.

The grade of aggregate specified shall meet all requirements of Articles 302.2 and 302.4 prior to the application of the precoat or fluxing material.

The materials may be mixed on the job or at a central mixing plant and shipped ready for use. Mixes that do not maintain flow qualities such that the precoated aggregate may be satisfactorily spread by approved mechanical spreading devices will not be acceptable.

302.3

Materials that are not uniformly and/or properly coated, in the opinion

of the Engineer, will not be accepted for use.

(4) Asphaltic Material. The precoating or fluxing material shall meet the requirements of Item 300 "Asphalts, Oils and Emulsions". Unless otherwise shown on the plans, any of the types and grades shown in Item 300, "Asphalt, Oils and Emulsions" may be used.

(5) Water. Water in the amount not to exceed three (3) percent by mass of the mixture may be used in precoating aggregate or fluxing limestone rock asphalt aggregate.

302.3. Types. Various aggregate types are identified as follows:
(1) Uncoated Aggregate Types.

Type A. Type A aggregate shall consist of gravel, crushed slag, crushed stone or natural limestone rock asphalt.

Type B. Type B aggregate shall consist of crushed gravel, crushed slag, crushed stone or natural limestone rock asphalt.

Type C. Type C aggregate shall consist of gravel, crushed slag or crushed stone.

Type D. Type D aggregate shall consist of crushed gravel, crushed slag or crushed stone.

Type E. Type E aggregate shall be as shown on the plans.

(2) Precoated Aggregate Types.

Type PA. Type PA shall be precoated aggregate consisting of gravel, crushed slag, crushed stone or natural limestone rock asphalt.

Type PB. Type PB shall be precoated aggregate consisting of crushed gravel, crushed slag, crushed stone or natural limestone rock asphalt.

Type PC. Type PC shall be precoated aggregate consisting of gravel, crushed slag or crushed stone.

Type PD. Type PD shall be precoated aggregate consisting of crushed gravel, crushed slag or crushed stone.

Type PE. Type PE shall be precoated aggregate as shown on the plans.

302.4. Grades. When tested by Test Method Tex-200-F, Part I, the gradation requirements shall be as follows:

		Percent By Mass
Grade 1:	Retained on 25.0 mm sieve	0
	Retained on 22.4 mm sieve	0 - 2
	Retained on 19.0 mm sieve	20 - 35
	Retained on 16.0 mm sieve	85 - 100
	Retained on 9.5 mm sieve	95 - 100
	Retained on 2.00 mm sieve	99 - 100
Grade 2:	Retained on 22.4 mm sieve	0
	Retained on 19.0 mm sieve	0 - 2
	Retained on 16.0 mm sieve	20 - 40
	Retained on 12.5 mm sieve	80 - 100
	Retained on 9.5 mm sieve	95 - 100
	Retained on 2.00 mm sieve	99 - 100
Grade 3:	Retained on 19.0 mm sieve	0
	Retained on 16.0 mm sieve	0 - 2
	Retained on 12.5 mm sieve	20 - 40
	Retained on 9.5 mm sieve	80 - 100
	Retained on 6.3 mm sieve	95 - 100
	Retained on 2.00 mm sieve	99 - 100
Grade 4:	Retained on 16.0 mm sieve	0
	Retained on 12.5 mm sieve	0 - 2
	Retained on 9.5 mm sieve	20 - 35
	Retained on 4.75 mm sieve	95 -100
	Retained on 2.00 mm sieve	99 - 100

Grade 5:	Retained on 12.5 mm sieve	0
	Retained on 9.5 mm sieve	0 - 5
	Retained on 4.75 mm sieve	40 - 85
	Retained on 2.00 mm sieve	98 - 100
	Retained on 850 µm sieve	99 - 100

When shown on the plans, the aggregate of the specified grade(s) shall have from 99.5 to 100 percent by mass retained on the 75 micrometer sieve.

302.5. Equipment.

(1) Mixing Plants. Mixing plants that will not continuously meet all the requirements of this specification shall be condemned.

Mixing plants may be either the weigh-batch type, the continuous mixing type or the drum mix type. All plants shall be equipped with satisfactory conveyors, power units, aggregate handling equipment, and bins.

If the Engineer approves the use of emulsion as a precoat material, he may also waive the requirement for a dryer, as specified below, if it is demonstrated that a satisfactory coating can be obtained without drying or heating the aggregate.

When using a low grade fuel oil or waste oil the plant shall meet the requirements of Subarticle 340.4.(2).

(a) Weigh-Batch Type.

Cold Aggregate Bin and Proportioning Device. The cold aggregate bins or aggregate stockpiles shall be of sufficient number and size to supply the amount of aggregate required to keep the plant in continuous operation. The proportioning device shall be such as will provide a uniform and continuous flow of aggregate in the desired proportion to the plant.

Dryer. The dryer shall continually agitate the aggregate during heating. The temperature shall be controlled so that the aggregate will not be damaged in the drying and heating operations.

The burner, or combination of burners, and type of fuel used shall be such that in the process of heating the aggregate to the desired or specified temperatures, no residue from the fuel shall adhere to the heated aggregate. A recording thermometer shall be provided which will record the temperature of the aggregate when it leaves the dryer. The dryer shall be of sufficient size to keep the plant in continuous operation. The dryer will not be required for precoating natural limestone rock asphalt.

Screening and Proportioning. The screening capacity and size of the bins shall be sufficient to screen and store the amount of aggregate required to properly operate the plant and keep the plant in continuous operation at full capacity. Proper provisions shall be made to enable inspection forces to have easy and safe access to the proper location on the mixing plant where accurate representative samples of aggregate may be taken from the bins for testing.

Weighing and Measuring Equipment. The weighing and measuring equipment shall be of sufficient capacity and of adequate design for proper batching. The following equipment, conforming to the requirements of Item 520, "Weighing and Measuring Equipment", shall be furnished:

1. Aggregate weigh box and batching scales.

2. Bucket and scales for precoat material or fluxing material.

A pressure type flow meter may be used to measure the precoat material or fluxing material for each batch.

If a pressure type flow meter is used to measure the asphaltic material, the requirements of Item 520, "Weighing and Measuring Equipment" shall apply.

Provisions of a permanent nature shall be made for checking the accuracy of the asphaltic material measuring device. The line to the measuring device shall be protected with a jacket of hot oil or other approved means to maintain the temperature of the line near the temperature specified for the precoating material.

Mixer. The mixer shall be of the pug mill type, and shall have a capacity of not less than 1350 kilograms in a single batch. Any mixer that has a tendency to segregate the aggregate or fails to secure a thorough and uniform mixing with the precoat material or fluxing material shall not be used. All mixers shall be provided with an automatic time lock that will lock the discharge doors of the mixer for the required mixing period. The dump door or doors and the shaft seals of the mixer shall be tight enough to prevent the spilling of aggregate or mixture from the pug mill.

(b) Modified Weigh-Batch Type.

General. This plant is similar to the weigh-batch type plant. The hot bin screens shall be removed and the aggregate control is placed at the cold feeds. The cold feed bins will be the same as those required for the drum-mix type plant.

Cold-Aggregate Bin Unit and Feed System. The number of bins in the cold-aggregate bin unit shall be equal to or greater than the number of stockpiles of individual materials to be used. The bins shall be of sufficient size to store the amount of aggregate required to keep the plant in continuous operation.

When blending materials, the bin unit shall be of proper design to prevent overflow of material from one bin to another. There shall be vertical partitions meeting the requirements of Subarticle 340.4.(2). The feed system shall provided a uniform and continuous flow of aggregate in the desired proportion to the dryer. The Contractor shall furnish a chart indicating the calibration of each cold bin in accordance with the manufacturer's recommendations or in a method acceptable to the Engineer.

Scalping Screen. A scalping screen shall be required after the cold feeds and ahead of the hot aggregate surge bins.

Dryer. The dryer shall continually agitate the aggregate during heating. The temperature shall be controlled so that the aggregate will not be damaged in the drying and heating operations. The dryer shall be of sufficient size to keep the plant in continuous operation.

Screening and Proportioning. The hot aggregate shall not be separated into sizes after being dried. There shall be one or more surge bins provided between the dryer and the weigh hopper. Surge bins shall be of sufficient size to hold enough combined aggregate for one complete batch of mixture.

Aggregate Weigh Box and Batching Scale. The aggregate weigh box and batching scales shall be of sufficient capacity to hold and weigh a complete batch of aggregate. The weigh box and scales shall conform to the requirements of Item 520, "Weighing and Measuring Equipment".

Asphaltic Material Measuring System. If an asphaltic material bucket and scales are used, they shall be of sufficient capacity to hold and weigh the necessary asphaltic material for one batch. The bucket and scales shall conform to the requirements of Item 520, "Weighing and Measuring Equipment".

If a pressure type flow meter is used to measure the asphaltic material, the requirements of Item 520, "Weighing and Measuring Equipment", shall apply. This system shall include an automatic temperature compensation device to insure a constant percent by mass of asphaltic material in the mixture.

Provisions of a permanent nature shall be made for checking the accuracy of the asphaltic material measuring device. The asphalt line to the measuring device shall be protected with a jacket of hot oil or other approved means to maintain the temperature of the line near the temperature specified for the asphaltic material.

Mixer. The mixer shall be of the pugmill type and shall have a capacity of not less than 1350 kilograms (of natural-aggregate mixture) in a single batch, unless otherwise shown on the plans. Any mixer that has a tendency to segregate the aggregate or fails to secure a thorough and uniform mixing with the precoat material or fluxing material shall not be used. All mixers shall be provided with an automatic timer that will lock the discharge doors of the mixer for the required mixing period. The dump door or doors and the shaft seals of the mixer shall be tight enough to prevent spilling of aggregate or mixture from the pugmill.

(c) Continuous Mixing Type.

Cold Aggregate Bin and Proportioning Device. Same as for weigh-batch type of plant.

302.5

Dryer. Same as for weigh-batch type of plant.

Screening and Proportioning. Same as for weigh-batch type of plant. These requirements shall also apply to materials that are stockpiled and that are proposed for direct use by a continuous mixing plant without the use of plant bins.

Aggregate Proportioning Device. The aggregate proportioning device shall be so designed that when properly operated a uniform and continuous flow of aggregate into the mixer will be maintained.

Spray Bar for Precoat Material and Fluxing Material. The spray bar for the precoat material or fluxing material shall be so designed that the material will spray uniformly and continuously into the mixer.

Meter for Precoat Material or Fluxing Material. An accurate recording meter for precoat material or fluxing material shall be placed in the line leading to the spray bar so that the accumulative amount of precoat material or fluxing material being used can be accurately determined. Provisions of a permanent nature shall be made for checking the accuracy of the meter output.

Mixer. The mixer shall be of the continuous type and shall have a capacity of not less than 36 megagrams of mixture per hour. Any mixer that has a tendency to segregate the aggregate or fails to secure a thorough and uniform mixing of the aggregate with the precoat material or fluxing material shall not be used.

(d) Drum Mix Plant.

General. The plant shall be adequately designed and constructed for the process of mixing aggregates and precoat material. The plant shall be equipped with satisfactory conveyors, power units, aggregate-handling equipment and feed controls.

Cold Aggregate Bin and Feed System. The number of bins in the cold aggregate bin unit shall be equal to or greater than the number of stockpiles of individual materials to be used. The bin unit shall be of sufficient size to store the amount of aggregate required to keep the plant in continuous operation.

When blending materials, the bin unit shall be of proper design to prevent overflow of material from one bin to another. There shall be vertical partitions meeting the requirements of Subarticle 340.4.(2). The feed system shall provide a uniform and continuous flow of aggregate in the desired proportion to the dryer. The Contractor shall furnish a chart indicating the calibration of each cold bin in accordance with the manufacturer's recommendations or in a method acceptable to the Engineer.

The system shall provide positive mass measurement of the combined cold aggregate feed by use of belt scales. Provisions of a permanent nature shall be made for checking the accuracy of the measuring device as required by Item 520, "Weighing and Measuring Equipment". When a belt scale is used, mixture production shall be maintained so that the scale normally operates between 50 percent and 100 percent of its rated capacity. Belt scale operation below 50 percent of the rated capacity may be allowed by the Engineer if accuracy checks show the scale to meet the requirements of Item 520, "Weighing and Measuring Equipment", at the selected rate and it can be satisfactorily demonstrated to the Engineer that mixture uniformity and quality have not been adversely affected.

Scalping Screen. A scalping screen shall be required, after the cold feeds and ahead of the combined aggregate belt scale.

Precoat Material Measuring System. An asphaltic material measuring device meeting the requirements of Item 520, "Weighing and Measuring Equipment", shall be placed in the line leading to the mixer so that the cumulative amount of precoat material used can be accurately determined. Provisions of a permanent nature shall be made for checking the accuracy of the measuring device output. The line to the measuring device shall be protected with a jacket of hot oil or other approved means to maintain the temperature of the line near the temperature specified for the precoat material. The measuring system shall include an automatic temperature compensation device to maintain a constant percent by mass of precoating material in the mixture.

Synchronization Equipment for Feed-Control Systems. The precoat material feed-control shall be coupled with the total aggregate mass measuring device to automatically vary the precoat material feed rate to maintain the required proportion.

Mix System. The mix system shall control the temperature so that aggregate and asphalt will not be damaged in the drying, heating and mixing operations. A continuously-recording thermometer shall be provided which will indicate the temperature of the mixture as it leaves the mixer.

Surge-Storage System. A surge-storage system shall be required to minimize the production interruptions during the normal day's operations. A device such as a gob hopper or other similar devices approved by the Engineer to prevent segregation in the surge-storage bin shall be required.

(2) Heating Equipment for Precoat Material and Fluxing Material. Heating equipment for precoat material and fluxing material shall be adequate to heat the required amount of material to the desired temperature. The material may be heated by steam coils which shall be absolutely tight. Direct fire heating will be permitted, provided the heating system used is manufactured by a reputable concern and there is positive circulation of the liquid throughout the heater. Agitation with steam or air will not be permitted. The heating apparatus shall be equipped with a recording thermometer with a 24-hour chart that will record the temperature of the precoat material or fluxing material where it is at the point of highest temperature.

302.6. Storage, Proportions and Mixing.

(1) Aggregate Storage. If the aggregates are stored or stockpiled, they shall be handled in such a manner as to prevent segregation, the mixing of the various materials or sizes, and the contamination with foreign materials. The grading of aggregates proposed for use and as supplied to the mixing plant shall be uniform. When required by the Engineer, additional material shall not be added to stockpiles that have been sampled for approval.

When asphalt cement is the precoating material, stockpile height shall be limited to approximately one (1) meter immediately after production to limit the build up of heat. These stockpiles may be consolidated after cooling adequately, in the opinion of the Engineer.

The use of limestone rock asphalt aggregate containing moisture in excess of the saturated surface-dry condition will not be permitted. Excess moisture will be evidenced by the visual surface moisture on the aggregate or any unusual quantities of fines clinging to the aggregate.

(2) Storage and Heating of Precoating Material or Fluxing Material. The precoating or fluxing material storage shall be ample to meet the requirements of the plant. The precoating material shall not be heated in storage above the maximum temperature set forth in Item 300, "Asphalts, Oils and Emulsions". All equipment used in the storage and handling of precoat material or fluxing material shall be kept in a clean condition at all times and shall be operated in such manner that there will be no contamination with foreign matter.

(3) Feeding and Drying of Aggregate. The feeding of various sizes of aggregate, other than natural limestone rock asphalt, to the dryer or drum mixer shall be done through the cold aggregate bin and proportioning device in such a manner that a uniform and constant flow of material in the required proportions will be maintained. The aggregate shall be heated to the temperature necessary to produce a mixture meeting the requirements of Subarticle 302.2.(3).

(4) Proportioning. The proportioning of the various materials entering into the mixture shall be as directed by the Engineer and in accordance with these specifications. Aggregate shall be proportioned by mass using the weigh box and batching scales herein specified when the weigh-batch type of plant is used and by volume using the aggregate proportioning device when the modified weigh-batch type, the continuous mixer type or drum mix plant is used. The precoat material or fluxing material shall be proportioned by mass or by volume based on mass using the specified equipment.

(5) Mixing.

(a) Weigh-Batch Type and Modified Weigh-Batch Type Mixer. In the charging of the weigh box and in the charging of the mixer from the weigh box, such methods or devices shall be used as are necessary to secure a uniform mixture. In introducing the batch into the mixer, the aggregate shall be introduced first; shall be mixed thoroughly, as directed, to uniformly distribute the various sizes throughout the batch before the precoat material or fluxing material is added; the precoat material or fluxing material shall then be added and the mixing continued until such time that the aggregate is properly coated. This mixing period may be varied, if, in the opinion of the Engineer, the mixture is not uniform.

(b) Continuous or Drum Mix Type Mixer. The amount of aggregate and precoat material or fluxing material entering the mixer and the rate of travel through the mixer shall be so coordinated that a uniform

mixture of the specified grading and percent by mass of precoat material or fluxing material will be produced.

302.7. Measurement and Payment. Aggregates provided in accordance with this specification will be measured and paid for in accordance with the governing specifications for the items of construction in which these materials are used.

ITEM 303

AGGREGATE FOR SURFACE TREATMENTS
(Lightweight)

303.1. Description. This Item shall govern for lightweight aggregate and precoated lightweight aggregate used in the construction of surface treatments.

303.2. Materials.

(1) Aggregate. Aggregate shall be composed of lightweight aggregate, defined as expanded shale, clay or slate produced by the rotary kiln method.

The dry loose unit weight of lightweight aggregate shall not be less than 560 kilograms per cubic meter and shall not exceed 960 kilograms per cubic meter unless otherwise shown on the plans. Furthermore, a shipment of lightweight aggregate shall be rejected if the dry loose unit weight of the shipment differs by more than 6 percent from that of the sample submitted for acceptance tests from that source. Tests shall be in accordance with Test Method Tex-404-A, Part C, and shall be performed on a sample of similar gradation to that of the acceptance sample.

The aggregate shall not contain more than 1.0 percent by mass of fine dust, clay-like particles and/or silt when tested in accordance with Test Method Tex-217-F, Part II.

The percentage of wear shall not exceed 35 percent when the aggregate is tested in accordance with Test Method Tex-410-A.

The freeze-thaw loss shall not exceed 7.0 percent when the aggregate is tested in accordance with Test Method Tex-432-A.

The pressure slaking value shall not exceed 4.0 percent when the aggregate is tested in accordance with Test Method Tex-431-A.

The water absorption in 24 hours shall not exceed 12.0 percent unless otherwise shown on the plans when the aggregate is tested in accordance with Test Method Tex-433-A.

The polish value for the aggregate used in the surface or finish course shall not be less than the value shown on the plans, when tested in accordance with Test Method Tex-438-A. Unless otherwise shown on the plans, the polish-value requirement will apply only to aggregate used on travel lanes. When aggregates requiring polish value are supplied from a source that is rated by the Materials and Tests Division, the Rated Source Polish Value (RSPV) for that source will be used to meet this requirement. When aggregates are supplied from a source that is not rated, the aggregate will be sampled and tested prior to use. The procedures will be in accordance with Test Methods Tex-400-A and Tex-438-A, Part I.

If blending aggregate from two or more sources, material from each source shall meet the requirements of this Item.

(2) Precoated Aggregate. Precoated aggregate shall be aggregate of the type and grade specified, coated with 0.5 to 3.0 percent, by mass, of residual bitumen from the precoating material.

The grade of aggregate specified shall meet all requirements of Article 303.2 and 303.4 prior to the application of the precoat material.

The materials may be mixed on the job or at a central mixing plant and shipped ready for use. Mixes that do not maintain flow qualities such that the precoated aggregate may be satisfactorily spread by approved mechanical spreading devices will not be acceptable.

Materials that are not uniformly and/or properly coated, in the opinion of the Engineer, will not be accepted for use.

(3) Asphaltic Material. The precoating material shall meet the requirements of Item 300, "Asphalts, Oils and Emulsions". Unless otherwise shown on the plans, any of the types and grades shown in Item 300, "Asphalts, Oils and Emulsions", may be used.

303.3. Types. The aggregate types are identified as follows:

Type L. Type L shall consist of lightweight aggregate.
Type PL. Type PL shall consist of precoated lightweight aggregate.

303.4. Grades. When tested by Test Method Tex-200-F, Part I, the gradation requirements shall be as follows:

		Percent by Mass
Grade 3:	Retained on 19.0 mm sieve	0
	Retained on 16.0 mm sieve	0 - 2
	Retained on 12.5 mm sieve	10 - 25
	Retained on 9.5 mm sieve	60 - 80
	Retained on 6.3 mm sieve	95 - 100
	Retained on 2.00 mm sieve	98 - 100
Grade 4:	Retained on 16.0 mm sieve	0
	Retained on 12.5 mm sieve	0 - 5
	Retained on 9.5 mm sieve	20 - 40
	Retained on 4.75 mm sieve	95 - 100
	Retained on 2.00 mm sieve	98 - 100
Grade 5:	Retained on 12.5 mm sieve	0
	Retained on 9.5 mm sieve	0 - 2
	Retained on 4.75 mm sieve	60 - 80
	Retained on 2.00 mm sieve	98 - 100

303.5. Equipment. Equipment shall meet the requirements of Article 302.5, except that other equipment which will consistently produce satisfactory results will be allowed.

303.6. Storage, Proportions and Mixing. Storage, proportions, and mixing shall meet the requirements of Article 302.6.

303.7. Measurement and Payment. Aggregates provided in accordance with this specification will be measured and paid for in accordance with the governing specifications for the items of construction in which these materials are used.

ITEM 305

SALVAGING, HAULING AND STOCKPILING RECLAIMABLE ASPHALTIC PAVEMENT

305.1. Description. This Item shall govern for salvaging, hauling and stockpiling existing asphaltic material. The material to be salvaged shall be asphaltic-concrete pavement and/or asphalt-stabilized base, including any accompanying surface treatment, plant-mix seal and micro-surfacing.

When shown on the plans, salvaged material may be allowed or required for use in other construction items of this project. If not used in other construction items of this project, the salvaged material shall be stockpiled by the Contractor at the location shown on the plans or approved by the Engineer and shall remain the property of the State.

305.2. Construction Methods. The existing asphaltic-concrete pavement and/or asphalt-stabilized base, at locations shown on the plans or as designated by the Engineer, shall be removed to the depth and width shown by the lines and grades on the plans or as established by the Engineer. The asphaltic surface shall first be cleaned of all dirt, raised pavement markings or other objectionable material by blading, brooming, or any other approved methods. Unless otherwise shown on the plans, the existing asphaltic material shall be removed and broken up so that 95 percent will pass a 50 millimeter sieve. Care shall be taken to insure that the asphaltic material being removed is not contaminated by nonasphaltic material during its removal, transportation and storage. Any pavement damaged or broken outside of established lines shall be replaced at the Contractor's entire expense.

The stockpile area shall be cleaned of trash, weeds and grass, and shall be relatively smooth and well drained. The Engineer may require separate stockpiling of salvaged asphaltic-paving material of differing type or quality. Maximum stockpile height, method of construction or other stockpile requirements may be shown on the plans. Silt fencing around stockpile areas shall be provided when shown on the plans.

Work performed under this Item shall begin at such time and be prosecuted in such manner as to cause a minimum of inconvenience to traffic or to the owners of adjacent property.

305.3. Measurement. This Item will be measured by the cubic meter of material measured by the average-end-area method in the stockpile or by the square meter in its original position.

305.4. Payment. The work performed in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid per cubic meter for "Salvaging, Hauling and Stockpiling Reclaimable Asphaltic Pavement" or at the unit price bid per square meter for "Salvaging, Hauling and Stockpiling Reclaimable Asphaltic Pavement" of the depth specified. This price shall be full compensation for cleaning and removing existing pavement; for any necessary stockpile area preparation; for loading, crushing or breaking, hauling and stockpiling of the material; and for furnishing all materials, labor, tools, equipment, supplies and all incidentals necessary to satisfactorily complete the work.

When plans call for the installation of silt fencing protection around stockpile areas, the fencing will be measured and paid for directly.

ITEM 310

PRIME COAT
(Cutback Asphaltic Material)

310.1. Description. This Item shall govern for the application of asphaltic material on the completed base course and/or other approved areas in accordance with these specifications.

310.2. Materials. The asphaltic material used for the prime coat shall be a cutback asphalt of the type and grade shown on the plans and shall meet the requirements of Item 300, "Asphalts, Oils and Emulsions".

310.3. Construction Methods. Prime coat shall not be applied when the air temperature is below 15 °C and falling, but it may be applied when the air temperature is above 10 °C and is rising, the air temperature being taken in the shade and away from artificial heat. Asphaltic material shall not be placed when general weather conditions, in the opinion of the Engineer, are not suitable.

When, in the opinion of the Engineer, the area and/or base is satisfactory to receive the prime coat, the surface shall be prepared by sweeping or other approved methods. If found necessary by the Engineer, the surface shall be lightly sprinkled just prior to application of the asphaltic material.

The asphaltic material shall be applied on the prepared surface by an approved self-propelled pressure distributor so operated as to distribute the

material at the rate directed by the Engineer, evenly and smoothly, under a pressure necessary for proper distribution.

The Contractor shall provide all necessary facilities and equipment for determining the temperature of the asphaltic material in all of the heating equipment and in the distributor, for determining the rate at which it is applied, and for securing uniformity at the junction of two (2) distributor loads.

The distributor tank, when used for pay purposes, shall have been calibrated within three (3) years from the date it is first used on this project. The tank calibration procedure shall be in accordance with Test Method Tex-922-K, Part I, and shall be signed and sealed by a registered professional engineer. Unless otherwise shown on the plans, the Contractor shall provide the tank calibration and shall furnish the Engineer an accurate and satisfactory calibration record prior to beginning the work. The Engineer may at any time verify calibration accuracy in accordance with Test Method Tex-922-K, Part II, and may perform the required recalibration if the calibration is found to be in error.

No traffic, hauling or placing of any subsequent courses shall be permitted over the freshly applied prime coat until authorized by the Engineer.

The Contractor shall be responsible for the maintenance of the surface until the work is accepted by the Engineer.

All equipment used in storing or handling asphaltic material shall be kept clean and in good operating condition at all times and shall be operated in such manner that there will be no contamination of the asphaltic material. When the asphaltic material is stored in a storage tank unit equipped with a heater, the Contractor shall provide and maintain a recording thermometer to continuously indicate the asphaltic material temperature.

The Engineer will select the temperature of application within the limits recommended in Item 300, "Asphalts, Oils and Emulsions". The Contractor shall apply the asphalt at a temperature within 8 °C of the temperature selected.

310.4. Measurement. This Item will be measured at the point of delivery on the road by the liters of asphaltic material at the applied temperature. The quantity to be measured for payment shall be the number of liters used, as directed, of the accepted prime coat.

310.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Asphaltic Material", of the type and grade specified. This price shall be full compensation for cleaning the area to be primed; for furnishing all required materials; for all heating, hauling, mixing and distributing the asphaltic material as specified; for all freight involved; and for all manipulation, labor, tools, equipment and incidentals necessary to complete the work.

ITEM 312

PRIME COAT
(Cutback Asphaltic Material and Sand)

312.1. Description. This Item shall govern for the application of asphaltic material on the completed base course and/or other approved area covered with sweepings from the base and native sand, and constructed in accordance with these specifications.

312.2. Materials. The asphaltic material used for the prime coat shall be a cutback asphalt of the type and grade shown on the plans and shall meet the requirements of Item 300, "Asphalts, Oils and Emulsions".

Base course sweepings shall be those sweepings obtained from cleaning the base.

Native sand shall be material obtained from sources approved by the Engineer.

312.3. Construction Methods. Prime coat shall not be applied when the air temperature is below 15 °C and falling, but may be applied when the air temperature is above 10 °C and is rising, the air temperature being taken in the shade and away from artificial heat. Asphaltic material shall not be placed when general weather conditions, in the opinion of the Engineer, are not suitable.

Native sand, as specified above, shall be hauled in vehicles of uniform capacity unless otherwise authorized by the Engineer. When, in the opinion

of the Engineer, the area and/or base is satisfactory to receive the prime coat, the surface shall be prepared by sweeping or other approved methods. If found necessary by the Engineer, the surface shall be lightly sprinkled just prior to application of the asphaltic material.

Asphaltic material shall be applied on the prepared surface by an approved self-propelled pressure distributor so operated as to distribute the material at the rate directed by the Engineer, evenly and smoothly, under a pressure necessary for proper distribution.

The surface shall then be covered with base sweepings and/or native sand as directed by the Engineer. The surface shall then be dragged with an approved type of drag broom so as to evenly and smoothly distribute the cover material. This brooming or dragging shall continue until, in the opinion of the Engineer, the prime coat has properly cured.

No traffic, hauling or placing of subsequent courses shall be permitted over the freshly applied prime coat until authorized by the Engineer. The surface shall be cleared of any surplus sand or sweepings by the Contractor by sweeping or other approved methods, when directed by the Engineer.

The Contractor shall be responsible for the maintenance of the surface until the work is accepted by the Engineer.

The Contractor shall provide all necessary facilities and equipment for determining the temperature of the asphaltic material in all of the heating equipment and in the distributor, for determining the rate at which it is applied, and for securing uniformity at the junction of two (2) distributor loads.

The distributor tank, when used for pay purposes, shall have been calibrated within three (3) years from the date it is first used on this project. The tank calibration procedure shall be in accordance with Test Method Tex-922-K, Part I, and shall be signed and sealed by a registered professional engineer. Unless otherwise shown on the plans, the Contractor shall provide the tank calibration and shall furnish the Engineer an accurate and satisfactory calibration record prior to beginning the work. The Engineer may at any time verify calibration accuracy in accordance with Test Method Tex-922-K, Part II, and may perform the required recalibration if the calibration is found to be in error.

312.4 to 314.1

All equipment used in storing or handling asphaltic material shall be kept clean and in good operating condition at all times and shall be operated in such

manner that there will be no contamination of the asphaltic material. When the asphaltic material is stored in a storage unit equipped with a heater, the Contractor shall provide and maintain a recording thermometer to continuously indicate the asphaltic material temperature.

The Engineer will select the temperature of application within the limits recommended in Item 300, "Asphalts, Oils and Emulsions". The Contractor shall apply the asphalt at a temperature within 8 °C of the temperature selected.

312.4. Measurement. The asphaltic material for prime coat will be measured at the point of delivery on the road in liters at the applied temperature. The quantity to be measured for payment shall be the number of liters used, as directed, of the specified prime coat.

Native sand will be measured by the cubic meter in vehicles as applied on the road, unless otherwise shown on the plans.

312.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit prices bid for "Asphaltic Material", of the type and grade specified, and for "Native Sand". These prices shall be full compensation for cleaning the area to be primed; for furnishing, preparing, hauling and placing all required materials (including application of base sweepings); for all freight and heating involved; for spreading, dragging, brooming, finishing and maintaining under traffic until accepted; and for all manipulation, labor, tools, equipment and incidentals necessary to complete the work.

ITEM 314

EMULSIFIED ASPHALT TREATMENT

314.1. Description. This Item shall govern for one (1) or more applications of a mixture of emulsified asphalt and water used as a base or subgrade treatment, earthwork or mulch sod seal for erosion control, prime coat or dust preventative, and constructed in accordance with these specifications.

314.2. Materials. All materials shall conform to the pertinent requirements of the following Items:

Item 204, "Sprinkling"
Item 300, "Asphalts, Oils and Emulsions"

The amount of emulsified asphalt in the mixture, expressed as a percent by volume of the total mixture, shall be within the limits and shall be of the type and grade shown on the plans.

314.3. Construction Methods.

(1) General. The emulsified asphalt and water mixture shall be applied by a self-propelled sprinkler meeting the requirements of Item 204, "Sprinkling", or other equipment approved by the Engineer that will uniformly distribute the mixture in the quantity determined by the Engineer.

This mixture shall be applied at the locations and to the extent shown on the plans or as directed by the Engineer.

The Contractor shall make suitable provisions for agitating the two (2) materials sufficiently to produce a uniform blend. The sprinkler or other equipment and/or the measuring devices shall have been recently calibrated, and the Engineer shall be furnished an accurate and satisfactory record of such calibration. After beginning the work, should the yield of the mixture applied appear to be in error, the sprinkler or other equipment and/or the measuring device shall be calibrated in a manner satisfactory to the Engineer before proceeding with the work.

(2) Base or Subgrade Treatment. Where indicated on the plans, "Emulsified Asphalt Treatment" shall be mixed with the base or subbase material. The emulsified asphalt and water mixture shall be applied and incorporated into the top portion of the subbase or base course layers to the depth and width shown on the plans. Successive applications of the mixture of emulsified asphalt and water shall be applied until the specified amount of emulsified asphalt has been incorporated into the material.

The percentage of emulsified asphalt in the mixture shall be regulated to insure that the specified amount of emulsified asphalt is incorporated into the material, while maintaining the proper moisture content.

The treated material shall be mixed by blading, then shaped and compacted as required by the pertinent specification for the particular course, to the lines, grades and typical sections shown on plans. The surface shall be maintained with light applications of emulsified asphalt and water mixture or water, as directed by the Engineer, during curing of the course.

(3) Earthwork or Mulch Sod Seal or Dust Preventative. The emulsified asphalt and water mixture shall be applied as approved by the Engineer, where indicated on the plans or directed by the Engineer.

(4) Prime Coat. Where indicated on the plans, "Emulsified Asphalt Treatment" shall be applied at the width shown on the plans. Successive applications of the mixture shall be applied until the specified amount of emulsified asphalt has been distributed. The percentage of emulsified asphalt in the mixture shall be regulated to insure that the specified amount of emulsified asphalt has been distributed.

314.4. Measurement. This Item will be measured by the liter of emulsified asphalt used in the emulsified asphalt and water mixture.

314.5. Payment. The work performed and the materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Emulsified Asphalt", "Emulsified Asphalt (Base or Subgrade Treatment)", or "Emulsified Asphalt (Erosion Control)" of the type and grade specified. This price shall be full compensation for furnishing all required materials, including mixing water for application; for all freight involved; for all hauling, mixing and distributing the mixture as specified; and for all manipulation, labor, tools, equipment and incidentals necessary to complete the work.

ITEM 315

EMULSIFIED ASPHALT SEAL

315.1. Description. This Item shall govern for one (1) or more applications of a mixture of emulsified asphalt and water used as a prime coat, aggregate loss preventative, or surface seal, and constructed in accordance with these specifications.

315.2. Materials. All materials shall conform to the pertinent requirements of the following Items:

Item 204, "Sprinkling"
Item 300, "Asphalts, Oils and Emulsions"

The amount of emulsified asphalt in the mixture, expressed as a percent by volume of the total mixture, shall be within the limits and shall be of the type and grade shown on the plans.

315.3. Construction Methods. Unless otherwise permitted by the Engineer, emulsified asphalt seals shall not be applied when the air temperature is below 15 °C and is falling, but may be applied when the air temperature is above 10 °C and is rising, the air temperature being taken in the shade and away from artificial heat. Asphaltic material shall not be placed when general weather conditions, in the opinion of the Engineer, are not suitable.

The emulsified asphalt and water mixture shall be applied by an approved self-propelled pressure distributor so operated as to distribute the material at the rate directed by the Engineer, evenly and smoothly, under a pressure necessary for proper distribution.

The Contractor shall provide all necessary facilities and equipment for determining the temperature of the asphaltic material in all of the heating equipment and in the distributor, for determining the rate at which it is applied, and for securing uniformity at the junction of two (2) distributor loads.

The distributor tank, when used for pay purposes, shall have been calibrated within three (3) years from the date it is first used on this project. The tank calibration procedure shall be in accordance with Test Method Tex-922-K, Part I, and shall be signed and sealed by a registered professional engineer. Unless otherwise shown on the plans, the Contractor shall provide the tank calibration record and shall furnish the Engineer an accurate and satisfactory calibration record prior to beginning the work. The Engineer may at any time verify calibration accuracy in accordance with Test Method Tex-922-K, Part II, and may perform the required recalibration if the calibration is found to be in error.

The Engineer will select the temperature of application. The Contractor shall apply the emulsified asphalt mixture at a temperature within 8 °C of the temperature selected.

The treated surface shall be opened to traffic when directed by the Engineer.

315.4. Measurement. This Item will be measured by the liter of emulsified asphalt used in the emulsified asphalt and water mixture.

315.5. Payment. The work performed and the materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Emulsified Asphalt Seal" of the type and grade specified. This price shall be full compensation for furnishing all required materials, including mixing water for application; for all hauling, mixing, heating, and distributing the mixture as specified; and for all manipulation, tools, labor, equipment and incidentals necessary to complete the work.

ITEM 316

SURFACE TREATMENTS

316.1. Description. This Item shall govern for the construction of a surface treatment composed of a single, double or triple application of asphaltic material, each covered with aggregate, constructed on existing pavements or on the prepared base course or surface in accordance with these specifications. This Item shall also govern for the furnishing of Aggregates (Stockpiled). Quantities for the different types of surfaces and materials will be as shown on the Basis of Estimate in the plans.

316.2. Materials. All materials shall be of the type(s) and grade(s) shown on the plans and shall conform to the pertinent material requirements of the following Items:

Item 300, "Asphalts, Oils and Emulsions"
Item 302, "Aggregate for Surface Treatments"
Item 303, "Aggregate for Surface Treatments (Lightweight)"

316.3. Equipment.

(1) Distributor. The distributor shall be a self-propelled pressure type, equipped with an asphaltic material heater and a distributing pump capable of pumping the material at the specified rate through the distributor spray bar. The distributor spray bar shall be capable of fully circulating the asphaltic material. The distributor spray bar shall contain nipples and valves so constructed that the nipples will not become partially plugged with **316.3**

congealing asphaltic material, in order to prevent streaking or irregular

distribution of asphaltic material. Distributor equipment shall include a tachometer, pressure gauges, volume measuring devices, and a thermometer for reading the temperature of tank contents.

The distributor tank, when used for pay purposes, shall have been calibrated within three (3) years from the date it is first used on this project. The tank calibration procedure shall be in accordance with Test Method Tex-922-K, Part I, and shall be signed and sealed by a registered professional engineer. Unless otherwise shown on the plans, the Contractor shall provide the tank calibration and shall furnish the Engineer an accurate and satisfactory calibration record prior to beginning the work. The Engineer may at any time verify calibration accuracy in accordance with Test Method Tex-922-K, Part II, and may perform the required recalibration if the calibration is found to be in error.

When a uniform application of asphaltic material is not being achieved, the Engineer may require that the spray bars on the distributor be controlled by an operator riding in such a position at the rear of the distributor that the operation of all sprays is in full view.

(2) Aggregate Spreader. A self-propelled continuous-feed aggregate spreader shall be used which will uniformly spread aggregate at the rate specified by the Engineer.

(3) Rollers. Rolling equipment shall meet the governing specifications for Item 210, "Rolling (Flat Wheel)" and Item 213, "Rolling (Pneumatic Tire)".

(4) Broom. The broom shall be a rotary, self-propelled power broom for cleaning existing surfaces.

(5) Asphalt Storing and Handling Equipment. All equipment used in storing or handling asphaltic material shall be kept clean and in good operating condition at all times and shall be operated in such a manner that there will be no contamination of the asphaltic material. The Contractor shall provide and maintain a recording thermometer to continuously indicate the temperature of the asphaltic material at the storage heating unit when storing of asphalt is permitted.

(6) Vehicles used for hauling aggregate shall be of uniform capacity unless otherwise authorized by the Engineer.

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316.4. Construction Methods.

(1) General. Temporary stockpiling of aggregates on the right of way will be permitted, provided that the stockpiles are so placed as to allow for the

safety of the traveling public and not obstruct traffic or sight distance, and do not interfere with access from abutting property, nor with roadway drainage.

The aggregate placement sites will be subject to the approval of the Engineer.

Location of stockpiles shall be either a minimum of ten (10) meters from the edge of the travel lanes or shall be signed and barricaded as shown on the plans.

When shown on the plans, the Department will furnish aggregate to the Contractor without cost for designated sections of the project. The aggregate will be in stockpiles at locations or within limits shown on the plans. The Contractor shall load, haul, distribute and apply the stockpiled aggregate in accordance with specification requirements governing for this Item. The stockpile areas and remaining stockpiles shall be left in a neat condition satisfactory to the Engineer.

Surface treatments shall not be applied when the air temperature is below 15 °C and is falling, but may be applied when the air temperature is above 10 °C and is rising, the air temperature being taken in the shade and away from artificial heat. Surface treatments shall not be applied when the temperature of the surface on which the surface treatment is to be applied is below 15 °C. When latex modified asphalt cement is specified, surface treatments shall not be applied when the air temperature is below 25 °C and is falling, but may be applied when the air temperature is above 20 °C and is rising and shall not be applied when the temperature of the surface on which the surface treatment is to be applied is below 20 °C. When cutback asphalt or asphaltic materials designed for cool weather placement are used, application may occur whenever the air and surface temperatures are acceptable to the Engineer. Asphaltic material shall not be placed when general weather conditions, in the opinion of the Engineer, are not suitable.

The area to be treated shall be cleaned of dirt, dust or other deleterious matter by sweeping or other approved methods. If it is found necessary by the Engineer, the surface shall be lightly sprinkled with water just prior to the first application of asphaltic material.

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The rates shown on the plans for asphalt and aggregate are for estimating purposes only. The rates may be varied as directed by the Engineer.

The Engineer will select the temperature of application within the limits recommended in Item 300, "Asphalts, Oils and Emulsions". The Contractor

shall apply the asphalt at a temperature within 8 °C of the temperature selected.

The width of each application of asphaltic material shall be such to allow uniform application and immediate covering with aggregate. The Contractor shall be responsible for uniform application of asphaltic material at the junction of distributor loads. Paper or other suitable material shall be used to prevent overlapping of transverse joints. Longitudinal joints shall match lane lines unless otherwise authorized by the Engineer. Application of asphaltic material will be measured as necessary to determine the rate of application.

The finished surface shall be cleared of any surplus aggregate by the Contractor by sweeping or other approved methods after all rolling is completed.

Prior to final acceptance of the project, aggregate stockpiles deemed undesirable by the Engineer shall be removed by the Contractor. The temporary stockpile areas shall be left in a neat condition satisfactory to the Engineer. Aggregate stockpiles remaining on the State's right of way 30 days after the final acceptance of the project will become the property of the Texas Department of Transportation.

When plans include "Aggregate (Stockpiled)", aggregate(s) of the type(s) and grade(s) specified shall be stockpiled within the limits of the project at sites designated by the Engineer.

(2) One Course Surface Treatments or First Course of a Multiple Surface Treatment. Asphaltic material shall be applied by an approved distributor so operated as to distribute the material under a pressure necessary for uniform distribution.

The Contractor shall protect the existing raised pavement markers by any means acceptable to the Engineer for one course surface treatments, unless otherwise shown on the plans.

Aggregates shall be immediately and uniformly applied and spread by the specified aggregate spreader, unless otherwise authorized by the Engineer.

After applying the aggregate, the entire surface shall then be broomed, bladed or raked as required by the Engineer and shall be thoroughly rolled with the type or types of rollers specified herein or as shown on the plans.

The Contractor shall be responsible for the maintenance of the surface treatment until the work is accepted by the Engineer. All holes or failures in the surface shall be repaired by use of additional asphalt and aggregate. All fat or bleeding surfaces shall be covered with approved cover material in such a manner that the asphaltic material will not adhere to or be picked up by the wheels of vehicles.

(3) Two Course or Three Course Surface Treatments. It is the intent of this specification that the application of asphalt and aggregate for multiple courses be applied within the same day or immediately thereafter and prior to opening the roadway to traffic.

The asphaltic material for each course of the surface treatment shall be applied and covered with aggregate in the same manner specified for the first application. Each surface shall then be broomed, bladed or raked as required by the Engineer and thoroughly rolled as specified for the first course. Asphaltic material and aggregate for each course shall be applied at the rates directed by the Engineer.

The Contractor shall be responsible for the maintenance of each course until covered by the succeeding courses or until the work is accepted by the Engineer. All holes or failures in the surface shall be repaired by use of additional asphalt and aggregate. All fat or bleeding surfaces shall be covered with approved cover material in such a manner that the asphaltic material will not adhere to or be picked up by the wheels of vehicles.

316.5. Measurement.

(1) Asphaltic Material. Asphaltic material will be measured as follows and as specified on the plans.

(a) Volume. Asphaltic material will be measured at point of application on the road in liters at the applied temperature. The quantity to

be measured for payment shall be the number of liters used, as directed, in the accepted surface treatment.

(b) Mass. Asphaltic material will be measured in megagrams at the point of origin. Weighing will be done by a certified public weigher and the transporting vehicle shall have a seal attached to the draining device and other openings. At the Contractor's expense, the Engineer may require random checking by reweighing on public scales to verify mass accuracy. An asphalt storage tank shall not be permitted unless approved by the Engineer. If an asphalt storage tank is used, the Contractor shall provide an acceptable means of measuring the amount of asphaltic material received to assure that all material measured at the point of origin is received and used on the project. Upon completion or temporary suspension of the prescribed work, any remaining asphaltic material will be weighed by a certified public weigher or shall be measured by volume in a calibrated distributor or calibrated tank and the quantity converted to megagrams with respect to the measured temperature. The quantity to be measured for payment shall be the number of megagrams received minus the number of megagrams remaining after all directed work is complete and minus the amount used for other items.

(2) Aggregates. Aggregate will be measured by the cubic meter in vehicles as applied on the road.

Aggregate (Stockpiled), if required to be furnished, will be measured by the cubic meter of material in vehicles at the point of stockpiling or by the cubic meter in the stockpile as computed by the method of average end areas.

When "Loading, Hauling and Distributing Aggregate" is a bid Item, it will be measured by the cubic meter in vehicles as applied on the road.

316.6. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit prices bid for "Asphalt", "Aggregate" and "Aggregate (Stockpiled)", if required, of the type and grade specified. These prices shall each be full compensation for cleaning and sprinkling the existing surface; for furnishing, preparing, hauling, and placing all materials; for protecting existing pavement markers; for rolling, removing excess aggregate, and cleaning up stockpiles; for all freight and heating involved; and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work.

When "Loading, Hauling and Distributing Aggregate" is a bid Item, the work performed and measured as provided for herein will be paid for at the unit price bid for "Loading, Hauling, and Distributing Aggregate". This price shall be full compensation for loading, hauling, applying and distributing aggregate; for protecting existing pavement markers; for rolling, removing excess aggregate, and cleaning up stockpiles; and for all manipulation, labor, tools, equipment and incidentals necessary to complete the work.

When "Driveways and Turnouts" is included in the contract as a bid Item, the work performed and materials furnished for driveways and turnouts will be paid for in accordance with Item 530, "Driveways and Turnouts".

ITEM 318

HOT ASPHALT-RUBBER SURFACE TREATMENTS

318.1. Description. This Item shall govern for the construction of a surface treatment composed of a single or double application of hot asphalt-rubber material, each covered with aggregate, constructed on existing pavements or on the prepared base course or surface in accordance with these specifications.

318.2. Materials. All materials shall conform to the pertinent material requirements of the following Items:

Item 300, "Asphalts, Oils and Emulsions"
Item 302, "Aggregate for Surface Treatments"
Item 303, "Aggregate for Surface Treatments (Lightweight)"

(1) Asphaltic Materials.

(a) Asphalt Cement. The asphalt cement shall be of the type and grade shown on the plans or designated by the Engineer.

(b) Tack Coat. Cut-back asphalt may not be diluted with gasoline and/or kerosene. Emulsions may be diluted with the addition of water, with the approval of the Engineer.

(2) Rubber. The rubber shall be Type I or Type II and shall meet the requirements specified in "Properties of Rubber Used in Sealer" in Section 300.2.(8).(b).

The ground rubber may contain up to four (4) percent by mass of a dusting material such as calcium carbonate to prevent the particles from sticking together. The rubber, irrespective of diameter, shall not be greater than six (6) millimeters in length and shall not have a moisture content in excess of two (2) percent by mass.

(3) Diluent. The diluent shall be a hydrocarbon distillate complying with the following requirements when tested in accordance with ASTM D 86:

Initial Boiling Point, °C, Minimum . . . 170
End Point, °C, Maximum 315

(4) Extender Oil. The extender oil shall be a high-flash, resinous aromatic type which, when blended with the asphalt cement, will result in a mixture with an absolute viscosity of 60 - 200 pascal·second at 60 °C. Sampling and testing will be in accordance with Test Method Tex-528-C.

(5) Aggregate. The aggregate shall be of the types and grades as shown on the plans.

318.3. Equipment.

(1) Distributor. The distributor shall be a self-propelled pressure type, equipped with an asphaltic material heater and a distributing pump capable of pumping the material at the specified rate through the distributor spray bar. The distributor spray bar shall be capable of fully circulating the asphaltic material. The distributor spray bar shall contain nipples and valves so constructed that the nipples will not become partially plugged with congealing asphaltic material, in order to prevent streaking or irregular distribution of asphaltic material. Distributor equipment shall include a tachometer, pressure gauges, volume measuring devices, and a thermometer for reading the temperature of tank contents. The distributor shall be capable of keeping the rubber in uniform suspension and adequately mixing the asphalt, rubber, and diluent or oil.

The distributor may be equipped with an onboard scale system. If this system is used for proportioning and/or measurement and payment, it shall be capable of weighing the load within an accuracy of 0.4 percent and

shall meet the requirements of Item 520, "Weighing and Measuring Equipment". The method and equipment for combining the rubber and asphalt shall be so designed and accessible that the Engineer can readily determine the percentages, by mass, of each of the materials being incorporated into the hot asphalt-rubber material.

When a uniform application of asphaltic material is not being achieved, the Engineer may require that the spray bars on the distributor be controlled by an operator riding in such a position at the rear of the distributor that the operation of all sprays is in full view.

(2) Aggregate Spreader. A self-propelled continuous-feed aggregate spreader shall be used which will uniformly spread aggregate at the rate specified by the Engineer.

(3) Rollers. Rolling equipment shall meet the governing specifications for Item 210, "Rolling (Flat Wheel)" and Item 213, "Rolling (Pneumatic Tire)". A minimum of three pneumatic tire rollers shall be required for the hot asphalt-rubber surface treatment unless otherwise directed by the Engineer.

(4) Broom. The broom shall be a rotary, self-propelled power broom for cleaning existing surfaces.

(5) Aggregate Heating System. The system for heating the aggregate shall continually agitate the aggregate during heating. The temperature shall be controlled so that the aggregate will not be damaged in the heating operations. The burner, or combination of burners, and type of fuel used shall be such that in the process of heating the aggregate to the specified temperature, no residue from the fuel shall adhere to the heated aggregate. A continuous recording thermometer shall be provided which will indicate the temperature of the aggregate when it leaves the heating system.

(6) Truck Scales. A set of standard platform truck scales, conforming to Item 520, "Weighing and Measuring Equipment", shall be placed at a location approved by the Engineer. This requirement is waived if the distributor has an adequate calibrated scale system on board.

(7) Asphalt Storing and Handling Equipment. All equipment used in storing or handling asphaltic material shall be kept clean and in

good operating condition at all times and shall be operated in such a manner that there will be no contamination of the asphaltic material. The Contractor shall provide and maintain a recording thermometer to continuously indicate the temperature of the asphaltic material at the storage heating unit.

(8) Vehicles used for hauling aggregate shall be of uniform capacity unless otherwise authorized by the Engineer.

318.4. Construction Methods.

(1) General. Temporary stockpiling of aggregates on the right of way will be permitted, provided that the stockpiles are so placed as to allow for the safety of the traveling public and not obstruct traffic or sight distance, and do not interfere with access from abutting property, nor with roadway drainage.

The aggregate placement sites will be subject to the approval of the Engineer.

Location of stockpiles shall be either a minimum of ten (10) meters from the edge of the travel lanes or shall be signed and barricaded as shown on the plans.

Surface treatments shall not be applied when the air temperature is below 25 °C and is falling, but may be applied when the air temperature is above 20 °C and is rising, the air temperature being taken in the shade and away from artificial heat. Surface treatments shall not be applied when the temperature of the surface on which the surface treatment is to be applied is below 20 °C. Hot asphalt-rubber material shall not be placed when general weather conditions, in the opinion of the Engineer, are not suitable.

The aggregate shall be surface dry before application unless otherwise directed by the Engineer.

When shown on the plans, the cover aggregate shall be preheated to a temperature between 120 °C and 175 °C. Canvas or similar covers that completely cover each load shall be used to minimize the temperature drop of the preheated cover aggregate, if directed by the Engineer.

When directed by the Engineer, a tack coat shall be applied prior to applying the hot asphalt-rubber treatment on an existing wearing surface. Application of tack coat shall be in accordance with Subarticle 340.6.(2).

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If a job delay results after the full reaction described below has occurred, the asphalt-rubber mixture may be allowed to cool but shall be slowly reheated to an acceptable spraying temperature just prior to application. If, in the opinion of the Engineer, the asphalt-rubber mixture has been damaged by excessive or prolonged heating, the mixture shall not be used.

The Contractor shall show proof that his equipment is capable of mixing the asphaltic material and rubber to achieve the required consistency, or demonstrate the ability to achieve this consistency by placing a test section at a location acceptable to the Engineer.

The Contractor may use a mixture of asphalt cement, diluent (if needed) and Type I rubber or a mixture of asphalt cement, extender oil (if needed) and Type II rubber.

(2) Mixing.

(a) Mixture of Asphalt Cement, Type I Rubber and Diluent (if needed). The proportions by mass of the asphalt cement and rubber in the mixture shall be 75 percent plus or minus two (2) percent and 25 percent plus or minus two (2) percent, respectively.

The temperature of the asphalt cement shall be between 175 °C and 215 °C during the addition of the rubber. The asphalt cement and rubber shall be carefully combined, mixed and reacted. The reaction period shall be at least 30 minutes after all rubber has been added. At the direction of the Engineer, the reaction period shall be extended to obtain the desired properties in the asphalt-rubber mixture. The temperature of the resulting asphalt-rubber mixture shall not be less than 163 °C during the reaction period.

Just prior to application, diluent up to a maximum amount of 7-1/2 percent by volume of the hot asphalt-rubber mixture may be added as required to obtain optimum viscosity for spray application and better "wetting" of the cover aggregate.

The temperature of the asphalt-rubber mixture and diluent shall be adjusted to obtain the proper application characteristics, but shall not exceed 175 °C.

(b) Mixture of Asphalt Cement, Extender Oil (if needed) and Type II Rubber. The proportions by mass of the asphalt cement (including extender oil, if needed) and rubber in the mixture, shall be 78 percent, plus or minus two (2) percent, and 22 percent, plus or minus two (2) percent, respectively. The asphalt cement and extender oil (if needed) shall be combined and heated to a temperature of not less than 200 °C.

After the asphalt cement and extender oil have reached the proper consistency, the rubber shall be added, thoroughly mixed and allowed to react. The reaction period shall be at least 30 minutes after all rubber has been added. Temperature of the material during the reaction period shall be 190 °C to 220 °C.

The temperature of the asphalt-rubber mixture shall be adjusted to obtain the proper application characteristics, but shall not exceed 220 °C.

(3) Application. The mixture shall be applied on the approved, prepared surface with a specified self-propelled pressure distributor so operated as to distribute the material at the rate specified, evenly and smoothly, under a pressure necessary for proper distribution. Aggregate shall be immediately and uniformly applied and spread by the specified aggregate spreader, unless otherwise authorized by the Engineer.

The rates shown on the plans for hot asphalt-rubber and aggregate are for estimating purposes only. The rates may be varied as directed by the Engineer.

Hot asphalt-rubber material shall be applied in a width not to exceed four (4) meters, unless otherwise shown on the plans. The width may be reduced if uniformity of distribution is not achieved. The Contractor shall be responsible for uniform application of the hot asphalt-rubber material at the junction of distributor loads. Paper or other suitable material shall be used to prevent overlapping of transverse joints. Longitudinal joints shall match lane lines unless otherwise authorized by the Engineer. Application of hot asphalt-rubber material will be measured as necessary to determine the rate of application. Hot asphalt-rubber material shall not be applied until immediate covering with aggregate at the proper temperature is assured.

After applying the aggregate the entire surface shall be broomed, bladed or raked when required by the Engineer and shall be thoroughly rolled with the type or types of rollers specified herein or as shown on the plans.

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The finished surface shall be cleared by the Contractor of any surplus aggregate by sweeping or other approved methods after all rolling is completed.

The Contractor shall be responsible for the maintenance of the surface until the work is accepted by the Engineer.

Prior to final acceptance of the project, aggregate stockpiles deemed undesirable by the Engineer shall be removed by the Contractor. The temporary stockpile areas shall be left in a neat condition satisfactory to the Engineer. Aggregate stockpiles remaining on the State's right of way 30 days after the final acceptance of the project will become the property of the Texas Department of Transportation.

318.5. Measurement. Hot asphalt-rubber mixture will be measured by the megagram including asphalt, rubber, and diluent (or extender oil); weighed upon completion of the mixing and just prior to delivery to the point of application and tared immediately after application. If the distributor is equipped with onboard scales, the weighing will be immediately before and after each application.

Aggregate will be measured by the cubic meter in vehicles, as applied on the road.

318.6. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit prices bid for "Hot Asphalt-Rubber" and "Aggregate" of the type and grade specified. These prices shall be full compensation for cleaning the existing surface; for furnishing all materials including tack coat and freight involved; for all heating, mixing, hauling and placing all materials, including tack coat; for rolling, removing excess aggregate and cleaning up stockpile areas; and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work including royalties, permits costs, etc., and test sections.

ITEM 330

LIMESTONE ROCK ASPHALT PAVEMENT
(Class A)

330.1. Description. This Item shall govern for the construction of a base course, a surface course, a level-up course, or a combination of these courses as shown on the plans, each course being composed of a

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compacted mixture of natural limestone rock asphalt and an approved flux material, cold mixed in a mixing plant, in accordance with the details shown on

the plans and the requirements herein.

330.2. Materials.

(1) Limestone Rock Asphalt. This material shall be composed of crushed limestone rock asphalt meeting the requirements herein.

The limestone rock asphalt aggregate shall have an average bitumen content of 5.0 to 9.0 percent by mass of naturally impregnated asphalt as determined by Test Method Tex-215-F.

The portion of the material passing the 2.00 millimeter sieve shall have by mass not more than 8.5 percent nor less than 5.0 percent of naturally impregnated asphalt as determined by Test Method Tex-215-F.

The limestone rock asphalt shall contain not more than 1.0 percent by mass of organic matter (other than native bitumen), clays, loam or pebbles coated therewith; and not more than 2.0 percent by mass of any combination of slate, shale, schist, soft particles, iron pyrites, or other objectionable matter, when tested in accordance with Test Method Tex-217-F, Part I.

Except for Types AA and D paving mixtures, the portion of the material retained on the 4.75 millimeter sieve shall contain by mass from 20 to 35 percent of material with a naturally impregnated asphalt content of less than 1.0 percent. For Type AA paving mixture, the amount and size distribution of aggregate with less than 1.0 percent naturally impregnated asphalt content shall be acceptable to the Engineer. The portion of the material retained on the 4.75 millimeter sieve for Type D paving mixture shall contain by mass from 15 to 35 percent of the material with a naturally impregnated asphalt content of less than 1.0 percent. This percentage shall be adjusted within the grading limits to obtain an acceptable mixture. The percentage of material with less than 1.0 percent naturally impregnated asphalt shall be determined according to Test Method Tex-220-F, and the asphalt content of this separated material shall be determined according to Test Method Tex-215-F.

The percent of wear on limestone rock asphalt aggregate shall not exceed 40 as determined by Test Method Tex-410-A. The percent of wear shall be determined on that portion of the material retained on the

4.75 millimeter sieve having a naturally impregnated asphalt content of less than 1.0 percent.

No material shall be used before the source has been approved and the material has been sampled, tested and approved by the Engineer. The Contractor shall notify the Engineer in advance if a change in the source of any material is desired, and both the new source and material shall be approved by the Engineer prior to use.

The polish value for the coarse aggregate used in the surface or finish course shall not be less than the value shown on the plans, when tested in accordance with Test Method Tex-438-A, Part I. Unless otherwise shown on the plans, the polish value requirement will apply only to aggregate used on travel lanes. For rated sources, the Materials and Tests Division's Rated Source Polish Value (RSPV) Catalog will be used to determine polish value compliance.

(2) Asphaltic Material.

(a) Fluxing Material. The fluxing material shall meet the requirements of Item 300, "Asphalts, Oils, and Emulsions".

(b) Tack Coat. Asphalt materials used for tack coat shall meet the requirements of Item 300, "Asphalts, Oils and Emulsions", as approved by the Engineer.

(3) Additives. Additives to facilitate mixing and/or improve the quality of the limestone rock asphalt paving mixture or tack coat shall be used when noted on the plans or may be used with the authorization of the Engineer.

330.3. Paving Mixtures.

(1) Physical Properties of the Mixture. The paving mixture shall consist of a uniform mixture of crushed limestone rock asphalt, fluxing material and, if allowed or required, water. The materials may be mixed on the job or at a central mixing plant and shipped ready to use. Paving mixtures that do not remain workable so as to permit loading, unloading, hauling, placing and compacting will not be accepted.

(2) Job-Mix Formula. Representative samples will be taken from the mixing plant bins for determining the job-mix formula gradation. The Engineer will furnish the Contractor a job-mix formula gradation for

production; however, the Engineer may accept a job-mix formula gradation submitted by the Contractor. The Contractor shall set the initial fluxing material and, if allowed or required, water percentages. The fluxing material and water percentages may be adjusted by the Engineer to improve placement and compaction characteristics.

When properly proportioned, for the type specified, the blend of limestone rock asphalt aggregates shall produce an aggregate gradation which will conform to the limits of the master grading shown in Table 1. Gradations of the limestone rock asphalt aggregate shall be determined in accordance with Test Method Tex-200-F, Part I, prior to application of fluxing material.

If, during initial production, it is determined that adjustments to the job-mix formula are necessary to achieve the specified requirements, or to more nearly match the limestone rock asphalt aggregate production, the Engineer may adjust the job-mix formula so long as the adjusted values remain within the limits of the master grading for the type specified.

(3) Stability. The mixture produced shall have a stability value of at least 35, unless otherwise shown on the plans, when tested in accordance with Test Method Tex-208-F.

If, during production, the stability value falls below the specified minimum, the Engineer and the Contractor shall closely evaluate other test result values for specification compliance, such as gradation, fluxing material content, moisture content, etc., to find and correct the cause of low stability. If two (2) consecutive tests fall below the minimum value specified, production shall cease unless test results or other information indicate, to the satisfaction of the Engineer, that the next material to be produced will meet the minimum value specified.

(4) Water Content. Water, in an amount up to 4.0 percent by mass of the mixture, may be added to the limestone rock asphalt mixture to prevent setting-up in transit. The Contractor shall set the initial amount of water. The Engineer may adjust the water percentage to improve placement and compaction characteristics.

All water and light hydrocarbon volatiles in the mixture in excess of 4.0 percent by mass at the time of weighing the mixture on approved scales shall be deducted in determining the megagrams of mixture for payment. The method of determining the water and light hydrocarbon volatiles content of the mixture shall be in accordance with Test Method Tex-212-F, Part II.

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(5) Types. The limestone rock asphalt gradation shall conform to the master gradation limits shown in Table 1 for the type mix specified on the plans:

TABLE 1
MASTER GRADING
Percent Retained by Mass

Sieve Size	Type					
	AA Coarse Base	A Medium Base	B Fine Base	C Coarse Surface	CC Medium Surface	D Fine Surface
37.5 mm	0					
31.5 mm	0-10					
25.0 mm		0				
22.4 mm	15-30	0-2				
16.0 mm		5-15	0			
12.5 mm			0-2	0	0	
9.5 mm	25-45	25-35	5-15	0-2	0-2	0
6.3 mm						0-2
4.75 mm	45-60	50-60	45-60	35-50	35-50	5-15
2.00 mm	60-75	65-75	60-75	65-80	50-65	50-65

(6) Tolerances. The aggregate and fluxing material content of the paving mixture produced shall not vary from the job-mix formula by more than the following tolerances. No tolerance is allowed on the sieve size for each mixture type which shows zero (0) percent retained in Table 1.

Percent By Mass

Retained on the 31.5 mm to 4.75 mm sieve... plus or minus 4
Total Retained on 2.00 mm sieve..... plus or minus 3
Fluxing Material..... plus or minus 0.2

330.4. Equipment.

(1) General. All equipment for the handling of all materials and the mixing and placing of the mixture shall be maintained in good repair and operating condition and subject to the approval of the Engineer. Any equipment found to be defective and potentially affecting the quality of the

paving mixture shall not be allowed. The Contractor shall provide all equipment, in advance of use, for inspection as directed by the Engineer.

(2) Mixing Plants. Mixing plants may be either the weigh-batch type or

the continuous mixing type as described herein. It shall be the Contractor's responsibility to provide safe and accurate means to enable inspection forces to take all required samples, to provide permanent means for checking the output of any specified metering device, and to perform calibration and mass checks as required by the Engineer. Mixing plants that will not continuously produce a mixture meeting all of the above requirements shall not be used.

Automatic proportioning devices are required in accordance with Item 520, "Weighing and Measuring Equipment", except that requirements concerning the aggregate heating process are not applicable.

(a) Weigh-Batch Type.

Cold Aggregate Bins and Proportioning Devices. The cold aggregate bins or aggregate stockpiles shall be of sufficient number and shall be of sufficient size to supply the amount of aggregate required to keep the plant in continuous operation. The proportioning device shall be such as will provide a uniform and continuous flow of aggregate in the desired proportion to the plant.

Screening and Proportioning. The screening capacity and size of the bins shall be sufficient to screen and store the amount of aggregate required to properly operate the plant and keep the plant in continuous operation at full capacity. Proper provisions shall be made to enable inspection forces to have easy and safe access to the proper location on the mixing plant where accurate representative samples of aggregate may be taken from the bins for testing. The aggregate shall be separated into at least five bins when producing Type "AA" mixtures, at least four bins when producing Type "A" mixtures, at least three bins when producing Type "B" mixtures, and at least two bins when producing Types "C", "CC" and "D" mixtures. These bins shall contain the following sizes of aggregates, as applicable.

Type "AA":

Bin No. 1 -shall contain aggregates of which 85 to 100 percent by mass will pass the 2.00 mm sieve.

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Bin No. 2 -shall contain aggregates of which at least 85 percent by mass will be of such size to pass the 9.5 mm sieve and be retained on the 2.00 mm sieve.

Bin No. 3 -shall contain aggregates of which at least 85 percent by mass will be of such size to pass the 12.5 mm sieve and be retained on the 4.75 mm sieve.

Bin No. 4 -shall contain aggregates of which at least 85 percent by mass will be of such size to pass the 16.0 mm sieve and be retained on the 6.3 mm sieve.

Bin No. 5 -shall contain aggregates of which at least 85 percent by mass will be of such size to pass the 37.5 mm sieve and be retained on the 16.0 mm sieve.

Type "A":

Bin No. 1 -shall contain aggregates of which 85 to 100 percent by mass will pass the 2.00 mm sieve.

Bin No. 2 -shall contain aggregates of which at least 85 percent by mass will be of such size to pass the 9.5 mm sieve and be retained on the 2.00 mm sieve.

Bin No. 3 -shall contain aggregates of which at least 85 percent by mass will be of such size as to pass the 12.5 mm sieve and be retained on the 6.3 mm sieve.

Bin No. 4 -shall contain aggregates of which at least 85 percent by mass will be of such size as to pass the 22.4 mm sieve and be retained on the 9.5 mm sieve.

Type "B":

Bin No. 1 -shall contain aggregates of which 85 to 100 percent by mass will pass the 2.00 mm sieve.

Bin No. 2 -shall contain aggregates of which at least 85 percent by mass will be of such size to pass the 9.5 mm sieve and be retained on the 2.00 mm sieve.

Bin No. 3 -shall contain aggregate of which at least 85 percent by mass will be of such size as to pass the 12.5 mm sieve and be retained on the 6.3 mm sieve.

Type "C", Type "CC" and Type "D":

Bin No. 1 -shall contain aggregates of which 85 to 100 percent by mass will pass the 2.00 mm sieve.

Bin No. 2 -shall contain aggregates of which at least 85 percent by mass will be of such size as to pass the 9.5 mm sieve and be retained on the 2.00 mm sieve.

Aggregate Weigh Box and Batching Scales. The aggregate weigh box and batching scales shall be of sufficient capacity to hold and weigh a complete batch of aggregate. The weigh box and scales shall conform to the requirements of Item 520, "Weighing and Measuring Equipment".

Fluxing Material Measuring System. When a fluxing material bucket and scales are used, they shall be of sufficient capacity to hold and weigh the necessary material for one batch. The bucket and scales shall conform to the requirements of Item 520, "Weighing and Measuring Equipment".

When a pressure type flow meter is used to measure the fluxing material, the requirements of Item 520, "Weighing and Measuring Equipment", shall apply.

Mixer. The mixer shall be of the pug mill type and shall have a capacity of not less than 1350 kilograms in a single batch, unless otherwise shown on the plans. The mixer shall be equipped with a spray bar that will distribute the fluxing material quickly and uniformly throughout the mixer. Mixers which have a tendency to segregate the aggregate or which fail to secure a thorough and uniform mixing with the fluxing material shall not be used. All mixers shall be provided with an automatic time lock that will lock the discharge doors of the mixer for the required mixing period. The dump door or doors and the shaft seals of the mixer shall be tight enough to prevent the spilling of aggregate or mixture from the pug mill.

(b) Continuous Mixing Type.

Cold Aggregate Bins and Proportioning Devices. The same requirements apply as for the weigh-batch type of plant.

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Screening and Proportioning. The same requirements apply as specified under weigh-batch plants. These requirements shall also apply to materials that are stockpiled and that are proposed for direct use by a continuous mixing plant without the use of plant bins.

Fluxing Material Measuring System. A fluxing material measuring device meeting the requirements of Item 520, "Weighing and Measuring Equipment", shall be placed in the fluxing material line leading to the mixer so that the accumulated amount of fluxing material can be accurately determined. Provisions of a permanent nature shall be made for checking the accuracy of the meter output.

Mixer. The mixer shall be of the continuous type and shall have a capacity of not less than 36 megagrams of mixture per hour. The mixer shall be equipped with a spray bar that will distribute the fluxing material quickly and uniformly throughout the mixer. Mixers which have a tendency to segregate the aggregate or which fail to secure a thorough and uniform mixing of the aggregate with the fluxing materials shall not be used.

(3) Scales. Scales may be standard platform truck scales or other equipment approved by the Engineer. All scales shall conform to the requirements of Item 520, "Weighing and Measuring Equipment". If truck scales are used, they shall be placed at a location approved by the Engineer. If other weighing equipment is used, the Engineer may require mass checks by truck scales for the basis of approval of the equipment.

(4) Spreading and Finishing Machine. The spreading and finishing machine shall meet the requirements of Subarticle 340.4.(4).

(5) Motor Grader. The motor grader shall meet the requirements of Subarticle 340.4.(6).

(6) Rollers. Rollers provided shall meet the requirements of Subarticle 340.4.(7).

(7) Straightedges and Templates. The Contractor shall provide acceptable 3-meter straightedges for surface testing. Satisfactory templates shall be provided as required by the Engineer.

(8) Alternate Equipment. When permitted by the Engineer, equipment other than that specified which will consistently produce satisfactory results may be used.

330.5. Storage, Proportions and Mixing.

(1) Storage of Limestone Rock Asphalt. Sufficient material shall be stored, stockpiled or produced to permit continuous operation throughout any working period without shutdowns due to material shortages.

Stockpiling of limestone rock asphalt aggregates shall be done in such a manner that will minimize aggregate degradation, prevent segregation, and prevent mixing of one stockpile with another, or contamination with foreign materials.

Stockpiled material that comes in contact with earth or other

objectionable foreign matter shall be rejected. Paving mixtures that do not remain workable so as to permit proper loading, unloading, hauling, placing, and compacting will not be accepted. Storage, handling or loading of the limestone rock asphalt mixture shall be in such a manner as to prevent undue segregation.

(2) Storage and Heating of Fluxing Material. The fluxing material storage capacity shall be ample to meet the requirements of the plant. Fluxing material shall not be heated to a temperature in excess of that specified in Item 300, "Asphalts, Oils and Emulsions".

(3) Proportioning. The proportions of the various materials in the mixture shall be in accordance with the job-mix formula. Aggregate shall be proportioned by mass using the weigh box and batching scales when the weigh-batch type of plant is used and by volume using the aggregate proportioning device when the continuous mixer type of plant is used. The fluxing material shall be proportioned by mass or by volume based on mass using the specified equipment. The proportions of each constituent by mass of the paving mixture shall be within the following limits:

Crushed Limestone Rock Asphalt, 96.0 to 97.5 percent by mass, except that Type AA may range from 96.0 to 97.7 percent by mass.

Fluxing Material, 2.5 to 4.0 percent by mass, except that Type AA may range from 2.3 to 4.0 percent by mass.

(4) Mixing. In introducing the batch into the mixer, the sequence of addition of aggregate and fluxing material and the amount of mixing shall be determined by the Engineer and shall be done in a manner to minimize formation of "flux balls" and produce optimum conditions for a homogeneous mix.

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When aromatic oil is used in the fluxing material, it may be metered independently into the mixing chamber separately from the flux oil in amounts not to exceed 35 percent of the total fluxing material in the paving mixture.

Mixtures produced when the limestone rock asphalt aggregates contain moisture in excess of saturated surface dry condition will not be accepted. Excess moisture will be evidenced by visual surface moisture on the aggregates or any unusual quantities of fines clinging to the coarse aggregate.

In order to observe plant operations and the limestone rock asphalt mixtures, adequate lighting shall be provided or mixing shall be confined to the daylight hours.

All limestone rock asphalt mixture shipped on the project shall be

produced out of the same mixing plant, unless, if in the opinion of the Engineer, there is no difference in the quality of the limestone rock asphalt mixture when produced by two different mixing plants.

330.6. Construction Methods.

(1) General. The limestone rock asphalt mixture, tack coat or prime coat shall not be placed when the air temperature is below 15 °C and is falling, but it may be placed when the air temperature is above 10 °C and is rising. The air temperature shall be taken in the shade away from artificial heat. It is further provided that the tack coat or asphaltic mixture shall be placed only when the humidity, general weather conditions, and temperature and moisture conditions of the base or existing pavement, in the opinion of the Engineer, are suitable.

(2) Tack Coat. The surface upon which the tack coat is to be placed shall be cleaned thoroughly to the satisfaction of the Engineer. The surface shall be given a uniform application of tack coat using asphaltic materials of this specification. The tack coat shall be applied, as directed by the Engineer, with an approved sprayer at a rate not to exceed 0.2 liter residual asphalt per square meter of surface. Where the paving mixture will adhere to the surface on which it is to be placed without the use of a tack coat, the tack coat may be eliminated by the Engineer. All contact surfaces of curbs and structures and all joints shall be painted with a thin uniform

coat of the asphaltic material meeting the requirements for tack coat. During the application of asphaltic material, care shall be taken to prevent splattering of adjacent pavement, curb and gutter and structures. The tack coat shall be rolled with a pneumatic tire roller as directed by the Engineer.

(3) Transporting Limestone Rock Asphalt Mixture. The limestone rock asphalt mixture shall be hauled to the work site in tight vehicles previously cleaned of all foreign materials.

(4) Placing. All requirements of Subarticle 340.6.(4) shall govern except as follows:

After placing the paving mixture, compaction shall be deferred for a period of time, as directed by the Engineer, to allow for volatilization. Where more than one course of pavement is to be placed, no succeeding course shall be placed until the preceding course has been in place for a sufficient period of time to adequately dry and cure. The drying and curing period shall be ample to reduce the hydrocarbon volatile content to 0.4 percent by mass or less, unless otherwise approved by the Engineer. The hydrocarbon volatile content will be determined in accordance with Test Method Tex-213-F.

Alternate Method of Placing. When indicated on the plans or directed by the Engineer in writing, the mixture may be spread with the specified motor grader. The mixture shall be thoroughly aerated and then spread into place with a motor grader, in a uniform layer of such depth that after receiving ultimate compaction by rolling, the requirements of the typical cross sections will have been fulfilled. Hand spreading will be permitted where the mixture is placed on narrow strips or small irregular areas.

(5) Compacting. All requirements for compacting in Subarticle 340.6.(5) shall govern.

(6) In-Place Compaction Control. In-place compaction control by the rolling pattern method is required for all mixtures.

The Contractor shall furnish one three-wheel roller, one pneumatic-tire roller, and one tandem roller for each compaction operation except as provided below or approved by the Engineer. The use of a tandem roller may be waived by the Engineer when the surface is already adequately smooth and further steel-wheel rolling is shown to be ineffective. With

approval of the Engineer, the Contractor may substitute a vibratory roller for the three-wheel roller and/or the tandem roller. Use of at least one pneumatic-tire roller is required. Additional or heavier rollers shall be furnished if required by the Engineer.

Rolling patterns shall be established by the Contractor as outlined in Test Method Tex-207-F, Part IV, to achieve the maximum compaction, unless otherwise directed by the Engineer. The selected rolling pattern shall be followed unless changes in the mixture or placement conditions occur which affect compaction. When changes in the mixture or placement conditions occur, a new rolling pattern will be established.

(7) Ride Quality. Unless otherwise shown on the plans, ride quality will be required in accordance with Item 585, "Ride Quality for Pavement Surfaces".

(8) Opening to Traffic. The pavement shall be opened to traffic when directed by the Engineer. The Contractor's attention is directed to the fact that all construction traffic allowed on the pavement open to the public will be subject to the State laws governing traffic on highways.

If the surface ravels, flushes, ruts or deteriorates in any manner prior to final acceptance of the work, it will be the Contractor's responsibility to correct this condition at his expense, to the satisfaction of the Engineer and in conformance with the requirements of this specification.

330.7. Measurement. This Item will be measured by the mass method or the volumetric method as specified on the plans.

(1) Mass Method. The limestone rock asphalt pavement will be measured by the megagram of the "Limestone Rock Asphalt Pavement (Class A)" of the type actually used in the completed and accepted work in accordance with the plans and specifications for the project. Measurement will be made on the scales as provided in this specification. Records will be kept on tare mass, gross mass and net mass of the limestone rock asphalt paving mixture for each load of same. All water and light hydrocarbon volatiles in the mixture in excess of 4.0 percent by mass at the time of weighing shall be deducted from the net mass to determine the quantity for which payment is made.

(2) Volumetric Method. The limestone rock asphalt pavement will be measured by the cubic meter of compacted "Limestone Rock Asphalt Pavement (Class A)" of the type actually used in the completed and

accepted work in accordance with the plans and specifications for the project. The volume of the limestone rock asphalt paving mixture will be calculated by the following formula:

$$V = \frac{W - Y}{1000\, G_a}$$

V =Cubic meters of compacted limestone rock asphalt mixture
W =Total mass of limestone rock asphalt mixture in kilograms
G_a =Average actual specific gravity of three molded specimens as prepared by Test Method Tex-206-F and determined in accordance with Test Method Tex-207-F
Y =Mass of water and light hydrocarbon volatiles in kilograms in excess of 4.0 percent of total mass of mix at time of weighing

330.8. Payment.

(1) The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for the "Limestone Rock Asphalt Pavement (Class A)" of the type specified.

Measurement Method	Bid Item	Unit of Measure
Mass	Limestone Rock Asphalt Pavement (Class A)	Megagram
Volumetric	Limestone Rock Asphalt	Cubic Meter

Pavement (Class A

The payment, based on the unit bid price, shall be full compensation for quarrying, furnishing all materials, additives, and freight involved; for all heating, mixing, hauling, cleaning the existing base course or pavement, tack coat, placing limestone rock asphalt mixture, and rolling and finishing; and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work.

(2) All templates, straightedges, scales and other weighing and measuring devices necessary for the proper construction, measuring and checking of the work shall be furnished, operated and maintained by the Contractor at his expense.

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ITEM 332

LIMESTONE ROCK ASPHALT PAVEMENT
(Class B)

332.1. Description. This Item shall govern for the construction of a surface course, a level-up course, or a combination of these courses as shown on the plans, each course being composed of a compacted mixture of a blend of natural limestone rock asphalt, special aggregates and fluxing material, cold mixed in a mixing plant, in accordance with the details shown on the plans and the requirements herein.

332.2. Materials

(1) Limestone Rock Asphalt. This material shall be composed of crushed limestone rock asphalt meeting the requirements herein.

The limestone rock asphalt aggregate shall have an average bitumen content of 5.0 to 9.0 percent by mass of naturally impregnated asphalt as determined by Test Method Tex-215-F.

The portion of the material passing the 2.00 millimeter sieve shall have not more than 8.5 percent nor less than 5.5 percent by mass of naturally impregnated asphalt as determined by Test Method Tex-215-F.

The limestone rock asphalt shall contain not more than 1.0 percent by mass of organic matter (other than native bitumen), clays, loam or pebbles coated therewith; and not more than 2.0 percent by mass of any combination of slate, shale, schist, soft particles, iron pyrites, or other objectionable matter, when tested in accordance with Test Method Tex-217-F, Part I.

For all types of paving mixtures except Type FS, the portion of the material retained on the 4.75 millimeter sieve shall contain by mass from 15 to 35 percent of material with a naturally impregnated asphalt content of less than 1.0 percent. This percentage shall be adjusted within the grading limits to obtain an acceptable mixture. The percentage of material with less than 1.0 percent naturally impregnated asphalt shall be determined according to Test Method Tex-220-F, and the asphalt content of this separated material shall be determined according to Test Method Tex-215-F.

The percent of wear on limestone rock asphalt aggregate shall not exceed 40 as determined by Test Method Tex-410-A. The percent of wear **332.3**

shall be determined on that portion of the material retained on the 4.75 millimeter sieve having a naturally impregnated asphalt content of less than 1.0 percent.

No material shall be used before the source has been approved and the material has been sampled, tested and approved by the Engineer. The Contractor shall notify the Engineer in advance if a change in the source of any material is desired, and both the new source and material shall be approved by the Engineer prior to use.

The polish value for the coarse aggregate used in the surface or finish course shall not be less than the value shown on the plans, when tested in accordance with Test Method Tex-438-A, Part I. Unless otherwise shown on the plans, the polish value requirement will apply only to aggregate used on travel lanes. For rated sources, the Materials and Tests Division's Rated Source Polish Value (RSPV) Catalog will be used to determine polish value compliance.

(2) Special Aggregate. This material shall meet all the requirements for natural coarse aggregate of Subarticle 340.2.(1) except the aggregate shall have a wear loss of not more than 20 percent when tested in accordance with Test Method Tex-410-A.

(3) Asphaltic Material.

(a) Fluxing Material. The fluxing material shall meet the requirements of Item 300, "Asphalts, Oils, and Emulsions".

(b) Tack Coat. Asphalt materials used for tack coat shall meet the requirements of Item 300, "Asphalts, Oils and Emulsions", as approved by the Engineer.

(4) Additives. Additives to facilitate mixing and/or improve the quality of the limestone rock asphalt paving mixture or tack coat shall be used when noted on the plans or may be used with the authorization of the Engineer.

332.3. Paving Mixtures.

(1) Fine Aggregate. No fines other than those produced by crushing the native limestone rock asphalt, or caused by the production and handling of the special aggregate, will be permitted.

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(2) Physical Properties of the Mixture. The paving mixture shall consist of a uniform mixture of crushed limestone rock asphalt aggregate, special aggregate, fluxing material and water if allowed or required. The materials may be mixed on the job or at a central mixing plant and shipped ready to use. Paving mixtures that do not remain workable so as to permit loading, unloading, hauling, placing and compacting will not be accepted.

(3) Job-Mix Formula. Representative samples will be taken from the mixing plant bins for determining the job-mix formula gradation. The Engineer will furnish the Contractor a job-mix formula gradation for production; however, the Engineer may accept a job-mix formula gradation submitted by the Contractor. The Contractor shall set the initial fluxing material and, if allowed or required, water percentages. The fluxing material and water percentages may be adjusted by the Engineer to improve placement and compaction characteristics.

When properly proportioned, for the type specified, the blend of limestone rock asphalt aggregate and special aggregate shall produce an aggregate gradation which will conform to the limits of the master grading shown in Table 1. Gradations of the limestone rock asphalt aggregate and special aggregate shall be determined in accordance with Test Method Tex-200-F, Part I, prior to application of fluxing material.

If, during initial production, it is determined that adjustments to the job-mix formula are necessary to achieve the specified requirements, or to more nearly match the limestone rock asphalt aggregate production, the Engineer may adjust the job-mix formula so long as the adjusted values remain within the limits of the master grading for the type specified.

(4) Stability. The mixture produced shall have a stability value of at least 35, unless otherwise shown on the plans, when tested in accordance with Test Method Tex-208-F.

If, during production, the stability value falls below the specified minimum, the Engineer and the Contractor shall closely evaluate other test result values for specification compliance, such as gradation, fluxing material content, moisture content, etc., to find and correct the cause of low stability. If two (2) consecutive tests fall below the minimum value specified, production shall cease unless test results or other information indicate, to the satisfaction of the Engineer, that the next material to be produced will meet the minimum value specified.

(5) Water Content. Water, in an amount up to 4.0 percent by mass of the mixture, may be added to the limestone rock asphalt mixture to prevent setting-up in transit. The Contractor shall set the initial amount of water. The Engineer may adjust the water percentage to improve placement and compaction characteristics.

All water and light hydrocarbon volatiles in the mixture in excess of 4.0 percent by mass at the time of weighing the mixture on approved scales shall be

deducted in determining the megagrams of mixture for payment. The method of determining the water and light hydrocarbon volatiles content of the mixture shall be in accordance with Test Method Tex-212-F, Part II.

(6) Types. The limestone rock asphalt gradation shall conform to the master gradation limits shown in Table 1 for the type mix specified on the plans:

TABLE 1
MASTER GRADING
Percent Retained by Mass

Sieve Size	Type			
	BS Surface	**CS Medium Surface**	**DS Fine Surface**	**FS Thin Surface**
19.0 mm	0			
16.0 mm	0-2	0		
12.5 mm	0-10	0-2	0	
9.5 mm	10-25	0-10	0-2	0
4.75 mm	40-55	35-55	10-25	0-10
2.00 mm	60-75	60-75	50-65	35-60

(7) Tolerances. The aggregates and fluxing material content of the paving mixture produced shall not vary from the job-mix formula by more than the following tolerances. No tolerance is allowed on the sieve size for each mixture type which shows zero (0) percent retained in Table 1.

Percent By Mass

Retained on the 16.0 mm to 4.75 mm sieve..... plus or minus 4
Total Retained on 2.00 mm sieve ..... plus or minus 3
Fluxing Material ..... plus or minus 0.2

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332.4. Equipment.

(1) General. All equipment for the handling of all materials and the mixing and placing of the mixture shall be maintained in good repair and operating condition and subject to the approval of the Engineer. Any equipment found to be defective and potentially affecting the quality of the paving mixture shall not be allowed. The Contractor shall provide all equipment, in advance of use, for inspection as directed by the Engineer.

(2) Mixing Plants. Mixing plants may be either the weigh-batch type or the continuous mixing type as described herein. It shall be the Contractor's responsibility to provide safe and accurate means to enable inspection forces to take all required samples, to provide permanent means for checking the output of any specified metering device, and to perform calibration and mass checks as required by the Engineer. Mixing plants that will not continuously produce a mixture meeting all of the above requirements shall not be used.

Automatic proportioning devices are required in accordance with Item 520, "Weighing and Measuring Equipment", except that requirements concerning the aggregate heating process are not applicable.

(a) Weigh-Batch Type.

Cold Aggregate Bins and Proportioning Devices. The cold aggregate bins or aggregate stockpiles shall be of sufficient number and shall be of sufficient size to supply the amount of aggregate required to keep the plant in continuous operation. The proportioning device shall be such as will provide a uniform and continuous flow of aggregate in the desired proportion to the plant.

Screening and Proportioning. The screening capacity and size of the bins shall be sufficient to screen and store the amount of aggregate required to properly operate the plant and keep the plant in continuous operation at full capacity. Proper provisions shall be made to enable inspection forces to have easy and safe access to the proper location on the mixing plant where accurate representative samples of aggregate may be taken from the bins for testing. The aggregate shall be separated into at least four bins when producing Type "BS" mixtures, at least three bins when producing Type "CS" and "DS" mixtures and at least two bins when producing Type "FS" mixtures. These bins shall contain the following sizes of aggregates, as applicable.

Type "BS":

Bin No. 1 - shall contain aggregates of which 85 to 100 percent by mass will pass the 2.00 mm si

Bin No. 2 - shall contain aggregates of which at least 85 percent by mass will be of such size to pass the 9.5 mm sieve and be retained on the 2.00 mm sieve.

Bin No. 3 - shall contain aggregate of which at least 85 percent by mass will be of such size as to

Bin No. 4 - shall contain special aggregate of the following gradation:

	Percent by Mass
Retained on 19.0 mm sieve	0
Retained on 16.0 mm sieve	0 to 2
Retained on 12.5 mm sieve	5 to 20
Retained on 9.5 mm sieve	50 to 80
Retained on 4.75 mm sieve	85 to 100
Retained on 2.00 mm sieve	95 to 100

Type"CS":

Bin No. 1 - shall contain aggregates of which 85 to 100 percent by mass will pass the 2.00 mm si

Bin No. 2 - shall contain aggregates of which at least 85 percent by mass will be of such size as to

Bin No. 3 - shall contain special aggregate of the following gradation:

	Percent by Mass
Retained on 16.0 mm sieve	0
Retained on 12.5 mm sieve	0 to 2
Retained on 9.5 mm sieve	5 to 25
Retained on 4.75 mm sieve	85 to 100
Retained on 2.00 mm sieve	95 to 100

Type "DS":

Bin No. 1 - shall contain aggregates of which 85 to 100 percent by mass will pass the 2.00 mm si

Bin No. 2 - shall contain aggregates of which at least 85 percent by mass will be of such size as to

Bin No. 3 - shall contain special aggregate of the following gradation:

	Percent by Mass
Retained on 12.5 mm sieve	0
Retained on 9.5 mm sieve	0 to 2
Retained on 4.75 mm sieve	40 to 80
Retained on 2.00 mm sieve	90 to 100

Type "FS":

Bin No. 1 - shall contain aggregates of which at least 85 to 100 percent by mass will pass the 2.00 mm sieve.

Bin No. 2 - shall contain special aggregate of the following gradation:

	Percent by Mass
Retained on 12.5 mm sieve	0
Retained on 4.75 mm sieve	0 to 20
Retained on 2.00 mm sieve	80 to 100

Aggregate Weigh Box and Batching Scales. The aggregate weigh box

and batching scales shall be of sufficient capacity to hold and weigh a complete batch of aggregate. The weigh box and scales shall conform to the requirements of Item 520, "Weighing and Measuring Equipment".

Fluxing Material Measuring System. When a fluxing material bucket and scales are used, they shall be of sufficient capacity to hold and weigh the necessary material for one batch. The bucket and scales shall conform to the requirements of Item 520, "Weighing and Measuring Equipment".

When a pressure type flow meter is used to measure the fluxing material, the requirements of Item 520, "Weighing and Measuring Equipment", shall apply.

Mixer. The mixer shall be of the pug mill type and shall have a capacity of not less than 1350 kilograms in a single batch, unless otherwise shown on the plans. The mixer shall be equipped with a spray bar that will distribute the fluxing material quickly and uniformly throughout the mixer. Mixers which have a tendency to segregate the aggregate or which fail to secure a thorough and uniform mixing with the fluxing material shall not be used. All mixers shall be provided with an automatic time lock that will lock the discharge doors of the mixer for the required mixing period. The dump door or doors and the shaft seals of the mixer shall be tight enough to prevent the spilling of aggregate or mixture from the pug mill.

(b) Continuous Mixing Type.

Cold Aggregate Bins and Proportioning Devices. The same requirements apply as for the weigh-batch type of plant.

Screening and Proportioning. The same requirements apply as specified under weigh-batch plants. These requirements shall also apply to materials that are stockpiled and that are proposed for direct use by a continuous mixing plant without the use of plant bins.

Fluxing Material Measuring System. A fluxing material measuring device meeting the requirements of Item 520, "Weighing and Measuring Equipment", shall be placed in the fluxing material line leading to the mixer so that the accumulated amount of fluxing material can be accurately determined. Provisions of a permanent nature shall be made for checking the accuracy of the meter output.

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Mixer. The mixer shall be of the continuous type and shall have a capacity of not less than 36 megagrams of mixture per hour. The mixer shall be equipped with a spray bar that will distribute the fluxing material quickly and

uniformly throughout the mixer. Mixers which have a tendency to segregate the aggregate or which fail to secure a thorough and uniform mixing of the aggregate with the fluxing materials shall not be used.

(3) Scales. Scales may be standard platform truck scales or other equipment approved by the Engineer. All scales shall conform to the requirements of Item 520, "Weighing and Measuring Equipment". If truck scales are used, they shall be placed at a location approved by the Engineer. If other weighing equipment is used, the Engineer may require mass checks by truck scales for the basis of approval of the equipment.

(4) Spreading and Finishing Machine. The spreading and finishing machine, shall meet the requirements of Subarticle 340.4.(4).

(5) Motor Grader. The motor grader shall meet the requirements of Subarticle 340.4.(6).

(6) Rollers. Rollers provided shall meet the requirements of Subarticle 340.4.(7).

(7) Straightedges and Templates. The Contractor shall provide acceptable 3-meter straightedges for surface testing. Satisfactory templates shall be provided as required by the Engineer.

(8) Alternate Equipment. When permitted by the Engineer, equipment other than that specified which will consistently produce satisfactory results may be used.

332.5. Storage, Proportions and Mixing.

(1) Storage of Limestone Rock Asphalt and Special Aggregate. Sufficient material shall be stored, stockpiled or produced to permit continuous operation throughout any working period without shutdowns due to material shortages.

Stockpiling of limestone rock asphalt aggregate and special aggregate shall be done in such a manner that will minimize aggregate degradation, prevent segregation, and prevent mixing of one stockpile with another, or contamination with foreign materials.

Stockpiled material that comes in contact with earth or other objectionable foreign matter shall be rejected. Paving mixtures that do not remain workable so as to permit proper loading, unloading, hauling, placing, and compacting will not be accepted. Storage, handling or loading of the limestone

rock asphalt and special aggregate mixture shall be in such a manner as to prevent undue segregation.

(2) Storage and Heating of Fluxing Material. The fluxing material storage capacity shall be ample to meet the requirements of the plant. Fluxing material shall not be heated to a temperature in excess of that specified in Item 300, "Asphalts, Oils and Emulsions".

(3) Proportioning. The proportions of the various materials in the mixture shall be in accordance with the job-mix formula. Aggregate shall be proportioned by mass using the weigh box and batching scales when the weigh-batch type of plant is used and by volume using the aggregate proportioning device when the continuous mixer type of plant is used. The fluxing material shall be proportioned by mass or by volume based on mass using the specified equipment. The proportions of each constituent by mass of the paving mixture shall be within the following limits:

	Types BS, CS, DS	Type FS
Crushed Limestone Rock Asphalt..	66.0 to 78.5%	36.0 to 63.0%
Special Aggregate.....	20.0 to 30.0%	35.0 to 60.0%
Fluxing Material.....	1.5 to 4.0%	1.4 to 4.0%

(4) Mixing. In introducing the batch into the mixer, the sequence of addition of aggregates and fluxing material and the amount of mixing shall be determined by the Engineer and shall be done in a manner to minimize formation of "flux balls" and produce optimum conditions for a homogeneous mix.

When aromatic oil is used in the fluxing material, it may be metered independently into the mixing chamber separately from the flux oil in amounts not to exceed 35 percent of the total fluxing material in the paving mixture.

Mixtures produced when the limestone rock asphalt and special aggregate blend contain moisture in excess of saturated surface dry condition will not be accepted. Excess moisture will be evidenced by visual surface moisture on the aggregates or any unusual quantities of fines clinging to the coarse aggregate.

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In order to observe plant operations and the limestone rock asphalt mixtures, adequate lighting shall be provided or mixing shall be confined to the daylight hours.

All limestone rock asphalt and special aggregate mixture shipped on the

project shall be produced out of the same mixing plant, unless, if in the opinion of the Engineer, there is no difference in the quality of the limestone rock asphalt and special aggregate mixture when produced by two different mixing plants.

332.6. Construction Methods.

(1) General. The limestone rock asphalt and special aggregate mixture, tack coat or prime coat shall not be placed when the air temperature is below 15 °C and is falling, but it may be placed when the air temperature is above 10 °C and is rising. The air temperature shall be taken in the shade away from artificial heat. It is further provided that the tack coat or asphaltic mixture shall be placed only when the humidity, general weather conditions, and temperature and moisture conditions of the base or existing pavement, in the opinion of the Engineer, are suitable.

(2) Tack Coat. The surface upon which the tack coat is to be placed shall be cleaned thoroughly to the satisfaction of the Engineer. The surface shall be given a uniform application of tack coat using asphaltic materials of this specification. The tack coat shall be applied, as directed by the Engineer, with an approved sprayer at a rate not to exceed 0.2 liter residual asphalt per square meter of surface. Where the paving mixture will adhere to the surface on which it is to be placed without the use of a tack coat, the tack coat may be eliminated by the Engineer. All contact surfaces of curbs and structures and all joints shall be painted with a thin uniform coat of the asphaltic material meeting the requirements for tack coat. During the application of asphaltic material, care shall be taken to prevent splattering of adjacent pavement, curb and gutter and structures. The tack coat shall be rolled with a pneumatic tire roller as directed by the Engineer.

(3) Transporting Limestone Rock Asphalt Mixture. The limestone rock asphalt and special aggregate mixture shall be hauled to the work site in tight vehicles previously cleaned of all foreign materials.

(4) Placing. All requirements of Subarticle 340.6.(4) shall govern except as follows:

After placing the paving mixture, compaction shall be deferred for a period of time, as directed by the Engineer, to allow for volatilization. Where more than one course of pavement is to be placed, no succeeding course shall be placed until the preceding course has been in place for a sufficient period of time to adequately dry and cure. The drying and curing period shall be ample to reduce the hydrocarbon volatile content to 0.4 percent by mass or less, unless otherwise approved by the Engineer. The hydrocarbon volatile content will be

determined in accordance with Test Method Tex-213-F.

Alternate Method of Placing. When indicated on the plans or directed by the Engineer in writing, the mixture may be spread with the specified motor grader. The mixture shall be thoroughly aerated and then spread into place with a motor grader, in a uniform layer of such depth that after receiving ultimate compaction by rolling, the requirements of the typical cross sections will have been fulfilled. Hand spreading will be permitted where the mixture is placed on narrow strips or small irregular areas.

(5) Compacting. All requirements for compacting in Subarticle 340.6.(5) shall govern.

(6) In-Place Compaction Control. In-place compaction control by the rolling pattern method is required for all mixtures.

The Contractor shall furnish one three-wheel roller, one pneumatic-tire roller, and one tandem roller for each compaction operation except as provided below or approved by the Engineer. The use of a tandem roller may be waived by the Engineer when the surface is already adequately smooth and further steel-wheel rolling is shown to be ineffective. With approval of the Engineer, the Contractor may substitute a vibratory roller for the three-wheel roller and/or the tandem roller. Use of at least one pneumatic-tire roller is required. Additional or heavier rollers shall be furnished if required by the Engineer.

Rolling patterns shall be established by the Contractor as outlined in Test Method Tex-207-F, Part III, to achieve the maximum compaction, unless otherwise directed by the Engineer. The selected rolling pattern shall be followed unless changes in the mixture or placement conditions occur which affect compaction. When changes in the mixture or placement conditions occur, a new rolling pattern will be established.

(7) Ride Quality. Unless otherwise shown on the plans, ride quality will be required in accordance with Item 585, "Ride Quality for Pavement Surfaces".

(8) Opening to Traffic. The pavement shall be opened to traffic when directed by the Engineer. The Contractor's attention is directed to the fact that all construction traffic allowed on the pavement open to the public will be subject to the State laws governing traffic on highways.

If the surface ravels, flushes, ruts or deteriorates in any manner prior to final acceptance of the work, it will be the Contractor's responsibility to correct this condition at his expense, to the satisfaction of the Engineer and in conformance with the requirements of this specification.

332.7. Measurement. This Item will be measured by the mass method or the volumetric method as specified on the plans.

(1) Mass Method. The limestone rock asphalt pavement will be measured by the megagram of the "Limestone Rock Asphalt Pavement (Class B)" of the type actually used in the completed and accepted work in accordance with the plans and specifications for the project. Measurement will be made on the scales as provided in this specification. Records will be kept on tare mass, gross mass and net mass of the limestone rock asphalt paving mixture for each load of same. All water and light hydrocarbon volatiles in the mixture in excess of 4.0 percent by mass at the time of weighing shall be deducted from the net mass to determine the quantity for which payment is made.

(2) Volumetric Method. The limestone rock asphalt pavement will be measured by the cubic meter of compacted "Limestone Rock Asphalt Pavement (Class B)" of the type actually used in the completed and accepted work in accordance with the plans and specifications for the project. The volume of the limestone rock asphalt paving mixture will be calculated by the following formula:

$$V = \frac{W - Y}{1000\, G_a}$$

V=Cubic meters of compacted limestone rock asphalt mixture

W=Total mass of limestone rock asphalt mixture in kilograms

G_a=Average actual specific gravity of three molded specimens as prepared by Test Method Tex-206-F and determined in accordance with Test Method Tex-207-F

Y=Mass of water and light hydrocarbon volatiles in kilograms in excess of 4.0 percent of total mass of mix at time of weighing

332.8. Payment.

(1) The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for the "Limestone Rock Asphalt Pavement (Class B)" of the type specified.

Measurement Method	Bid Item	Unit of Measure
Mass	Limestone Rock Asphalt Pavement (Class B)	Megagram
Volumetric	Limestone Rock Asphalt Pavement (Class B)	Cubic Meter

The payment, based on the unit bid price, shall be full compensation for quarrying, furnishing all materials, additives, and freight involved; for all heating, mixing, hauling, cleaning the existing base course or pavement, tack coat, placing limestone rock asphalt mixture, rolling and finishing; and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work.

(2) All templates, straightedges, scales and other weighing and measuring devices necessary for the proper construction, measuring and checking of the work shall be furnished, operated and maintained by the Contractor at his expense.

ITEM 334

HOT MIX-COLD LAID ASPHALTIC CONCRETE PAVEMENT

334.1. Description. This Item shall govern for the construction of a base course, a level-up course, a surface course or any combination of

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these courses as shown on the plans, each course being composed of a compacted mixture of aggregate and asphaltic material mixed hot in a mixing

plant, in accordance with the details shown on the plans and the requirements herein.

The mixture covered by this Item has been designed for cold placement. Should the placement temperature of the mixture be 79 °C or greater, the mixture is not considered as being placed cold and shall be designed, mixed, placed and compacted in accordance with Item 340, "Hot Mix Asphaltic Concrete Pavement", to include any applicable requirements for the use of reclaimed asphalt pavement.

334.2. Materials. The Contractor shall furnish materials to the project meeting the following requirements prior to mixing. Additional test requirements affecting the quality of individual materials or the paving mixture shall be required when indicated on the plans.

(1) Aggregate. The aggregate shall be composed of a coarse aggregate, a fine aggregate, and if required or allowed, a mineral filler. Samples of each aggregate shall be submitted for approval in accordance with Item 6, "Control of Materials".

Aggregate from each stockpile shall meet the quality requirements of Table 1 and other requirements as specified herein.

(a) Coarse Aggregate. Coarse aggregate is defined as that part of the aggregate retained on a 2.00 millimeter sieve. The aggregate shall be natural, lightweight or manufactured, and be of uniform quality throughout. When specified on the plans, certain coarse aggregate material may be allowed, required or prohibited.

Lightweight aggregate is defined as expanded shale, clay or slate produced by the rotary kiln method. Manufactured aggregate is defined as any aggregate other than natural or lightweight.

Lightweight or manufactured materials with the same or similar gradation, whose unit weight vary by more than 6.0 percent from that used in the mixture design, may require a redesign.

Gravel from each source shall be so crushed as to have a minimum of 85 percent of the particles retained on the 4.75 millimeter sieve with two or more mechanically induced crushed faces, as determined by Test Method Tex-460-A (Part I). The material passing the 4.75 millimeter sieve and

retained on the 2.00 millimeter sieve must be the product of crushing aggregate that was originally retained on the 4.75 millimeter sieve.

The polish value for the coarse aggregate used in the surface or finish course shall not be less than the value shown on the plans, when tested in accordance with Test Method Tex-438-A. Unless otherwise shown on the plans, the polish value requirement will apply only to aggregate used on travel lanes. For rated sources, the Materials and Tests Division's Rated Source Polish Value (RSPV) catalog will be used to determine polish value compliance. Unless otherwise shown on the plans, coarse aggregates may be blended in accordance with Test Method Tex-438-A, Part II, Method B, to meet the polish value requirement. When blending is allowed, the blended aggregates shall contain non-polishing aggregates of not less than the percent by volume of the critical size shown below for the specified mixture.

	Type C	Type D	Type F
Retained on the 4.75 mm sieve	50%	50%	
Retained on the 2.00 mm sieve		50%	

(b) Fine Aggregate. The fine aggregate is defined as that part of the aggregate passing the 2.00 millimeter sieve and shall be of uniform quality throughout. When specified on the plans, certain fine aggregate material may be allowed, required or prohibited. However, a maximum of 15 percent of the total aggregate may be field sand or other uncrushed fine aggregate.

Screenings shall be supplied from sources whose coarse aggregate meets the Los Angeles abrasion and magnesium sulfate soundness loss requirements shown in Table 1, unless otherwise shown on the plans.

1. Unless otherwise shown on the plans, stone screenings are required and shall be the result of a rock crushing operation and meet the following gradation requirements, when tested in accordance with Test Method Tex-200-F, Part I.

	Percent by Mass
Passing the 9.5 mm sieve	100
Passing the 2.00 mm sieve	70-100
Passing the 75 µm sieve	0-15

2. Crushed gravel screenings may be used with, or in lieu of, stone screenings when shown on the plans. Crushed gravel screenings must be

the product of crushing aggregate that was originally retained on the 4.75 millimeter sieve and meet the gradation for stone screenings shown above.

(c) Mineral Filler. Mineral filler shall consist of thoroughly dried stone dust, portland cement, lime, fly ash, or other mineral dust approved by the Engineer. The mineral filler shall be free from foreign matter.

When a specific type of mineral filler is specified on the plans, fines collected by the baghouse or other air cleaning or dust collecting equipment shall not be used to meet this requirement. When mineral filler is not specifically required, the addition of baghouse or other collected fines will be permitted if the mixture quality is not adversely affected in the opinion of the Engineer. In no case shall the amount of material passing the 75 micrometer sieve exceed the tolerances of the job-mix formula or the master gradation limits.

When mineral filler is specified or allowed by the Engineer, or baghouse fines are permitted to be added to the mixture, it shall be proportioned into the mix by a vane meter or an equivalent measuring device acceptable to the Engineer. A hopper or other acceptable storage system shall be required to maintain a constant supply of mineral filler to the measuring device.

The measuring device for adding mineral filler shall be tied into the automatic plant controls so that the supply of mineral filler will be automatically adjusted to plant production and provide a consistent percentage to the mixture. When shown on the plans, the measuring device for adding baghouse fines shall have controls in the plant control room which will allow manual adjustment of feed rates to match plant production rate adjustments.

When tested in accordance with Test Method Tex-200-F (Part I or Part III, as applicable), the mineral filler shall meet the following gradation requirements, unless otherwise shown on the plans. Baghouse fines are not required to meet the gradation requirements.

	Percent by Mass or Volume
Passing the 600 µm sieve	95-100
Passing the 180 µm sieve, not less than	75
Passing the 75 µm sieve, not less than	55

TABLE 1
AGGREGATE
QUALITY REQUIREMENTS *

Requirement	Test Method	Manufactured or Natural Aggregate	Lightweight Aggregate
COARSE AGGREGATE			
Dry Loose Unit Weight, kg/m^3 minimum	Tex-404-A	-	560
Pressure Slaking Value, maximum	Tex-431-A	-	4.0
Freeze Thaw Loss, percent, max.	Tex-432-A	-	7.0
24 Hour Water Absorption, percent, maximum	Tex-433-A	-	12.0
Deleterious Material, percent, maximum	Tex-217-F Part I	1.5	1.5
Decantation, percent, maximum	Tex-217-F Part II	1.5	1.5
Los Angeles Abrasion, percent, maximum	Tex-410-A	40	35
Magnesium Sulfate Soundness Loss, 5 cycle, percent, maximum	Tex-411-A	30**	-
FINE AGGREGATE			
Linear Shrinkage, maximum	Tex-107-E Part II	3	3
COMBINED AGGREGATES * **			
Sand Equivalent Value, minimum	Tex-203-F	45	45

* Sampled during delivery to the plant or from the stockpile, unless otherwise shown on the plans.
** Unless otherwise shown on the plans.
*** Aggregates, without added mineral filler, or additives, combined as used in the job-mix formula.

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(2) Asphaltic Material.

(a) Paving Mixture. Asphalt for the paving mixture shall be of the type shown on the plans or designated by the Engineer and shall meet the

requirements of Item 300, "Asphalts, Oils and Emulsions". The Contractor shall notify the Engineer of the source of the asphaltic material prior to design of the asphaltic mixture. This source shall not be changed during the course of the project without the authorization of the Engineer. Should the source of asphaltic material be changed, the moisture resistance of the new material combination will be evaluated to verify that the requirements of Subarticle 334.3(1) are met.

(b) Primer. Asphalt primer shall be a blend of asphalt cement and hydrocarbon volatiles meeting with the approval of the Engineer.

(c) Tack Coat. Asphaltic materials, shown on the plans or approved by the Engineer, shall meet the requirements of Item 300, "Asphalts, Oils and Emulsions".

(3) Additives. Additives to facilitate mixing and/or improve the quality of the asphaltic mixture or tack coat shall be used when noted on the plans or may be used with the authorization of the Equipment.

Unless otherwise shown on the plans, the Contractor may choose to use either lime or a liquid antistripping agent to reduce the moisture susceptibility of the aggregate. The evaluation and addition of antistripping agents will be in accordance with Item 301, "Asphalt Antistripping Agents".

334.3. Paving Mixtures. The paving mixtures shall consist of a uniform mixture of aggregate, asphaltic material, and primer, additives and water if allowed or required. The materials may be mixed on the job or at a central mixing plant and shipped ready to use. Mixtures that do not remain workable a sufficient period of time to permit loading, unloading, hauling, placing, and compacting will not be acceptable.

An asphalt mixture design is a laboratory process which includes the determination of the quality of the asphaltic materials and the individual aggregates, the development of the job-mix formula, and the testing of the combined mixture.

The job-mix formula lists the quantity of each component to be used in the mix and the combined gradation of the aggregates used.

(1) Mixture Design. The Contractor shall furnish the Engineer with representative samples of the materials to be used in production. Using these materials, the mix shall be designed by the Engineer in accordance with Test Method Tex-204-F to conform with the requirements herein. The amount of primer and water, if allowed or required, will be selected by the Engineer to meet

the other mix requirements. The Engineer may accept a design from the Contractor which was derived using these design procedures.

The second and subsequent mixture designs, or partial designs, for each type of paving mixture which are necessitated by changes in the material or at the request of the Contractor will be charged to the Contractor when a rate is shown on the plans.

The bulk specific gravity will be determined for each aggregate to be used in the design mixture. If the determined values vary by 0.300 or more, the Volumetric Method, Test Method Tex-204-F, Part II, will be used.

When properly proportioned for the type specified, the blend of aggregates shall produce an aggregate gradation which will conform to the limits of the master grading shown in Table 2. Unless otherwise shown on the plans, the gradation of the aggregate will be determined in accordance with Test Method Tex-200-F, Part I (Dry Sieve Analysis), to develop the job-mix formula.

The master grading limits for the appropriate type and the proposed job-mix formula will be plotted on a gradation chart with sieve sizes raised to the 0.45 power. This plot must show that the proposed job-mix formula is within the limits of the master grading. Gaps in gradation shown by this plot should be avoided.

The voids in the mineral aggregate (VMA) will be determined as a mixture design requirement only, in accordance with Test Method Tex-207-F, and shall not be less than the value indicated in Table 2.

Unless otherwise shown on the plans, the mixture of aggregate, asphaltic material and additives proposed for use will be evaluated in the design stage for moisture susceptibility, in accordance with Item 301, "Asphalt Antistripping Agents". The Engineer may waive this test if a similar design, using the same ingredients, has proven satisfactory.

To substantiate the design, trial mixtures shall be produced and tested using all of the proposed project materials and equipment prior to any placement. The Engineer may waive trial mixtures if similar designs have proven satisfactory.

(2) Density. The mixture shall be designed to produce an acceptable mixture at an optimum density of 95.0 percent, when tested in accordance with Test Method Tex-207-F and Test Method Tex-227-F. The operating range for control of laboratory density during production shall be optimum density plus or minus 1.5 percent.

Laboratory density is a mixture design and process control parameter. If the laboratory density of the mixture produced has a value outside the range specified above, the Contractor shall investigate the cause and take corrective action. If three (3) consecutive test results fall outside the specified range, production shall cease unless test results or other information indicate, to the satisfaction of the Engineer, that the next mixture to be produced will be within the specified range.

(3) Stability. The materials used in the mixture design shall produce a mixture with a stability value of at least 35, unless otherwise shown on the plans, when tested in accordance with Test Method
Tex-208-F.

If, during production, the stability value falls below the specified minimum, the Engineer and the Contractor shall closely evaluate other test result values for specification compliance such as gradation, asphalt content, moisture content, crushed faces, etc., to determine the cause and take corrective action. If three (3) consecutive test results fall below the minimum value specified, production shall cease unless test results or other information indicate, to the satisfaction of the Engineer, that the next material to be produced will meet the minimum value specified.

(4) Job-Mix Formula Field Adjustments. The Contractor shall produce a mixture of uniform composition closely conforming to the approved job-mix formula.

If, during initial days of production, it is determined that adjustments to the mixture design job-mix formula are necessary to achieve the specified requirements, or to more nearly match the aggregate production, the Engineer may allow adjustment of the mixture design job-mix formula within the following limits without a laboratory redesign of the mixture.

The adjusted job-mix formula shall not exceed the limits of the master grading for the type of mixture specified nor shall the adjustments exceed five (5) percent on any one sieve, 12.5 millimeter size and larger, or three (3) percent on the sieve sizes below the 12.5 millimeter sieve.

When the considered adjustments exceed either the five (5) or three (3) percent limits, and the Engineer determines that the impact of these changes may adversely affect pavement performance, a new laboratory mixture design will be required.

The asphalt content will be adjusted as deemed necessary by the Engineer to maintain desirable laboratory density near the optimum value while achieving other mix requirements.

(5) Types. The aggregate gradation of the job-mix formula shall conform to the master grading limits shown in Table 2 for the type mix specified on the plans.

TABLE 2
Master Grading
Percent Passing by Mass or Volume

Sieve Size	Type				
	A Coarse Base	B Fine Base	C Coarse Surface	D Fine Surface	F Fine Mixture
37.5 mm	100				
31.5 mm	95-100				
25.0 mm		100			
22.4 mm	70-90	95-100	100		
16.0 mm		75-95	95-100		
12.5 mm	50-70			100	
9.5 mm		60-80	70-85	85-100	100
6.3 mm					95-100
4.75 mm	30-50	40-60	43-63	50-70	
2.00 mm	20-34	27-40	30-40	32-42	32-42
425 µm	5-20	10-25	10-25	11-26	9-24
180 µm	2-12	3-13	3-13	4-14	3-13
75 µm	1-6*	1-6*	1-6*	1-6*	1-6*
VMA % minimum	11	12	13	14	15

* 2 - 8 when Test Method Tex-200-F, Part II (Washed Sieve Analysis) is used.

(6) Asphalt Primer. When approved by the Engineer, the use of an asphalt primer will be permitted. In the event an asphalt primer is used, the hydrocarbon volatile content of the asphaltic concrete, as determined by Test Method Tex-213-F, shall not exceed 0.6 percent of the mixture by mass. The asphalt content of the primer shall be included in the total asphalt content of the paving mixture.

When used, the primer shall be added as directed by the Engineer during mixing.

(7) Water. When approved by the Engineer, water in an amount not to exceed 4.0 percent by mass of the mixture, as determined by Test Method Tex-212-F, may be used in preparing the mixture. In the event water is used in the mixing operation, adequate measuring devices as approved by the Engineer shall be used.

When used, the water shall be added as directed by the Engineer during the mixing.

(8) Tolerances. The gradation of the aggregate and the asphalt cement content of the produced mixture shall not vary from the job-mix formula by more than the tolerances allowed herein. When within applied tolerances, the gradation of the produced mixture may fall outside the master grading limits for any of the sieve sizes from the largest sieve size on which aggregate may be retained down through the 180 micrometer sieve. Only the quantity of aggregate passing the 75 micrometer sieve is further restricted to conform to the master grading limitations shown in Table 2 or as modified in Test Method Tex-229-F. A tolerance of two (2) percent is allowed on the sieve size for each mixture type which shows 100 percent passing in Table 2.

	Tolerance, Percent by Mass or Volume as Applicable
Passing the 31.5 mm to 2.00 mm sieve	Plus or Minus 5
Passing the 425 µm to 75 µm sieve	Plus or Minus 3
Asphalt, mass	Plus or Minus 0.5
Asphalt, volume	Plus or Minus 1.2

The mixture will be tested in accordance with Test Method Tex-210-F, or Test Method Tex-228-F will be used in conjunction with combined cold feed belt samples tested in accordance with Test Method Tex-229-F. Other methods of proven accuracy may be used. The methods of test will be determined by the Engineer. However, mixtures produced by weigh-batch plants will be tested for gradation in accordance with Test Method Tex-210-F. If three (3) consecutive tests indicate that the material produced exceeds the above tolerances on any individual sieve, or if two (2) consecutive tests indicate that the asphalt content tolerance is exceeded, production shall stop and not resume until test results or other information indicate, to the satisfaction of the Engineer, that the next mixture to be produced will be within the above tolerances.

When disagreements concerning determination of specification compliance occur between allowed sampling and testing procedures, extracted aggregate testing shall take precedence over cold feed belt testing.

When cold feed belt samples are used for job control, the Engineer will select the sieve analysis method that corresponds with the one used to determine the mixture design gradation. The tolerances will be adjusted as outlined in Test Method Tex-229-F.

334.4. Equipment.

(1) General. All equipment for the handling of all materials, mixing, placing and compacting of the mixture shall be maintained in good repair and operating condition and subject to the approval of the Engineer. Any equipment found to be defective and potentially having a negative effect on the quality of the paving mixture or ride quality will not be allowed.

(2) Mixing Plants. Mixing plants may be the weigh-batch type, the modified weigh-batch type or the drum-mix type. All plants shall be equipped with satisfactory conveyors, power units, mixing equipment, aggregate handling equipment, bins and dust collectors.

Automatic proportioning devices are required for all plants and shall be in accordance with Item 520, "Weighing and Measuring Equipment".

It shall be the Contractor's responsibility to provide safe and accurate means to enable inspection forces to take all required samples, to provide permanent means for checking the output of any specified metering device, and to perform calibration and mass checks as required by the

Engineer. When cold feed belt sampling is to be used for gradation testing, occasional stoppage of the belt may be necessary unless other means of sampling are approved by the Engineer.

When using fuel oil heavier than Grade No. 2, or waste oil, the Contractor shall insure that the fuel delivered to the burner is at a viscosity of 100 SSU or less, when tested in accordance with Test Method Tex-534-C, to insure complete burning of the fuel. Higher viscosities will be allowed if recommended by the burner manufacturer. If necessary, the Contractor shall preheat the oil to maintain the required viscosity.

The Contractor shall provide means for obtaining a sample of the fuel, just prior to entry into the burner, in order to perform the viscosity test. The Contractor shall perform this test or provide a laboratory test report that will establish the temperature of the fuel necessary to meet the viscosity requirements. There shall be an in-line thermometer to check the temperature of the fuel delivered to the burner.

Regardless of the burner fuel used, the burner or combination of burners and types of fuel used shall provide a complete burn of the fuel and not leave any fuel residue that will adhere to the heated aggregate or become mixed with the asphalt.

(a) Weigh-Batch Type.

Cold Aggregate Bin Unit and Proportioning Device. The cold aggregate bin unit shall have at least four bins of sufficient size to store the amount of aggregate required to keep the plant in continuous operation and of proper design to prevent overflow of material from one bin to another. There shall be vertical partitions between each bin and on each end of the bins of sufficient height so that any overflow will be to the front and back, and not allow overflow to the sides or between bins. Overflow that might occur shall not fall onto any feeder belt. The proportioning device shall provide a uniform and continuous flow of aggregate in the desired proportion to the dryer. Each aggregate shall be proportioned from a separate bin.

When mineral filler is used, as specified in Section 334.2.(1)(c), an additional bin shall be provided.

Dryer. The dryer shall continually agitate the aggregate during heating. The temperature shall be controlled so that the aggregate will not be damaged in the drying and heating operations. The dryer shall be of sufficient size to keep the plant in continuous operation.

Screening and Proportioning. The screening capacity and size of the hot aggregate bins shall be sufficient to screen and store the amount of aggregate required to properly operate the plant and keep the plant in continuous operation at full capacity. The hot bins shall be constructed so that oversize and overloaded material will be discarded through overflow chutes. Provisions shall be made to enable inspection forces to have easy and safe access to the proper location on the mixing plant where representative samples may be taken from the hot bins for testing. The aggregate shall be separated into at least four bins when producing Type "A", Type "B" or Type "C" mixtures, at least three bins when producing Type "D" mixture and at least two bins when producing Type "F" mixture. These bins shall contain the following sizes of aggregates, in percentages by mass or by volume, as applicable.

Type "A" (Coarse-Graded Base Course):

Bin No. 1 - Shall contain aggregates of which 85 to 100 percent will pass the 2.00 mm sieve.

Bin No. 2 - Shall contain aggregates of which at least 85 percent will be of such size as to pass the 12.5 mm sieve and be retained on the 2.00 mm sieve.

Bin No. 3 - Shall contain aggregates of which at least 85 percent will be of such size as to pass the 22.4 mm sieve and be retained on the 9.5 mm sieve.

Bin No. 4 - Shall contain aggregates of which at least 85 percent will be of such size as to pass the 37.5 mm sieve and be retained on the 22.4 mm sieve.

Type "B" (Fine-Graded Base Course):

Bin No. 1 - Shall contain aggregates of which 85 to 100 percent will pass the 2.00 mm sieve.

Bin No. 2 - Shall contain aggregates of which at least 70 percent will be of such size as to pass the 4.75 mm sieve and be retained on the 2.00 mm sieve.

Bin No. 3 - Shall contain aggregates of which at least 75 percent will be of such size as to pass the 9.5 mm sieve and be retained on the 4.75 mm sieve.

Bin No. 4 - Shall contain aggregates of which at least 75 percent will be of such size as to pass the 25.0 mm sieve and be retained on the 9.5 mm sieve.

Type "C" (Coarse-Graded Surface Course):

Bin No. 1 - Shall contain aggregates of which 85 to 100 percent will pass the 2.00 mm sieve.

Bin No. 2 - Shall contain aggregates of which at least 70 percent will be of such size as to pass the 4.75 mm sieve and be retained on the 2.00 mm sieve.

Bin No. 3 - Shall contain aggregates of which at least 75 percent will be of such size as to pass the 9.5 mm sieve and be retained on the 4.75 mm sieve.

Bin No. 4 - Shall contain aggregates of which at least 75 percent will be of such size as to pass the 22.4 mm sieve and be retained on the 9.5 mm sieve.

Type "D" (Fine-Graded Surface Course):

Bin No. 1 - Shall contain aggregates of which 85 to 100 percent will pass the 2.00 mm sieve.

Bin No. 2 - Shall contain aggregates of which at least 70 percent will be of such size as to pass the 4.75 mm sieve and be retained on the 2.00 mm sieve.

Bin No. 3 - Shall contain aggregates of which at least 75 percent will be of such size as to pass the 12.5 mm sieve and be retained on the 4.75 mm sieve.

Type "F" (Fine-Graded Mixture):

Bin No. 1 - Shall contain aggregates of which 85 to 100 percent will pass the 2.00 mm sieve.

Bin No. 2 - Shall contain aggregates of which at least 75 percent will be of such size as to pass the 9.5 mm sieve and be retained on the 2.00 mm sieve.

Aggregate Weigh Box and Batching Scale. The aggregate weigh box and batching scales shall be of sufficient capacity to hold and weigh a complete batch of aggregate. The weigh box and scales shall conform to the requirements of Item 520, "Weighing and Measuring Equipment".

Asphaltic Material Measuring System. If an asphaltic material bucket and scales are used, they shall be of sufficient capacity to hold and weigh the necessary asphaltic material for one batch. The bucket and scales shall conform to the requirements of Item 520, "Weighing and Measuring Equipment".

If a pressure type flow meter is used to measure the asphaltic material, the requirements of Item 520, "Weighing and Measuring Equipment", shall apply. This system shall include an automatic temperature compensation device to insure a constant percent by mass of asphaltic material in the mixture.

Provisions of a permanent nature shall be made for checking the accuracy of the asphaltic material measuring device. The asphalt line to the measuring device shall be protected with a jacket of hot oil or other approved means to maintain the temperature of the line near the temperature specified for the asphaltic material.

Mixer. The mixer shall be of the pugmill type and shall have a capacity of not less than 1350 kilograms (of natural-aggregate mixture) in a single batch, unless otherwise shown on the plans. Any mixer that has a tendency to segregate the aggregate or fails to secure a thorough and uniform mixture with the asphaltic material shall not be used. All mixers shall be provided with an automatic timer that will lock the discharge doors of the mixer for the required mixing period. The dump door or doors and the shaft seals of the mixer shall be tight enough to prevent spilling of aggregate or mixture from the pugmill. Provisions shall be made for introducing primer and water into the mixer when required or approved by

the Engineer. The method and equipment shall meet with the approval of the Engineer.

Surge-Storage System and Scales. A surge-storage system may be used to minimize the production interruptions during the normal day's operations. A device such as a gob hopper or other device approved by the Engineer to prevent segregation in the surge-storage bin shall be used. The mixture shall be weighed at a point designated by the Engineer.

When a surge-storage system is used, scales shall be standard platform truck scales or other equipment such as weigh hopper (suspended) scales and shall conform to Item 520, "Weighing and Measuring Equipment". If truck scales are used, they shall be placed at a location approved by the Engineer. If other weighing equipment is used, the Engineer may require mass checks by truck scales for the basis of approval of the equipment.

Recording Device and Record Printer. The mixture shall be weighed for payment. If a surge-storage system is used, an automatic recording device and a digital record printer shall be provided to indicate the date, project identification number, vehicle identification, total mass of the load, tare mass of the vehicle, the mass of asphaltic mixture in each load and the number of loads for the day, unless otherwise indicated on the plans or designated by the Engineer. When surge-storage is not used, batch mass will be used as the basis for payment and automatic recording devices and automatic digital record printers in accordance with Item 520, "Weighing and Measuring Equipment", shall be required.

(b) Modified Weigh-Batch Type.

General. This plant is similar to the weigh-batch type plant. The hot bin screens shall be removed and the aggregate control is placed at the cold feeds. The cold feed bins shall be the same as those required for the drum-mix type plant.

Cold-Aggregate Bin Unit and Feed System. The number of bins in the cold-aggregate bin unit shall be equal to or greater than the number of stockpiles of individual materials to be used.

The bins shall be of sufficient size to store the amount of aggregate required to keep the plant in continuous operation and of proper design to prevent overflow of material from one bin to another. There shall be vertical partitions between each bin and on each end of the bins of sufficient

height so that any overflow will be to the front and back and not allow overflow to the sides or between bins. Overflow that might occur shall not fall onto any feeder belt. When required by the Engineer, an approved stationary scalping screen shall be placed on top of the field sand bin to eliminate roots and other objectionable material. The feed system shall provide a uniform and continuous flow of aggregate in the desired proportion to the dryer. The Contractor shall furnish a chart indicating the calibration of each cold bin in accordance with the manufacturer's recommendations or in a method acceptable to the Engineer.

When mineral filler is used, as specified in Section 334.2.(1)(c), an additional bin shall be provided.

Scalping Screen. A scalping screen shall be required after the cold feeds and ahead of the hot aggregate surge bins.

Dryer. The dryer shall continually agitate the aggregate during heating. The temperature shall be controlled so that the aggregate will not be damaged in the drying and heating operations. The dryer shall be of sufficient size to keep the plant in continuous operation.

Screening and Proportioning. The hot aggregate shall not be separated into sizes after being dried. There shall be one or more surge bins provided between the dryer and the weigh hopper. Surge bins shall be of sufficient size to hold enough combined aggregate for one complete batch of mixture.

Aggregate Weigh Box and Batching Scale. The aggregate weigh box and batching scales shall be of sufficient capacity to hold and weigh a complete batch of aggregate. The weigh box and scales shall conform to the requirements of Item 520, "Weighing and Measuring Equipment".

Asphaltic Material Measuring System. If an asphaltic material bucket and scales are used, they shall be of sufficient capacity to hold and weigh the necessary asphaltic material for one batch. The bucket and scales shall conform to the requirements of Item 520, "Weighing and Measuring Equipment".

If a pressure type flow meter is used to measure the asphaltic material, the requirements of Item 520, "Weighing and Measuring Equipment", shall apply. This system shall include an automatic temperature compensation device to insure a constant percent by mass of asphaltic material in the mixture.

Provisions of a permanent nature shall be made for checking the accuracy of the asphaltic material measuring device. The asphalt line to the measuring device shall be protected with a jacket of hot oil or other approved means to maintain the temperature of the line near the temperature specified for

the asphaltic material.

Provisions shall be made to measure and distribute uniformly any required primer and water approved by the Engineer. The method and equipment shall meet with the approval of the Engineer.

Mixer. The mixer shall be of the pugmill type and shall have a capacity of not less than 1350 kilograms (of natural-aggregate mixture) in a single batch, unless otherwise shown on the plans. Any mixer that has a tendency to segregate the aggregate or fails to secure a thorough and uniform mixture with the asphaltic material shall not be used. All mixers shall be provided with an automatic timer that will lock the discharge doors of the mixer for the required mixing period. The dump door or doors and the shaft seals of the mixer shall be tight enough to prevent spilling of aggregate or mixture from the pugmill. Provisions shall be made for introducing primer and water into the mixer when these materials are
required or approved by the Engineer. The method and equipment shall meet with the approval of the Engineer.

Surge-Storage System and Scales. A surge-storage system may be used to minimize the production interruptions during the normal day's operations. A device such as a gob hopper or other device approved by the Engineer to prevent segregation in the surge-storage bin shall be used. The mixture shall be weighed at a point designated by the Engineer.

When a surge-storage system is used, scales shall be standard platform truck scales or other equipment such as weigh hopper (suspended) scales and shall conform to Item 520, "Weighing and Measuring Equipment". If truck scales are used, they shall be placed at a location approved by the Engineer. If other weighing equipment is used, the Engineer may require mass checks by truck scales for the basis of approval of the equipment.

Recording Device and Record Printer. The mixture shall be weighed for payment. If a surge-storage system is used, an automatic recording device and a digital record printer shall be provided to indicate the date, project identification number, vehicle identification, total mass of the load, tare mass of the vehicle, the mass of asphaltic mixture in each load and the number of loads for the day, unless otherwise indicated on the 334.4

plans or designated by the Engineer. When surge-storage is not used, batch mass will be used as the basis for payment and automatic recording devices and automatic digital record printers in accordance with Item 520, "Weighing and Measuring Equipment", shall be required.

(c) Drum-Mix Type.

General. The plant shall be adequately designed and constructed for the process of mixing aggregates and asphalt. The plant shall be equipped with satisfactory conveyors, power units, aggregate-handling equipment and feed controls.

Cold-Aggregate Bin Unit and Feed System. The number of bins in the cold-aggregate bin unit shall be equal to or greater than the number of stockpiles of individual materials to be used.

The bins shall be of sufficient size to store the amount of aggregate required to keep the plant in continuous operation and of proper design to prevent overflow of material from one bin to another. There shall be vertical partitions between each bin and on each end of the bins of sufficient height so that any overflow will be to the front and back and not allow overflow to the sides or between bins. Overflow that might occur shall not fall onto any feeder belt. When required by the Engineer, an approved stationary scalping screen shall be placed on top of the field sand bin to eliminate roots and other objectionable material. The feed system shall provide a uniform and continuous flow of aggregate in the desired proportion to the mixer. The Contractor shall furnish a chart indicating the calibration of each cold bin in accordance with the manufacturer's recommendations or in a method acceptable to the Engineer.

The system shall provide positive mass measurement of the combined cold-aggregate feed by use of belt scales or other approved devices. Provisions of a permanent nature shall be made for checking the accuracy of the measuring device as required by Item 520, "Weighing and Measuring Equipment". When a belt scale is used, mixture production shall be maintained so that the scale normally operates between 50 percent and 100 percent of its rated capacity. Belt scale operation below 50 percent of the rated capacity may be allowed by the Engineer if accuracy checks show the scale to meet the requirements of Item 520, "Weighing and Measuring Equipment", at the selected rate. It shall be satisfactorily demonstrated to the Engineer that mixture uniformity and quality have not been adversely affected.

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Scalping Screen. A scalping screen shall be required after the cold feeds and ahead of the combined aggregate belt scales.

Asphaltic Material Measuring System. An asphaltic material measuring device meeting the requirements of Item 520, "Weighing and Measuring Equipment", shall be placed in the asphalt line leading to the mixer so that the cumulative amount of asphalt used can be accurately determined. Provisions of a permanent nature shall be made for checking the accuracy of the measuring device output. The asphalt line to the measuring device shall be protected with a jacket of hot oil or other approved means to maintain the temperature of the

line near the temperature specified for the asphaltic material. The measuring system shall include an automatic temperature compensation device to maintain a constant percent by mass of asphaltic material in the mixture.

Provisions shall be made to measure and distribute uniformly any required primer and water approved by the Engineer. The method and equipment shall meet with the approval of the Engineer.

Synchronization Equipment for Feed-Control Systems. The asphaltic material, primer and water feed-controls shall be coupled with the total aggregate mass measuring device to automatically vary these feed rates in order to maintain the required proportion.

Mixing System. The mixing system shall control the temperature so that the aggregate and asphalt will not be damaged in the drying, heating and mixing operations. A continuously recording thermometer shall be provided which will indicate the temperature of the mixture as it leaves the mixer.

Surge-Storage System and Scales. A surge-storage system shall be used to minimize the production interruptions during the normal day's operations. A device such as a gob hopper or other device approved by the Engineer to prevent segregation in the surge-storage bin shall be used. The mixture shall be weighed at a point designated by the Engineer.

Scales shall be standard platform truck scales or other equipment such as weigh hopper (suspended) scales and shall conform to Item 520, "Weighing and Measuring Equipment". If truck scales are used, they shall be placed at a location approved by the Engineer. If other weighing equipment is used, the Engineer may require mass checks by truck scales for the basis of approval of the equipment.

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Recording Device and Record Printer. Automatic recording devices and automatic digital record printers shall be provided to indicate the date, project identification number, vehicle identification, total mass of the load, tare mass of the vehicle, the mass of asphaltic mixture in each load and the number of loads for the day in accordance with Item 520, "Weighing and Measuring Equipment", unless otherwise shown on the plans, or designated by the Engineer.

(3) Asphaltic Material Heating Equipment. Asphaltic material heating equipment shall be adequate to heat the required amount of asphaltic material to the desired temperature. The heating apparatus shall be equipped with a continuously recording thermometer with a 24-hour chart that will record the temperature of the asphaltic material at the location of highest temperature.

(4) Spreading and Finishing Machine. The spreading and finishing machine shall be approved by the Engineer and shall meet the requirements indicated below.

(a) Screed Unit. The spreading and finishing machine shall be equipped with a compacting screed. It shall produce a finished surface meeting the requirements of the typical cross sections and the surface tests.

Extensions added to the screed shall be provided with the same compacting action as the main screed unit, except for use on variable depth tapered areas and/or as approved by the Engineer.

The spreading and finishing machine shall be equipped with an approved automatic dual longitudinal screed control system and automatic transverse screed control system. The longitudinal controls shall be capable of operating from any longitudinal grade reference including a stringline, ski, mobile stringline, or matching shoe.

The Contractor shall furnish all equipment required for grade reference. It shall be maintained in good operating condition by personnel trained in the use of this type of equipment.

The grade reference used by the Contractor may be of any type approved by the Engineer. Control points, if required by the plans, shall be established for the finished profile in accordance with Item 5, "Control of the Work". These points shall be set at intervals not to exceed 15 meters. The Contractor shall set the grade reference from the control

points. The grade reference shall have sufficient support so that the maximum deflection shall not exceed two (2) millimeters between supports.

(b) Tractor Unit. The tractor unit shall be equipped with a hydraulic hitch sufficient in design and capacity to maintain contact between the rear wheels of the hauling equipment and the pusher rollers of the finishing machine while the mixture is being unloaded.

No portion of the mass of hauling equipment, other than the connection, shall be supported by the asphalt paver. No vibrations or other motions of the loading equipment, which could have a detrimental effect on the riding quality of the completed pavement, shall be transmitted to the paver.

The use of any vehicle which requires dumping directly into the finishing machine and which the finishing machine cannot push or propel to obtain the desired lines and grades without resorting to hand finishing will not be allowed.

(5) Material Transfer Equipment. Equipment to transfer mixture from the hauling units or the roadbed to the spreading and finishing machine will be allowed unless otherwise shown on the plans. A specific type of material transfer equipment shall be required when shown on the plans.

(a) Windrow Pick-Up Equipment. Windrow pick-up equipment shall be constructed in such a manner that substantially all the mixture deposited on the roadbed is picked up and loaded into the spreading and finishing machine. The mixture shall not be contaminated with foreign material. The loading equipment shall be designed so that it does not interfere with the spreading and finishing machine in obtaining the required line, grade and surface without resorting to hand finishing.

(b) Material Feeding System. Material feeding systems shall be designed to provide a continuous flow of uniform mixture to the spreading and finishing machine. When use of a material feeding system is required on the plans, it shall meet the storage capacity, remixing capability, or other requirements shown on the plans.

(6) Motor Grader. The motor grader, when used, shall be a self-propelled power motor grader and shall be equipped with smooth tread pneumatic tired wheels unless otherwise directed. It shall have a blade length of not less than 3.6 meters and a wheelbase of not less than 4.8 meters.
334.4

(7) Rollers. Rollers provided shall meet the requirements for their

type as follows:

(a) Pneumatic-Tire Roller. The roller shall be an acceptable medium pneumatic tire roller conforming to the requirements of Item 213, "Rolling (Pneumatic Tire)", Type B, unless otherwise specified on the plans. Pneumatic-tire rollers used for compaction shall provide a ground contact pressure acceptable to the Engineer.

(b) Two-Axle Tandem Roller. This roller shall be an acceptable self-propelled tandem roller weighing not less than 7.2 megagrams.

(c) Three-Wheel Roller. This roller shall be an acceptable self-propelled three wheel roller weighing not less than 9.1 megagrams.

(d) Three-Axle Tandem Roller. This roller shall be an acceptable self-propelled three axle roller weighing not less than 9.1 megagrams.

(e) Trench Roller. This roller shall be an acceptable self-propelled trench roller equipped with a sprinkler for keeping the wheels wet and an adjustable road wheel so that the roller may be kept level during rolling. The drive wheel shall be not less than 500 millimeters wide. The roller under working conditions shall produce not less than 5803 kilograms per meter of roller width and be so geared that a speed of approximately three (3) kilometers per hour is obtained in low gear.

(f) Vibratory Steel-Wheel Roller. This roller shall have a minimum mass of 5.4 megagrams. The compactor shall be equipped with amplitude and frequency controls and shall be specifically designed to compact the material on which it is used.

(8) Straightedges and Templates. When directed by the Engineer, the Contractor shall provide acceptable three (3) meter straightedges for surface testing. Satisfactory templates shall be provided as required by the Engineer.

(9) Alternate Equipment. When permitted by the Engineer, equipment other than that specified herein which will consistently produce satisfactory results may be used.

334.5. Stockpiling, Storage and Mixing.

(1) Stockpiling of Aggregates.

(a) Weigh-Batch Plant. Prior to stockpiling of aggregates, the area shall be cleaned of trash, weeds, grass and shall be relatively smooth and well drained. The stockpiling shall be done in a manner that will minimize aggregate degradation, segregation, mixing of one stockpile with another, and will not allow contamination with foreign material.

The plant shall have at least a two-day supply of aggregates on hand before production can begin and at least a two-day supply shall be maintained through the course of the project, unless otherwise directed by the Engineer.

No stockpile shall contain aggregate from more than one source.

Coarse aggregates for mixture Types "A", "B" and "C" shall be separated into at least two stockpiles of different gradation, such as a large-coarse-aggregate and a small-coarse-aggregate stockpile.

When shown on the plans, coarse aggregates for Type "D" mixtures shall also be separated into at least two stockpiles.

No coarse-aggregate stockpile shall contain more than 15 percent by mass of material that will pass a 2.00 millimeter sieve.

Fine-aggregate stockpiles may contain coarse aggregate in amounts up to 20 percent by mass. This requirement does not apply to stone screenings stockpiles, which must meet the gradation requirements shown in Section 334.2.(1)(b), unless otherwise shown on the plans.

When required by the Engineer, additional material shall not be added to stockpiles that have previously been sampled for approval.

Equipment of an acceptable size and type shall be furnished to work the stockpiles and prevent segregation and degradation of the aggregates.

(b) Modified Weigh-Batch Plant. The stockpiling requirements for aggregate shall be the same as required for a drum-mix type plant.

(c) Drum-Mix Plant. When a drum-mix plant is used, the following stockpiling requirements for coarse aggregates shall apply in 334.5

addition to the aggregate stockpiling requirements listed under Section 334.5.(1)(a).

Once a job-mix formula has been established in accordance with Article 334.3, the coarse aggregates delivered to the stockpiles shall not vary on any grading size fraction by more than plus or minus 8 percentage points from the percentage found in the samples submitted by the Contractor and upon which the job-mix formula was based. Should the gradation of coarse aggregates in the stockpiles vary by more than the allowed tolerance, the Engineer may stop production. If production is stopped, new aggregates shall be furnished that meet the gradations of the aggregates submitted for the job-mix formula, or a new mix design shall be formulated in accordance with Article 334.3.

When the volume of production from a commercial plant makes sampling of all coarse aggregate delivered to the stockpiles impractical, cold feeds will be sampled to determine stockpile uniformity. Should this sampling prove the stockpiles non-uniform beyond the acceptable tolerance, separate stockpiles which meet these specifications may be required.

(2) Storage and Heating of Asphaltic Materials. The asphaltic material storage capacity shall be ample to meet the requirements of the plant. Asphalt shall not be heated to a temperature in excess of that specified in Item 300, "Asphalts, Oils and Emulsions". All equipment used in the storage and handling of asphaltic material shall be kept in a clean condition at all times and shall be operated in such a manner that there will be no contamination with foreign matter.

(3) Feeding and Drying of Aggregate. The feeding of various sizes of aggregate to the dryer shall be done through the cold aggregate bins and the proportioning device in such a manner that a uniform and constant flow of materials in the required proportions will be maintained. The aggregate shall be dried and heated to the temperature necessary to produce a mixture having the specified temperature.

(4) Mixing and Storage.

(a) Weigh-Batch Plant. In introducing the batch into the mixer, all aggregate shall be introduced first and shall be mixed thoroughly for a minimum period of 5 seconds to uniformly distribute the various sizes throughout the batch before the asphaltic material is added. The asphaltic material shall then be added and the mixing continued for a wet mixing period of not less than 15 seconds. The mixing period shall be increased

if, in the opinion of the Engineer, the mixture is not uniform or the aggregates are not properly coated.

The asphaltic mixture may be stored either in a surge-storage system or in a stockpile. If the asphaltic mixture is stored in a stockpile, the area shall be cleaned of trash, weeds and grass and be relatively smooth and well drained. The stockpiling shall be done in a manner that will minimize degradation, segregation and not allow contamination with foreign material. Equipment of an acceptable size and type shall be furnished to work the stockpiles and shall not segregate or degrade the asphaltic mixture.

(b) Modified Weigh-Batch Plant. The mixing and storage requirements shall be the same as is required for a standard weigh-batch plant.

(c) Drum-Mix Plant. The amount of aggregate and asphaltic material entering the mixer and the rate of travel through the mixing unit shall be so coordinated that a uniform mixture of the specified grading and asphalt content will be produced.

The asphaltic mixture may be stored either in a surge-storage system or in a stockpile. If the asphaltic mixture is stored in a stockpile, the area shall be cleaned of trash, weeds and grass and be relatively smooth and well drained. The stockpiling shall be done in a manner that will minimize degradation, segregation and not allow contamination with foreign material. Equipment of an acceptable size and type shall be furnished to work the stockpiles and shall not segregate or degrade the asphaltic mixture.

(d) Discharge Temperature. The Engineer will select the target discharge temperature of the mixture between 65 °C and 135 °C. The mixture, when discharged from the mixer, shall not vary from this selected temperature more than 15 °C.

(e) Moisture Content. The mixture produced from each type of mixer shall have a moisture content not greater than one (1) percent by mass when discharged from the mixer, unless otherwise shown on the plans and/or approved by the Engineer. The moisture content shall be determined in accordance with Test Method Tex-212-F.

334.6. Construction Methods.

(1) General. It shall be the responsibility of the Contractor to produce, transport, place and compact the specified paving mixture in accordance with the requirements herein.

The asphaltic mixture and the tack coat shall not be placed when the air temperature is below 15 °C and is falling, but it may be placed when the air temperature is above 10 °C and is rising.

The air temperature shall be taken in the shade away from artificial heat. It is further provided that the tack coat or asphaltic mixture shall be placed only when the humidity, general weather conditions and temperature and moisture condition of the base, in the opinion of the Engineer, are suitable.

(2) Tack Coat. The surface upon which the tack coat is to be placed shall be cleaned thoroughly to the satisfaction of the Engineer. The surface shall be given a uniform application of tack coat using asphaltic materials of this specification. This tack coat shall be applied, as directed by the Engineer, with an approved sprayer at a rate not to exceed 0.2 liter residual asphalt per square meter of surface. Where the mixture will adhere to the surface on which it is to be placed without the use of a tack coat, the tack coat may be eliminated by the Engineer. All contact surfaces of curbs and structures and all joints shall be painted with a thin uniform application of tack coat. During the application of tack coat, care shall be taken to prevent splattering of adjacent pavement, curb and gutter and structures. The tack coat shall be rolled with a pneumatic tire roller when directed by the Engineer.

(3) Transporting Asphaltic Concrete. The asphaltic mixture shall be hauled to the work site in tight vehicles previously cleaned of all foreign material.

(4) Placing.

(a) The asphaltic mixture shall be dumped and spread on the approved prepared surface with the spreading and finishing machine. When properly compacted, the finished pavement shall be smooth, of uniform texture and density and shall meet the requirements of the typical cross sections and the surface tests. In addition, the placing of the asphaltic mixture shall be done without tearing, shoving, gouging or segregating the mixture and without producing streaks in the mat.

Unloading into the finishing machine shall be controlled so that bouncing or jarring the spreading and finishing machine shall not occur and the required lines and grades shall be obtained without resorting to hand finishing, except as shown under Section 334.6.(4)(d).

Unless otherwise shown on the plans, dumping of the asphaltic mixture in a windrow and then placing the mixture in the finishing machine with windrow pick-up equipment will be permitted. The windrow pick-up equipment shall be operated in such a manner that substantially all the mixture deposited on the roadbed is picked up and loaded into the finishing machine without contamination by foreign material. The windrow pick-up equipment will be so operated that the finishing machine will obtain the required line, grade and surface without resorting to hand finishing. Any operation of the windrow pick-up equipment resulting in the accumulation and subsequent shedding of accumulated material into the asphaltic mixture will not be permitted.

In placing the material with a spreading and finishing machine, rolling shall be deferred for a period of time, as directed by the Engineer, to allow for volatilization.

Where more than one course of pavement is to be placed, no succeeding course shall be placed until the preceding course has been in place for a sufficient period of time to allow the preceding course to dry and cure. The drying and curing period shall be not less than 45 days unless authorized by the Engineer.

(b) Alternate Method of Placing. When shown on the plans or allowed by the Engineer, the mixture may be spread with a motor grader. The mixture shall be thoroughly aerated and then spread into place with a power motor grader in a uniform layer of such depth that after compaction is complete, the requirements of the typical cross section will have been fulfilled. Hand spreading will be permitted where the mixture is placed on narrow strips or small irregular areas.

Where more than one course of pavement is to be placed, no succeeding course shall be placed until the preceding course has been in place for a sufficient period of time to allow the preceding course to dry and cure. The drying and curing period shall be not less than 45 days unless authorized by the Engineer.

(c) The spreading and finishing machine shall be operated at a uniform forward speed consistent with the plant production rate, hauling **334.6**

capability, and roller train capacity to result in a continuous operation. The speed shall be slow enough that stopping between trucks is not ordinarily required. If, in the opinion of the Engineer, sporadic delivery of material is

adversely affecting the mat, the Engineer may require paving operations to cease until acceptable methods are provided to minimize starting and stopping of the paver.

The hopper flow gates of the spreading and finishing machine shall be adjusted to provide an adequate and consistent flow of material. These shall result in enough material being delivered to the augers so that they are operating approximately 85 percent of the time or more. The augers shall provide means to supply adequate flow of material to the center of the paver. Augers shall supply an adequate flow of material for the full width of the mat, as approved by the Engineer. Augers should be kept approximately one-half to three-quarters full of mixture at all times during the paving operation.

(d) When the asphaltic mixture is placed in a narrow strip along the edge of an existing pavement, or used to level up small areas of an existing pavement, or placed in small irregular areas where the use of a finishing machine is not practical, the finishing machine may be eliminated when authorized by the Engineer.

(e) Adjacent to flush curbs, gutters and structures, the surface shall be finished uniformly high so that when compacted it will be slightly above the edge of the curb or structure.

(f) Construction joints of successive courses of asphaltic material shall be offset at least 150 millimeters. Construction joints on surface courses shall coincide with lane lines, or as directed by the Engineer.

(g) If a pattern of surface irregularities or segregation is detected, the Contractor shall make an investigation into the causes and immediately take the necessary corrective action. With the approval of the Engineer, placement may continue for no more than one full production day from the time the Contractor is first notified and while corrective actions are being taken. If the problem still exists after that time, paving shall cease until the Contractor further investigates the causes and the Engineer approves further corrective action to be taken.

(5) Compacting.

(a) The pavement shall be compacted thoroughly and uniformly with the necessary rollers to obtain the compaction and cross section of the finished paving mixture meeting the requirements of the plans and specifications.

(b) When rolling with the three-wheel, tandem or vibratory rollers, rolling shall start by first rolling the joint with the adjacent pavement and then continue by rolling longitudinally at the sides and proceed toward the center of the pavement, overlapping on successive trips by at least 300 millimeters, unless otherwise directed by the Engineer. Alternate trips of the roller shall be slightly different in length. On super-elevated curves, rolling shall begin at the low side and progress toward the high side, unless otherwise directed by the Engineer.

When rolling with vibratory steel-wheel rollers, equipment operation shall be in accordance with Item 217, "Rolling (Vibratory)", and the manufacturer's recommendations, unless otherwise directed by the Engineer. Vibratory rollers shall not be left vibrating while not rolling or when changing directions. Unless otherwise shown on the plans or approved by the Engineer, vibratory rollers shall not be allowed in the vibrating mode on mats with a plan depth of less than 40 millimeters.

The motion of the rollers shall be slow enough to avoid other than usual initial displacement of the mixture. If any displacement occurs, it shall be corrected to the satisfaction of the Engineer. The roller shall not be allowed to stand on pavement which has not been fully compacted. When necessary to prevent adhesion of the surface mixture to the steel-wheel rollers, the wheels shall be kept thoroughly moistened with water, but an excess of water will not be permitted. Necessary precautions shall be taken to prevent the dropping of diesel, gasoline, oil, grease or other foreign matter on the pavement, either when the rollers are in operation or when standing.

(c) The edges of the pavement along curbs, headers and similar structures, and all places not accessible to the roller, or in such positions as will not allow thorough compaction with the rollers, shall be thoroughly compacted with lightly oiled tamps.

(d) Rolling with a trench roller will be required on widened areas, in trenches and other limited areas where satisfactory compaction cannot be obtained with the approved rollers.

(6) In-Place Compaction Control. The Contractor shall furnish one (1) three-wheel roller, one (1) pneumatic-tire roller, and one (1) tandem roller for each compaction operation except as provided below or approved by the Engineer. The use of a tandem roller may be waived by the Engineer when the surface is already adequately smooth. With the approval of the Engineer, the Contractor may substitute a vibratory roller for the three-wheel roller and/or the tandem roller. Use of at least one (1) pneumatic-tire roller is required. Additional or heavier rollers shall be furnished if required by the Engineer.

Rolling patterns shall be established by the Contractor as outlined in Test Method Tex-207-F, Part IV, to achieve the maximum compaction, unless otherwise directed by the Engineer. The selected rolling pattern shall be followed unless changes in the mixture or placement conditions occur which affect compaction. When changes in the mixture or placement conditions occur, a new rolling pattern shall be established.

(7) Ride Quality. Unless otherwise shown on the plans, Ride Quality will be required in accordance with Item 585, "Ride Quality for Pavement Surfaces".

(8) Opening to Traffic. The pavement shall be opened to traffic when directed by the Engineer. The Contractor's attention is directed to the fact that all construction traffic allowed on the pavement open to the public will be subject to the State laws governing traffic on highways.

If the surface ravels, flushes, ruts or deteriorates in any manner prior to final acceptance of the work, it will be the Contractor's responsibility to correct this condition at his expense, to the satisfaction of the Engineer and in conformance with the requirements of this specification.

334.7. Measurement. The quantity of hot mix-cold laid asphaltic concrete will be measured by the composite mass or composite volumetric method.

(1) Composite Mass Method. Asphaltic concrete will be measured by the megagram of the composite "Hot Mix-Cold Laid Asphaltic Concrete" of the type actually used in the completed and accepted work in accordance with the plans and specifications for the project. The composite asphaltic concrete mixture is hereby defined as the asphalt, primer, aggregate, additives as noted in the plans and/or approved by the Engineer, and any residual moisture which is not designated to be deducted.

If mixing is done by a drum-mix plant, measurement will be made on scales as specified herein.

If mixing is done by a weigh-batch plant or modified weigh-batch plant, measurement will be determined on the batch scales unless surge-storage or stockpiling is used. Records of the number of batches, batch design and the mass of the composite "Hot Mix-Cold Laid Asphaltic Concrete" shall be kept. Where surge-storage or stockpiling is used, measurement of the material taken from the surge-storage bin or stockpile will be made on truck scales or suspended hopper scales.

(2) Composite Volumetric Method. The asphaltic concrete will be measured by the cubic meter of compacted "Hot Mix-Cold Laid Asphaltic Concrete" of the type actually used in the completed and accepted work in accordance with the plans and specifications for the project. The composite asphaltic concrete mixture is hereby defined as the asphalt, primer, aggregate, additives as noted in the plans and/or approved by the Engineer, and any residual moisture which is not designated to be deducted. The volume of the composite asphaltic concrete mixture shall be calculated by the following formula:

$$V = \frac{W}{1000\, G_a}$$

V =Cubic meters of compacted "Hot Mix-Cold Laid Asphaltic Concrete"

W =Total mass of asphaltic concrete in kilograms

G_a =Average actual specific gravity of three molded specimens as prepared by Test Method Tex-206-F and determined in accordance with Test Method Tex-207-F

If mixing is done by a drum-mix plant, measurement will be made on scales as specified herein.

If mixing is done by a weigh-batch plant or modified weigh-batch plant, measurement will be determined on the batch scales unless surge-storage or stockpiling is used. Records of the number of batches, batch design and the mass of the composite "Hot Mix-Cold Laid Asphaltic Concrete" shall be kept. Where surge-storage or stockpiling is used,
measurement of the material taken from the surge-storage bin or stockpile will be made on truck scales or suspended hopper scales.
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(3) Ride Quality. Ride quality will be measured as described in Item 585, "Ride Quality for Pavement Surfaces".

334.8. Payment.

(1) The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for the "Hot Mix-Cold Laid Asphaltic Concrete" of the type specified.

Measurement Method	Bid Item	Unit of Measure
Composite Mass	Hot Mix-Cold Laid Asphaltic Concrete	Megagram
Composite Volumetric	Hot Mix-Cold Laid Asphaltic Concrete	Cubic Meter

The payment based on the unit bid price shall be full compensation for quarrying, furnishing all materials, additives, freight involved, for all heating, mixing, hauling, cleaning the existing base course or pavement, tack coat, placing, rolling and finishing hot mix-cold laid asphaltic concrete mixture, and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work. The unit bid price shall include full compensation for asphalt primer and water, when used.

(2) When surface Test Type-B, as specified in Item 585, "Ride Quality for Pavement Surfaces", is used, a bonus or deduction for each 0.1609 kilometer section of each travel lane will be calculated in dollars and cents. A running total of this will be determined for each day's placement. The bonus or deduction for ride quality will be paid for separately from the payment for the material placed.

(3) All templates, straightedges, scales and other weighing and measuring devices necessary for the proper construction, measuring and checking of the work shall be furnished, operated and maintained by the Contractor at his expense.

ITEM 340

HOT MIX ASPHALTIC CONCRETE PAVEMENT

340.1. Description. This Item shall govern for the construction of a base course, a level-up course, a surface course or any combination of these courses as shown on the plans, each course being composed of a compacted mixture of aggregate and asphalt cement mixed hot in a mixing plant, in accordance with the details shown on the plans and the requirements herein.

340.2. Materials. The Contractor shall furnish materials to the project meeting the following requirements prior to mixing. Additional test requirements affecting the quality of individual materials or the paving mixture shall be required when indicated on the plans.

(1) Aggregate. The aggregate shall be composed of a coarse aggregate, a fine aggregate, and if required or allowed, a mineral filler and may include reclaimed asphalt pavement (RAP). The use of RAP may be required on the plans. RAP use will be allowed in all mixtures except as specifically excluded herein or on the plans. Samples of each aggregate shall be submitted for approval in accordance with Item 6, "Control of Materials".

Aggregate from each stockpile shall meet the quality requirements of Table 1 and other requirements as specified herein. The aggregate contained in RAP will not be required to meet Table 1 requirements except as shown on the plans.

(a) Coarse Aggregate. Coarse aggregate is defined as that part of the aggregate retained on a 2.00 millimeter sieve. The aggregate shall be natural, lightweight or manufactured, and be of uniform quality throughout. When specified on the plans, certain coarse aggregate material may be allowed, required or prohibited.

Lightweight aggregate is defined as expanded shale, clay or slate produced by the rotary kiln method. Manufactured aggregate is defined as any aggregate other than natural or lightweight.

Lightweight or manufactured materials with the same or similar gradation whose unit weight vary by more than 6.0 percent from that used in the mixture design may require a redesign.

Gravel from each source shall be so crushed as to have a minimum of 85 percent of the particles retained on the 4.75 millimeter sieve with two or more mechanically induced crushed faces, as determined by Test Method Tex-460-A (Part I). The material passing the 4.75 millimeter sieve and retained on the 2.00 millimeter sieve must be the product of crushing aggregate that was originally retained on the 4.75 millimeter sieve.

The polish value for the virgin (not previously used in construction) coarse aggregate used in the surface or finish course shall not be less than the value shown on the plans, when tested in accordance with Test Method Tex-438-A. Unless otherwise shown on the plans, the polish value requirement will apply only to aggregate used on travel lanes. For rated sources, the Materials and Tests Division's Rated Source Polish Value (RSPV) catalog will be used to determine polish value compliance. Unless otherwise shown on the plans, virgin coarse aggregates may be blended in accordance with Test Method Tex-438-A, Part II, Method B, to meet the polish value requirement. When blending is allowed, the blended virgin aggregates shall contain non-polishing aggregates of not less than the percent by volume of the critical size shown below for the specified mixture.

	Type C	Type D	Type F
Retained on the 4.75 mm sieve	50%	50%	
Retained on the 2.00 mm sieve			50%

The polish value of RAP aggregate will not be used in any determination of polish value specification compliance.

(b) Reclaimed Asphalt Pavement (RAP). RAP is defined as a salvaged, milled, pulverized, broken or crushed asphaltic pavement. The RAP to be used in the mix shall be crushed or broken to the extent that 100 percent will pass the 50 millimeter sieve.

The stockpiled RAP shall not be contaminated by dirt or other objectionable materials. Unless otherwise shown on the plans, stockpiled, crushed RAP must have either a decantation of no more than five (5) percent or a plasticity index of no more than eight (8), when tested in accordance with Test Method Tex-406-A, Part I, or Test Method Tex-106-E, respectively. This requirement applies to stockpiled RAP from which the asphalt has not been removed by extraction.

State-owned RAP sources that are designated on the plans will be available for use by the Contractor. Only RAP from state-owned sources **340.2**

will be allowed in mixes using more than 20 percent RAP, unless otherwise shown on the plans. When RAP sources are designated, either in stockpile or existing pavements, the approximate gradation, asphalt content, and asphalt

cement properties of this material will be shown on the plans for material existing in pavements, or in a special provision "Local Material Sources for Reclaimed Asphaltic Pavement" for material in existing stockpiles.

Any Contractor-owned RAP that is to be used on this project shall remain the property of the Contractor while stockpiled and shall not be intermingled with State-owned RAP stockpiles. Any unused Contractor-owned RAP material shall be removed from the project site upon completion of the project.

Only RAP from designated sources may be used in surface courses.

Excess RAP removed from designated sources will remain the property of the State and will be delivered to stockpile locations shown on the plans.

(c) Fine Aggregate. The fine aggregate is defined as that part of the aggregate passing the 2.00 millimeter sieve and shall be of uniform quality throughout. When specified on the plans, certain fine aggregate material may be allowed, required or prohibited. However, a maximum of 15 percent of the total virgin aggregate may be field sand or other uncrushed fine aggregate.

Screenings shall be supplied from sources whose coarse aggregate meets the Los Angeles abrasion and magnesium sulfate soundness loss requirements shown in Table 1, unless otherwise shown on the plans.

1. Unless otherwise shown on the plans, stone screenings are required and shall be the result of a rock crushing operation and meet the following gradation requirements, when tested in accordance with Test Method Tex-200-F, Part I.

	Percent by Mass
Passing the 9.5 mm sieve	100
Passing the 2.00 mm sieve	70-100
Passing the 75 µm sieve	0-15

2. Crushed gravel screenings may be used with, or in lieu of, stone screenings when shown on the plans. Crushed gravel screenings must be **340.2**

the product of crushing aggregate that was originally retained on the 4.75 millimeter sieve and meet the gradation for stone screenings shown above.

(d) Mineral Filler. Mineral filler shall consist of thoroughly dried stone dust, portland cement, lime, fly ash, or other mineral dust approved by the Engineer. The mineral filler shall be free from foreign matter.

When a specific type of mineral filler is specified on the plans, fines collected by the baghouse or other air cleaning or dust collecting equipment shall not be used to meet this requirement. When mineral filler is not specifically required, the addition of baghouse or other collected fines will be permitted if the mixture quality is not adversely affected in the opinion of the Engineer. In no case shall the amount of material passing the 75 micrometer sieve exceed the tolerances of the job-mix formula or the master gradation limits.

When mineral filler is specified or allowed by the Engineer, or baghouse fines are permitted to be added to the mixture, it shall be proportioned into the mix by a vane meter or an equivalent measuring device acceptable to the Engineer. A hopper or other acceptable storage system shall be required to maintain a constant supply of mineral filler to the measuring device.

The measuring device for adding mineral filler shall be tied into the automatic plant controls so that the supply of mineral filler will be automatically adjusted to plant production and provide a consistent percentage to the mixture. When shown on the plans, the measuring device for adding baghouse fines shall have controls in the plant control room which will allow manual adjustment of feed rates to match plant production rate adjustments.

When tested in accordance with Test Method Tex-200-F (Part I or Part III, as applicable), the mineral filler shall meet the following gradation requirements, unless otherwise shown on the plans. Baghouse fines are not required to meet the gradation requirements.

	Percent by Mass or Volume
Passing the 600 µm sieve	95-100
Passing the 180 µm sieve, not less than	75
Passing the 75 µm sieve, not less than	55

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TABLE 1
AGGREGATE
QUALITY REQUIREMENTS *

Requirement	Test Method	Manufactured or Natural Aggregate	Lightweight Aggregate
COARSE AGGREGATE			
Dry Loose Unit Weight, kg/m^3 minimum	Tex-404-A	_	560

Pressure Slaking Value, maximum	Tex-431-A	-	4.0
Freeze Thaw Loss, percent, max.	Tex-432-A	-	7.0
24 Hour Water Absorption, percent, maximum	Tex-433-A	-	12.0
Deleterious Material, percent, maximum	Tex-217-F Part I	1.5	1.5
Decantation, percent, maximum	Tex-217-F Part II	1.5	1.5
Los Angeles Abrasion, percent, maximum	Tex-410-A	40	35
Magnesium Sulfate Soundness Loss, 5 cycle, percent, maximum	Tex-411-A	30**	-
FINE AGGREGATE			
Linear Shrinkage, maximum	Tex-107-E Part II	3	3
COMBINED AGGREGATES * **			
Sand Equivalent Value, minimum	Tex-203-F	45	45

* Sampled during delivery to the plant or from the stockpile, unless otherwise shown on the plans.
** Unless otherwise shown on the plans.
*** Aggregates, without added mineral filler, RAP, or additives, combined as used in the job-mix formula.

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(2) Asphaltic Material.

(a) Paving Mixture. Asphalt cement for the paving mixture shall be of the grade shown on the plans or designated by the Engineer and shall meet the requirements of Item 300, "Asphalts, Oils and Emulsions". The Contractor shall notify the Engineer of the source of the asphaltic material prior to design of the asphaltic mixture. This source shall not be changed during the course of the project without the authorization of the Engineer. Should the source of asphaltic material be changed, the moisture resistance of the new material combination will be evaluated to verify that the requirements of Subarticle 340.3(1) are met.

(b) RAP Paving Mixture. When more than 20 percent RAP is used in the produced mixture, the asphalt in the RAP shall be restored to the properties indicated below. Restoration will be made by adding asphalt recycling agent and/or virgin asphalt cement meeting the requirements of Item 300, "Asphalts, Oils and Emulsions".

The mixture design will include recovery of asphalt from the RAP in

accordance with Test Method Tex-211-F. The recovered asphalt shall be blended in the laboratory with the amount of asphalt cement and/or asphalt recycling agent selected for the project. The following tests shall be performed on the laboratory blend:

1. Viscosity, 60 °C, Pa·s - Test Method Tex-528-C
2. Thin Film Oven Aging Test - Test Method Tex-510-C
3. Viscosity, 60 °C, Pa·s, on residue from the Thin Film Oven Aging Test - Test Method Tex-528-C
4. Penetration at 25 °C, 100 g, 5 s, (0.1 mm), on residue from the Thin Film Oven Aging Test - Test Method Tex-502-C

The viscosity in poises equivalent to the residue penetration at 25 °C shall be calculated as set forth in Test Method Tex-535-C. The viscosity index of the residue shall then be calculated as follows:

$$\text{Residue Viscosity Index} = \frac{\text{Residue Viscosity, Pa·s, equivalent to Penetration at 25 °C, (0.1 mm)}}{\text{Residue Viscosity, 60 °C, Pa·s}}$$

The aging index of the laboratory blended asphalt shall be determined as follows:

$$\text{Aging Index} = \frac{\text{Residue Viscosity, 60 °C, Pa·s}}{\text{Original Viscosity, 60 °C, Pa·s}}$$

The laboratory blended asphalt shall meet the following requirements:

Residue Viscosity Index, maximum.....1500
Aging Index, maximum 3.0

Samples of asphalt recovered from plant produced mixture shall show the asphalt to meet the following requirements when tested in accordance with Test Methods Tex-211-F and Tex-502-C.

	Minimum	Maximum
Penetration, 25 °C, 100 g, 5 s, (0.1 mm)	30	55

(c) Tack Coat. Asphaltic materials, shown on the plans or approved by the Engineer, shall meet the requirements of Item 300, "Asphalts, Oils and Emulsions".

(3) Additives. Additives to facilitate mixing and/or improve the quality of the asphaltic mixture or tack coat shall be used when noted on the plans or may be used with the authorization of the Engineer.

Unless otherwise shown on the plans, the Contractor may choose to use either lime or a liquid antistripping agent to reduce the moisture susceptibility of the aggregate. The evaluation and addition of antistripping agents will be in accordance with Item 301, "Asphalt Antistripping Agents".

340.3. Paving Mixtures. The paving mixtures shall consist of a uniform mixture of aggregate, hot asphalt cement, and additives if allowed or required.

An asphalt mixture design is a laboratory process which includes the determination of the quality of the asphalt and the individual aggregates, the development of the job-mix formula, and the testing of the combined mixture.

The job-mix formula lists the quantity of each component to be used in the mix and the combined gradation of the aggregates used.

(1) Mixture Design. The Contractor shall furnish the Engineer with representative samples of the materials to be used in production. Using these materials, the mix shall be designed in accordance with Test Method Tex-204-F to conform with the requirements herein. Unless otherwise shown on the plans, the Engineer will furnish the mix design for mixtures when using 20 percent or less RAP. The Engineer may accept a design from the Contractor which was derived using these design procedures.

The second and subsequent mixture designs, or partial designs, for each type of paving mixture which are necessitated by changes in the material or at the request of the Contractor will be charged to the Contractor when a rate is shown on the plans.

The Contractor shall furnish the mixture design for all mixtures containing more than 20 percent RAP. This mixture design shall include, in addition to the results of the tests required for virgin mixes, the results of tests run on the proposed asphalt blend. The Contractor shall furnish the Engineer with representative samples of all materials to be used in the proposed mixture. The Engineer will verify the proposed mixture design. Should the Engineer's tests find that the proposed mixture design does not meet the requirements of this specification, the Contractor shall furnish another mixture design.

The bulk specific gravity will be determined for each aggregate to be used in the design mixture. If the determined values vary by 0.300 or more, the Volumetric Method, Test Method Tex-204-F, Part II, will be used. The bulk specific gravity of aggregates in RAP will be determined on extracted aggregates.

When properly proportioned, for the type specified, the blend of aggregates shall produce an aggregate gradation which will conform to the limits of the master grading shown in Table 2. Unless otherwise shown on the plans, the gradation of the aggregate will be determined in accordance with Test Method Tex-200-F, Part I (Dry Sieve Analysis), to develop the job-mix formula.

The master grading limits for the appropriate type and the proposed job-mix formula will be plotted on a gradation chart with sieve sizes raised to the 0.45 power. This plot must show that the proposed job-mix formula

is within the limits of the master grading. Gaps in gradation shown by this plot should be avoided.

The voids in the mineral aggregate (VMA) will be determined as a mixture design requirement only, in accordance with Test Method Tex-207-F, and shall not be less than the value indicated in Table 2.

Unless otherwise shown on the plans, the mixture of aggregate, asphalt and additives proposed for use will be evaluated in the design stage for moisture susceptibility, in accordance with Item 301, "Asphalt Antistripping Agents". The Engineer may waive this test if a similar design, using the same ingredients, has proven satisfactory.

To substantiate the design, trial mixtures shall be produced and tested using all of the proposed project materials and equipment prior to any placement. The Engineer may waive trial mixtures if similar designs have proven satisfactory.

(2) Density. The mixture shall be designed to produce an acceptable mixture at an optimum density of 96.0 percent, when tested in accordance with Test Method Tex-207-F and Test Method Tex-227-F. The operating range for control of laboratory density during production shall be optimum density plus or minus 1.5 percent.

Laboratory density is a mixture design and process control parameter. If the laboratory density of the mixture produced has a value outside the range specified above, the Contractor shall investigate the cause and take corrective action. If three (3) consecutive test results fall outside the specified range, production shall cease unless test results or other information indicate, to the satisfaction of the Engineer, that the next mixture to be produced will be within the specified range.

(3) Stability. The materials used in the mixture design shall produce a mixture with a stability value of at least 35, unless otherwise shown on the plans, when tested in accordance with Test Method Tex-208-F.

If, during production, the stability value falls below the specified minimum, the Engineer and the Contractor shall closely evaluate other test result values for specification compliance such as gradation, asphalt content, moisture content, crushed faces, etc., to determine the cause and take corrective action. If three (3) consecutive test results fall below the minimum value specified, production shall cease unless test results or other

information indicate, to the satisfaction of the Engineer, that the next material to be produced will meet the minimum value specified.

(4) Job-Mix Formula Field Adjustments. The Contractor shall produce a mixture of uniform composition closely conforming to the approved job-mix formula.

If, during initial days of production, it is determined that adjustments to the mixture design job-mix formula are necessary to achieve the specified requirements, or to more nearly match the aggregate production, the Engineer may allow adjustment of the mixture design job-mix formula within the following limits without a laboratory redesign of the mixture. The adjusted job-mix formula shall not exceed the limits of the master grading for the type of mixture specified nor shall the adjustments exceed five (5) percent on any one sieve, 12.5 millimeter size and larger, or three (3) percent on the sieve sizes below the 12.5 millimeter sieve.

When the considered adjustments exceed either the five (5) or three (3) percent limits, and the Engineer determines that the impact of these changes may adversely affect pavement performance, a new laboratory mixture design will be required.

The asphalt content will be adjusted as deemed necessary by the Engineer to maintain desirable laboratory density near the optimum value while achieving other mix requirements.

(5) Types. The aggregate gradation of the job-mix formula shall conform to the master grading limits shown in Table 2 for the type mix specified on the plans.

TABLE 2
Master Grading
Percent Passing by Mass or Volume

Sieve Size	Type				
	A Coarse Base	B Fine Base	C Coarse Surface	D Fine Surface	F Fine Mixture
37.5 mm	100				
31.5 mm	95-100				
25.0 mm		100			
22.4 mm	70-90	95-100	100		
16.0 mm		75-95	95-100		
12.5 mm	50-70			100	
9.5 mm		60-80	70-85	85-100	100
6.3 mm					95-100
4.75 mm	30-50	40-60	43-63	50-70	
2.00 mm	20-34	27-40	30-40	32-42	32-42
425 µm	5-20	10-25	10-25	11-26	9-24
180 µm	2-12	3-13	3-13	4-14	3-13
75 µm	1-6*	1-6*	1-6*	1-6*	1-6*
VMA % minimum	11	12	13	14	15

* 2 - 8 when Test Method Tex-200-F, Part II (Washed Sieve Analysis) is used.

(6) Tolerances. The gradation of the aggregate and the asphalt cement content of the produced mixture shall not vary from the job-mix formula by more than the tolerances allowed herein. When within applied tolerances, the gradation of the produced mixture may fall outside the master grading limits for any of the sieve sizes from the largest sieve size on which aggregate may be retained down through the 180 micrometer sieve. Only the quantity of aggregate passing the 75 micrometer sieve is further restricted to conform to the master grading limitations shown in Table 2 or as modified in Test Method Tex-229-F. A tolerance of two (2) percent is allowed on the sieve size for each mixture type which shows 100 percent passing in Table 2.

	Tolerance, Percent by Mass or Volume as Applicable
Passing the 31.5 mm to 2.00 mm sieve	Plus or Minus 5
Passing the 425 µm to 75 µm sieve	Plus or Minus 3
Asphalt, mass	Plus or Minus 0.5
Asphalt, volume	Plus or Minus 1.2

The mixture will be tested in accordance with Test Method Tex-210-F, or Test Method Tex-228-F will be used in conjunction with combined cold feed belt samples tested in accordance with Test Method Tex-229-F. Other methods of proven accuracy may be used. The methods of test will be determined by the Engineer. However, mixtures produced by weigh-batch plants and all mixtures containing RAP will be tested for gradation in accordance with Test Method Tex-210-F. If three (3) consecutive tests indicate that the material produced exceeds the above tolerances on any individual sieve, or if two (2) consecutive tests indicate that the asphalt content tolerance is exceeded, production shall stop and not resume until test results or other information indicate, to the satisfaction of the Engineer, that the next mixture to be produced will be within the above tolerances.

When disagreements concerning determination of specification compliance occur between allowed sampling and testing procedures, extracted aggregate testing shall take precedence over cold feed belt testing.

When cold feed belt samples are used for job control, the Engineer will select the sieve analysis method that corresponds with the one used to determine the mixture design gradation. The tolerances will be adjusted as outlined in Test Method Tex-229-F.

340.4. Equipment.

(1) General. All equipment for the handling of all materials, mixing, placing and compacting of the mixture shall be maintained in good repair and operating condition and subject to the approval of the Engineer. Any equipment found to be defective and potentially having a negative effect on the quality of the paving mixture or ride quality will not be allowed.

(2) Mixing Plants. Mixing plants may be the weigh-batch type, the modified weigh-batch type, the drum-mix type, or the specialized recycling type. All plants shall be equipped with satisfactory conveyors, power units, mixing equipment, aggregate handling equipment, bins and dust collectors.

Automatic proportioning devices are required for all plants and shall be in accordance with Item 520, "Weighing and Measuring Equipment".

It shall be the Contractor's responsibility to provide safe and accurate means to enable inspection forces to take all required samples, to provide permanent means for checking the output of any specified metering device, and to perform calibration and mass checks as required by the Engineer. When cold feed belt sampling is to be used for gradation testing, occasional stoppage of the belt may be necessary unless other means of sampling are approved by the Engineer.

When using fuel oil heavier than Grade No. 2, or waste oil, the Contractor shall insure that the fuel delivered to the burner is at a viscosity of 100 SSU or less, when tested in accordance with Test Method Tex-534-C, to insure complete burning of the fuel. Higher viscosities will be allowed if recommended by the burner manufacturer. If necessary, the Contractor shall preheat the oil to maintain the required viscosity.

The Contractor shall provide means for obtaining a sample of the fuel, just prior to entry into the burner, in order to perform the viscosity test. The Contractor shall perform this test or provide a laboratory test report that will establish the temperature of the fuel necessary to meet the

viscosity requirements. There shall be an in-line thermometer to check the temperature of the fuel delivered to the burner.

Regardless of the burner fuel used, the burner or combination of burners and types of fuel used shall provide a complete burn of the fuel and not leave any fuel residue that will adhere to the heated aggregate or become mixed with the asphalt.

(a) Weigh-Batch Type.

Cold Aggregate Bin Unit and Proportioning Device. The cold aggregate bin unit shall have at least four bins of sufficient size to store the amount of aggregate required to keep the plant in continuous operation and of proper design to prevent overflow of material from one bin to another. There shall be vertical partitions between each bin and on each end of the bins of sufficient height so that any overflow will be to the front and back, and not allow overflow to the sides or between bins. Overflow that might occur shall not fall onto any feeder belt. The proportioning device shall provide a uniform and continuous flow of aggregate in the desired proportion to the dryer. Each aggregate shall be proportioned from a separate bin.

If RAP is used, a separate cold bin shall be required. The RAP feed system shall be equipped with a scalping screen to remove particles over 50 millimeters in size. The cold bin system shall supply the proper amount of RAP to the weigh box. RAP will not be allowed in the hot bins.

When mineral filler is used, as specified in Section 340.2.(1)(d), an additional bin shall be provided.

Dryer. The dryer shall continually agitate the aggregate during heating. The temperature shall be controlled so that the aggregate will not be damaged in the drying and heating operations. The dryer shall be of sufficient size to keep the plant in continuous operation.

Screening and Proportioning. The screening capacity and size of the hot aggregate bins shall be sufficient to screen and store the amount of aggregate required to properly operate the plant and keep the plant in continuous operation at full capacity. The hot bins shall be constructed so that oversize and overloaded material will be discarded through overflow chutes. Provisions shall be made to enable inspection forces to have easy

and safe access to the proper location on the mixing plant where representative samples may be taken from the hot bins for testing. The aggregate shall be separated into at least four bins when producing Type "A", Type "B" or Type "C" mixtures, at least three bins when producing Type "D" mixture and at least two bins when producing Type "F" mixture. These bins shall contain the following sizes of aggregates, in percentages by mass or by volume, as applicable.

Type "A" (Coarse-Graded Base Course):

Bin No. 1 - Shall contain aggregates of which 85 to 100 percent will pass the 2.00 mm sieve.

Bin No. 2 - Shall contain aggregates of which at least 85 percent will be of such size as to pass the retained on the 2.00 mm sieve.

Bin No. 3 - Shall contain aggregates of which at least 85 percent will be of such size as to pass the retained on the 9.5 mm sieve.

Bin No. 4 - Shall contain aggregates of which at least 85 percent will be of such size as to pass the 37.5 mm sieve and be retained on the 22.4 mm sie

Type "B" (Fine-Graded Base Course):

Bin No. 1 - Shall contain aggregates of which 85 to 100 percent will pass the 2.00 mm sieve.

Bin No. 2 - Shall contain aggregates of which at least 70 percent will be of such size as to pass the 4.75 mm sieve and be retained on the 2.00 mm sieve.

Bin No. 3 - Shall contain aggregates of which at least 75 percent will be of such size as to pass the 9.5 mm sieve and be retained on the 4.75 mm sieve.

Bin No. 4 - Shall contain aggregates of which at least 75 percent will be of such size as to pass the retained on the 9.5 mm sieve.

Type "C" (Coarse-Graded Surface Course):

Bin No. 1 - Shall contain aggregates of which 85 to 100 percent will pass the 2.00 mm sieve.

Bin No. 2 - Shall contain aggregates of which at least 70 percent will be of such size as to pass the retained on the 2.00 mm sieve.

Bin No. 3 - Shall contain aggregates of which at least 75 percent will be of such size as to pass the retained on the 4.75 mm sieve.

Bin No. 4 - Shall contain aggregates of which at least 75 percent will be of such size as to pass the

Type "D" (Fine-Graded Surface Course):

Bin No. 1 - Shall contain aggregates of which 85 to 100 percent will pass the 2.00 mm sieve.

Bin No. 2 - Shall contain aggregates of which at least 70 percent will be of such size as to pass the retained on the 2.00 mm sieve.

Bin No. 3 - Shall contain aggregates of which at least 75 percent will be of such size as to pass the retained on the 4.75 mm sieve.

Type "F" (Fine-Graded Mixture):

Bin No. 1 - Shall contain aggregates of which 85 to 100 percent will pass the 2.00 mm sieve.

Bin No. 2 - Shall contain aggregates of which at least 75 percent will be of such size as to pass the retained on the 2.00 mm sieve.

Aggregate Weigh Box and Batching Scale. The aggregate weigh box and batching scales shall be of sufficient capacity to hold and weigh a complete batch of aggregate. The weigh box and scales shall conform to the requirements of Item 520, "Weighing and Measuring Equipment".

Asphaltic Material Measuring System. If an asphaltic material bucket and scales are used, they shall be of sufficient capacity to hold and weigh the necessary asphaltic material for one batch. The bucket and scales shall conform to the requirements of Item 520, "Weighing and Measuring Equipment".

If a pressure type flow meter is used to measure the asphaltic material, the requirements of Item 520, "Weighing and Measuring Equipment", shall apply. This system shall include an automatic temperature compensation device to insure a constant percent by mass of asphaltic material in the mixture.

Provisions of a permanent nature shall be made for checking the accuracy of the asphaltic material measuring device. The asphalt line to the measuring device shall be protected with a jacket of hot oil or other approved means to maintain the temperature of the line near the temperature specified for the asphaltic material.

Mixer. The mixer shall be of the pugmill type and shall have a capacity of not less than 1350 kilograms (of natural-aggregate mixture) in a single batch, unless otherwise shown on the plans. Any mixer that has a tendency to segregate the aggregate or fails to secure a thorough and uniform mixture with the asphaltic material shall not be used. All mixers shall be provided with an automatic timer that will lock the discharge doors of the mixer for the required mixing period. The dump door or doors and the shaft seals of the mixer shall be tight enough to prevent spilling of aggregate or mixture from the pugmill.

Surge-Storage System and Scales. A surge-storage system may be used to minimize the production interruptions during the normal day's operations. A device such as a gob hopper or other device approved by the

Engineer to prevent segregation in the surge-storage bin shall be used. The mixture shall be weighed upon discharge from the surge-storage system.

When a surge-storage system is used, scales shall be standard platform truck scales or other equipment such as weigh hopper (suspended) scales and shall conform to Item 520, "Weighing and Measuring Equipment". If truck scales are used, they shall be placed at a location approved by the Engineer. If other weighing equipment is used, the Engineer may require mass checks by truck scales for the basis of approval of the equipment.

Recording Device and Record Printer. The mixture shall be weighed for payment. If a surge-storage system is used, an automatic recording device and a digital record printer shall be provided to indicate the date, project identification number, vehicle identification, total mass of the load, tare mass of the vehicle, the mass of asphaltic mixture in each load and the number of loads for the day, unless otherwise indicated on the plans. When surge-storage is not used, batch mass will be used as the basis for payment and automatic recording devices and automatic digital record printers in accordance with Item 520, "Weighing and Measuring Equipment", shall be required.

(b) Modified Weigh-Batch Type.

General. This plant is similar to the weigh-batch type plant. The hot bin screens shall be removed and the aggregate control is placed at the cold feeds. The cold feed bins shall be the same as those required for the drum-mix type plant.

Cold-Aggregate Bin Unit and Feed System. The number of bins in the cold-aggregate bin unit shall be equal to or greater than the number of stockpiles of individual materials to be used.

The bins shall be of sufficient size to store the amount of aggregate required to keep the plant in continuous operation and of proper design to prevent overflow of material from one bin to another. There shall be vertical partitions between each bin and on each end of the bins of sufficient height so that any overflow will be to the front and back and not allow overflow to the sides or between bins. Overflow that might occur shall not fall onto any feeder belt. When required by the Engineer, an approved stationary scalping screen shall be placed on top of the field sand bin to

eliminate roots and other objectionable material. The feed system shall provide a uniform and continuous flow of aggregate in the desired proportion to the dryer. The Contractor shall furnish a chart indicating the calibration of each cold bin in accordance with the manufacturer's recommendations or in a method acceptable to the Engineer.

When mineral filler is used, as specified in Section 340.2.(1)(d), an additional bin shall be provided.

If RAP is used, a separate cold bin shall be required. The RAP feed system shall be equipped with a scalping screen to remove particles over 50 millimeters in size. The cold bin system shall supply a uniform and proper amount of RAP to the mixture. The RAP may be added at the weigh box. If not added at the weigh box, the system shall include means acceptable to the Engineer to verify that the correct amount of RAP is continuously being fed.

Scalping Screen. A scalping screen shall be required after the cold feeds and ahead of the hot aggregate surge bins.

Dryer. The dryer shall continually agitate the aggregate during heating. The temperature shall be controlled so that the aggregate will not be damaged in the drying and heating operations. The dryer shall be of sufficient size to keep the plant in continuous operation.

Screening and Proportioning. The hot aggregate shall not be separated into sizes after being dried. There shall be one or more surge bins provided between the dryer and the weigh hopper. Surge bins shall be of sufficient size to hold enough combined aggregate for one complete batch of mixture.

Aggregate Weigh Box and Batching Scale. The aggregate weigh box and batching scales shall be of sufficient capacity to hold and weigh a complete batch of aggregate. The weigh box and scales shall conform to the requirements of Item 520, "Weighing and Measuring Equipment".

Asphaltic Material Measuring System. If an asphaltic material bucket and scales are used, they shall be of sufficient capacity to hold and weigh the necessary asphaltic material for one batch. The bucket and scales shall conform to the requirements of Item 520, "Weighing and Measuring Equipment".

If a pressure type flow meter is used to measure the asphaltic material, the requirements of Item 520, "Weighing and Measuring Equipment", shall apply. This system shall include an automatic temperature compensation device to insure a constant percent by mass of asphaltic material in the mixture.

Provisions of a permanent nature shall be made for checking the accuracy of the asphaltic material measuring device. The asphalt line to the measuring device shall be protected with a jacket of hot oil or other approved means to maintain the temperature of the line near the temperature specified for the asphaltic material.

Mixer. The mixer shall be of the pugmill type and shall have a capacity of not less than 1350 kilograms (of natural-aggregate mixture) in a single batch, unless otherwise shown on the plans. Any mixer that has a tendency to segregate the aggregate or fails to secure a thorough and uniform mixture with the asphaltic material shall not be used. All mixers shall be provided with an automatic timer that will lock the discharge doors of the mixer for the required mixing period. The dump door or doors and the shaft seals of the mixer shall be tight enough to prevent spilling of aggregate or mixture from the pugmill.

Surge-Storage System and Scales. A surge-storage system may be used to minimize the production interruptions during the normal day's operations. A device such as a gob hopper or other device approved by the Engineer to prevent segregation in the surge-storage bin shall be used. The mixture shall be weighed upon discharge from the surge-storage system.

When a surge-storage system is used, scales shall be standard platform truck scales or other equipment such as weigh hopper (suspended) scales and shall conform to Item 520, "Weighing and Measuring Equipment". If truck scales are used, they shall be placed at a location approved by the Engineer. If other weighing equipment is used, the Engineer may require mass checks by truck scales for the basis of approval of the equipment.

Recording Device and Record Printer. The mixture shall be weighed for payment. If a surge-storage system is used, an automatic recording device and a digital record printer shall be provided to indicate the date, project identification number, vehicle identification, total mass of the load, tare mass of the vehicle, the mass of asphaltic mixture in

each load and the number of loads for the day, unless otherwise indicated on the plans. When surge-storage is not used, batch mass will be used as the basis for payment and automatic recording devices and automatic digital record printers in accordance with Item 520, "Weighing and Measuring Equipment", shall be required.

(c) Drum-Mix Type.

General. The plant shall be adequately designed and constructed for the process of mixing aggregates and asphalt. The plant shall be equipped with satisfactory conveyors, power units, aggregate-handling equipment and feed controls.

Cold-Aggregate Bin Unit and Feed System. The number of bins in the cold-aggregate bin unit shall be equal to or greater than the number of stockpiles of individual materials to be used.

The bins shall be of sufficient size to store the amount of aggregate required to keep the plant in continuous operation and of proper design to prevent overflow of material from one bin to another. There shall be vertical partitions between each bin and on each end of the bins of sufficient height so that any overflow will be to the front and back and not allow overflow to the sides or between bins. Overflow that might occur shall not fall onto any feeder belt. When required by the Engineer, an approved stationary scalping screen shall be placed on top of the field sand bin to eliminate roots and other objectionable material. The feed system shall provide a uniform and continuous flow of aggregate in the desired proportion to the mixer. The Contractor shall furnish a chart indicating the calibration of each cold bin in accordance with the manufacturer's recommendations or in a method acceptable to the Engineer.

The system shall provide positive mass measurement of the combined cold-aggregate feed by use of belt scales or other approved devices. Provisions of a permanent nature shall be made for checking the accuracy of the measuring device as required by Item 520, "Weighing and Measuring Equipment". When a belt scale is used, mixture production shall be maintained so that the scale normally operates between 50 percent and 100 percent of its rated capacity. Belt scale operation below 50 percent of the rated capacity may be allowed by the Engineer if accuracy checks show the scale to meet the requirements of Item 520, "Weighing and Measuring Equipment", at the selected rate. It shall be satisfactorily demonstrated to the Engineer that mixture uniformity and quality have not been adversely affected.

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If RAP is used, a separate cold bin shall be required. The RAP feed system shall be equipped with a scalping screen to remove particles over 50 millimeters in size prior to the weighing device. There shall be adequate cold bin controls to provide a uniform amount of RAP to the mixture.

When RAP is used, positive mass measurement of RAP shall be provided by the use of belt scales or other approved devices.

Scalping Screen. A scalping screen shall be required after the cold feeds and ahead of the combined aggregate belt scales.

Asphaltic Material Measuring System. An asphaltic material measuring device meeting the requirements of Item 520, "Weighing and Measuring Equipment", shall be placed in the asphalt line leading to the mixer so that the cumulative amount of asphalt used can be accurately determined. Provisions of a permanent nature shall be made for checking the accuracy of the measuring device output. The asphalt line to the measuring device shall be protected with a jacket of hot oil or other approved means to maintain the temperature of the line near the temperature specified for the asphaltic material. The measuring system shall include an automatic temperature compensation device to maintain a constant percent by mass of asphaltic material in the mixture.

Synchronization Equipment for Feed-Control Systems. The asphaltic material feed-control shall be coupled with the total aggregate mass measuring device to automatically vary the asphalt-feed rate in order to maintain the required proportion.

Mixing System. The mixing system shall control the temperature so that the aggregate and asphalt will not be damaged in the drying, heating and mixing operations. A continuously recording thermometer shall be provided which will indicate the temperature of the mixture as it leaves the mixer.

Surge-Storage System and Scales. A surge-storage system shall be used to minimize the production interruptions during the normal day's operations. A device such as a gob hopper or other device approved by the Engineer to prevent segregation in the surge-storage bin shall be used. The mixture shall be weighed upon discharge from the surge-storage system.

Scales shall be standard platform truck scales or other equipment such as weigh hopper (suspended) scales and shall conform to Item 520, "Weighing and Measuring Equipment". If truck scales are used, they shall

be placed at a location approved by the Engineer. If other weighing equipment is used, the Engineer may require mass checks by truck scales for the basis of approval of the equipment.

Recording Device and Record Printer. Automatic recording devices and automatic digital record printers shall be provided to indicate the date, project identification number, vehicle identification, total mass of the load, tare mass of the vehicle, the mass of asphaltic mixture in each load and the number of loads for the day in accordance with Item 520, "Weighing and Measuring Equipment", unless otherwise shown on the plans.

(d) Specialized Recycling Type.

General. Alternate methods of heating may be used which will not abnormally age the asphalt cement. This type of plant shall be capable of continually producing a minimum of 136 megagrams per hour of completed asphalt mixture that will meet all the requirements of this specification.

Cold-Aggregate Bin Unit and Feed System. The cold-aggregate feed system and controls shall meet all the requirements as listed under the drum-mix type plant.

Scalping Screen. A scalping screen shall be required after the cold feeds and ahead of the combined aggregate belt scales.

Dryer. The dryer shall continually agitate the RAP and aggregate during heating. The temperature shall be controlled so that the aggregate and asphalt will not be damaged in the drying and heating operations. The dryer shall be of sufficient size to keep the plant in continuous operation.

Asphalt Material Measuring System. An asphaltic material measuring device meeting the requirements of Item 520, "Weighing and Measuring Equipment", shall be placed in the asphalt line leading to the mixer so that the cumulative amount of asphalt used can be accurately determined. Provisions of a permanent nature shall be made for checking the accuracy of the measuring device output. The asphalt line to the measuring device shall be protected with a jacket of hot oil or other approved means to maintain the temperature of the line near the temperature specified for the asphaltic material. The measuring system shall include an automatic temperature compensation device to maintain a constant percent by mass of asphaltic material in the mixture.

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Synchronization Equipment for Feed-Control Systems. The asphaltic material feed-control shall be coupled with the total aggregate mass measuring device to automatically vary the asphalt-feed rate in order to maintain the required proportion.

Mixer. The mixer shall be of the continuous mechanical mixing type.

Any mixer that has a tendency to segregate the mixture or fails to secure a thorough and uniform mixture shall not be used. A continuously recording thermometer shall be provided which will indicate the temperature of the mixture as it leaves the mixer.

Surge-Storage System and Scales. A surge-storage system shall be used to minimize the production interruptions during the normal day's operations. A device such as a gob hopper or other device approved by the Engineer to prevent segregation in the surge-storage bin shall be used. The mixture shall be weighed upon discharge from the surge-storage system.

Scales shall be standard platform truck scales or other equipment such as weigh hopper (suspended) scales and shall conform to Item 520, "Weighing and Measuring Equipment". If truck scales are used, they shall be placed at a location approved by the Engineer. If other weighing equipment is used, the Engineer may require mass checks by truck scales for the basis of approval of the equipment.

Recording Device and Record Printer. Automatic recording devices and automatic digital record printers shall be provided to indicate the date, project identification number, vehicle identification, total mass of the load, tare mass of the vehicle, the mass of asphaltic mixture in each load and the number of loads for the day in accordance with Item 520, "Weighing and Measuring Equipment", unless otherwise shown on the plans.

(3) Asphaltic Material Heating Equipment. Asphaltic material heating equipment shall be adequate to heat the required amount of asphaltic material to the desired temperature. The heating apparatus shall be equipped with a continuously recording thermometer with a 24-hour chart that will record the temperature of the asphaltic material at the location of highest temperature.

(4) Spreading and Finishing Machine. The spreading and finishing machine shall be approved by the Engineer and shall meet the requirements indicated below.

(a) Screed Unit. The spreading and finishing machine shall be equipped with a heated compacting screed. It shall produce a finished surface meeting the requirements of the typical cross sections and the surface tests.

Extensions added to the screed shall be provided with the same compacting action and heating capability as the main screed unit, except for use on variable depth tapered areas and/or as approved by the Engineer.

The spreading and finishing machine shall be equipped with an

approved automatic dual longitudinal screed control system and automatic transverse screed control system. The longitudinal controls shall be capable of operating from any longitudinal grade reference including a stringline, ski, mobile stringline, or matching shoe.

The Contractor shall furnish all equipment required for grade reference. It shall be maintained in good operating condition by personnel trained in the use of this type of equipment.

The grade reference used by the Contractor may be of any type approved by the Engineer. Control points, if required by the plans, shall be established for the finished profile in accordance with Item 5, "Control of the Work". These points shall be set at intervals not to exceed 15 meters. The Contractor shall set the grade reference from the control points. The grade reference shall have sufficient support so that the maximum deflection shall not exceed two (2) millimeters between supports.

(b) Tractor Unit. The tractor unit shall be equipped with a hydraulic hitch sufficient in design and capacity to maintain contact between the rear wheels of the hauling equipment and the pusher rollers of the finishing machine while the mixture is being unloaded.

No portion of the mass of hauling equipment, other than the connection, shall be supported by the asphalt paver. No vibrations or other motions of the loading equipment, which could have a detrimental effect on the riding quality of the completed pavement, shall be transmitted to the paver.

The use of any vehicle which requires dumping directly into the finishing machine and which the finishing machine cannot push or propel to obtain the desired lines and grades without resorting to hand finishing will not be allowed.

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(5) Material Transfer Equipment. Equipment to transfer mixture from the hauling units or the roadbed to the spreading and finishing machine will be allowed unless otherwise shown on the plans. A specific type of material transfer equipment shall be required when shown on the plans.

(a) Windrow Pick-Up Equipment. Windrow pick-up equipment shall be constructed in such a manner that substantially all the mixture deposited on the roadbed is picked up and loaded into the spreading and finishing machine. The mixture shall not be contaminated with foreign material. The loading equipment shall be designed so that it does not interfere with the spreading and finishing machine in obtaining the required line, grade and surface without resorting to hand finishing.

(b) Material Feeding System. Material feeding systems shall be designed to provide a continuous flow of uniform mixture to the spreading and finishing machine. When use of a material feeding system is required on the plans, it shall meet the storage capacity, remixing capability, or other requirements shown on the plans.

(6) Motor Grader. The motor grader, when used, shall be a self-propelled power motor grader and shall be equipped with smooth tread pneumatic tired wheels unless otherwise directed. It shall have a blade length of not less than 3.6 meters and a wheelbase of not less than 4.8 meters.

(7) Rollers. Rollers provided shall meet the requirements for their type as follows:

(a) Pneumatic-Tire Roller. The roller shall be an acceptable medium pneumatic tire roller conforming to the requirements of Item 213, "Rolling (Pneumatic Tire)", Type A, unless otherwise specified on the plans. Pneumatic-tire rollers used for compaction shall provide a minimum 550 kilopascals ground contact pressure. When used for kneading and sealing the surface only, they shall provide a minimum of 380 kilopascals ground contact pressure.

(b) Two-Axle Tandem Roller. This roller shall be an acceptable self-propelled tandem roller weighing not less than 7.2 megagrams.

(c) Three-Wheel Roller. This roller shall be an acceptable self-propelled three wheel roller weighing not less than 9.1 megagrams.

(d) Three-Axle Tandem Roller. This roller shall be an acceptable self-propelled three axle roller weighing not less than 9.1 megagrams.

(e) Trench Roller. This roller shall be an acceptable self-propelled trench roller equipped with a sprinkler for keeping the wheels wet and an adjustable road wheel so that the roller may be kept level during rolling. The drive wheel shall be not less than 500 millimeters wide. The roller under working conditions shall produce not less than 5800 kilograms per meter of roller width and be so geared that a speed of approximately three (3) kilometers per hour is obtained in low gear.

(f) Vibratory Steel-Wheel Roller. This roller shall have a minimum mass of 5.4 megagrams. The compactor shall be equipped with amplitude and frequency controls and shall be specifically designed to compact the material on

which it is used.

(8) Straightedges and Templates. When directed by the Engineer, the Contractor shall provide acceptable 3-meter straightedges for surface testing. Satisfactory templates shall be provided as required by the Engineer.

(9) Alternate Equipment. When permitted by the Engineer, equipment other than that specified herein which will consistently produce satisfactory results may be used.

340.5. Stockpiling, Storage and Mixing.

(1) Stockpiling of Aggregates.

(a) Weigh-Batch Plant. Prior to stockpiling of aggregates, the area shall be cleaned of trash, weeds, grass and shall be relatively smooth and well drained. The stockpiling shall be done in a manner that will minimize aggregate degradation, segregation, mixing of one stockpile with another, and will not allow contamination with foreign material.

The plant shall have at least a two-day supply of aggregates on hand before production can begin and at least a two-day supply shall be maintained through the course of the project, unless otherwise directed by the Engineer.

No stockpile shall contain aggregate from more than one source.

Coarse aggregates for mixture Types "A", "B" and "C" shall be separated into at least two stockpiles of different gradation, such as a large-coarse-aggregate and a small-coarse-aggregate stockpile, except when the use of large percentages of RAP preclude the need for two virgin coarse aggregate stockpiles.

When shown on the plans, coarse aggregates for Type "D" mixtures shall also be separated into at least two stockpiles.

No coarse-aggregate stockpile shall contain more than 15 percent by mass of material that will pass a 2.00 millimeter sieve.

Fine-aggregate stockpiles may contain coarse aggregate in amounts up to 20 percent by mass. This requirement does not apply to stone screenings stockpiles, which must meet the gradation requirements shown in Section 340.2.(1)(c), unless otherwise shown on the plans.

Prior to starting RAP stockpiling operations, the Contractor shall

develop and submit in writing to the Engineer an acceptable stockpile production procedure and management plan which will ensure that a homogeneous stockpile of RAP is available. Stockpiles of contractor-owned RAP material shall be completely established at the plant site prior to submission of mixture design samples and shall be of sufficient quantity to meet the material requirements of the project for which they are prepared. When shown on the plans, plant site stockpiles composed of RAP from designated sources shall be of the minimum size shown on the plans prior to submission of mixture design samples.

When required by the Engineer, additional material shall not be added to stockpiles that have previously been sampled for approval.

Equipment of an acceptable size and type shall be furnished to work the stockpiles and prevent segregation and degradation of the aggregates.

(b) Modified Weigh-Batch Plant. The stockpiling requirements for aggregate shall be the same as required for a drum-mix type plant.

(c) Drum-Mix Plant. When a drum-mix plant is used, the following stockpiling requirements for coarse aggregates shall apply in addition to the aggregate stockpiling requirements listed under Section 340.5.(l)(a).

Once a job-mix formula has been established in accordance with Article 340.3, the virgin coarse aggregates delivered to the stockpiles shall

not vary on any grading size fraction by more than plus or minus eight (8) percentage points from the percentage found in the samples submitted by the Contractor and upon which the job-mix formula was based. Should the gradation of virgin coarse aggregates in the stockpiles vary by more than the allowed tolerance, the Engineer may stop production. If production is stopped, new aggregates shall be furnished that meet the gradations of the aggregates submitted for the job-mix formula, or a new mix design shall be formulated in accordance with Article 340.3.

When the volume of production from a commercial plant makes sampling of all coarse aggregate delivered to the stockpiles impractical, cold feeds will be sampled to determine stockpile uniformity. Should this sampling prove the stockpiles non-uniform beyond the acceptable tolerance, separate stockpiles which meet these specifications may be required.

(d) Specialized Recycling Plant. The stockpiling requirements for aggregate shall be the same as required for drum-mix type plant.

(2) Storage and Heating of Asphaltic Materials. The asphaltic material

storage capacity shall be ample to meet the requirements of the plant. Asphalt shall not be heated to a temperature in excess of that specified in Item 300, "Asphalts, Oils and Emulsions". All equipment used in the storage and handling of asphaltic material shall be kept in a clean condition at all times and shall be operated in such a manner that there will be no contamination with foreign matter.

(3) Feeding and Drying of Aggregate. The feeding of various sizes of aggregate and RAP, if applicable, to the dryer shall be done through the cold aggregate bins and the proportioning device in such a manner that a uniform and constant flow of materials in the required proportions will be maintained. The aggregate shall be dried and heated to the temperature necessary to produce a mixture having the specified temperature.

(4) Mixing and Storage.

(a) Weigh-Batch Plant. In introducing the batch into the mixer, all aggregate shall be introduced first and shall be mixed thoroughly for a minimum period of five (5) seconds to uniformly distribute the various sizes throughout the batch before the asphaltic material is added. The asphaltic material shall then be added and the mixing continued for a wet mixing period of not less than 15 seconds. The mixing period shall be increased if, in the opinion of the Engineer, the mixture is not uniform or the aggregates are not properly coated.

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Temporary storing or holding of the asphaltic mixture by the surge-storage system will be permitted during the normal day's operation. Overnight storage will not be permitted unless authorized in the plans or by the Engineer. The mixture coming out of the surge-storage bin shall be of equal quality to that coming out of the mixer.

(b) Modified Weigh-Batch Plant. The mixing and storage requirements shall be the same as is required for a standard weigh-batch plant.

(c) Drum-Mix Plant. The amount of aggregate and asphaltic material entering the mixer and the rate of travel through the mixing unit shall be so coordinated that a uniform mixture of the specified grading and asphalt content will be produced.

Temporary storing or holding of the asphaltic mixture by the surge-storage system will be required during the normal day's operation. Overnight storage will not be permitted unless authorized in the plans or by the Engineer. The mixture coming out of the surge-storage bin shall be of equal quality to that coming out of the mixer.

(d) Specialized Recycling Plant. The mixing and storage requirements shall be the same as that stated for the drum-mix plant.

(e) Discharge Temperature. The Engineer will select the target discharge temperature of the mixture between 120 °C and 175 °C. The mixture, when discharged from the mixer, shall not vary from this selected temperature more than 15 °C, but in no case shall the temperature exceed 180 °C.

(f) Moisture Content. The mixture produced from each type of mixer shall have a moisture content not greater than one (1) percent by mass when discharged from the mixer, unless otherwise shown on the plans and/or approved by the Engineer. The moisture content shall be determined in accordance with Test Method Tex-212-F.

(g) RAP. If RAP is used, it shall be mixed and blended so that there is no evidence of unseparated particles in the mixture as it leaves the mixer.

340.6. Construction Methods.

(1) General. It shall be the responsibility of the Contractor to produce, transport, place and compact the specified paving mixture in accordance with the requirements herein.

The asphaltic mixture, when placed with a spreading and finishing machine, or the tack coat shall not be placed when the air temperature is below 10 °C and is falling, but it may be placed when the air temperature is above 5 °C and is rising.

The asphaltic mixture, when placed with a motor grader, shall not be placed when the air temperature is below 15 °C and is falling, but may be placed when the air temperature is above 10 °C and is rising.

The air temperature shall be taken in the shade away from artificial heat.

Mat thicknesses of 40 millimeters and less shall not be placed when the temperature of the surface on which the mat is to be placed is below 10 °C.

Mixtures with lightweight coarse aggregate shall not be placed when the temperature of the surface on which the mat is to be placed is below 10 °C.

Additional surface temperature requirements may be shown on the plans.

It is further provided that the tack coat or asphaltic mixture shall be placed only when the humidity, general weather conditions and temperature and moisture condition of the base, in the opinion of the Engineer, are suitable.

If, after being discharged from the mixer and prior to placing, the temperature of the asphaltic mixture is 10 °C or more below the selected discharge temperature established by the Engineer, all or any part of the load may be rejected and payment will not be made for the rejected material.

(2) Tack Coat. The surface upon which the tack coat is to be placed shall be cleaned thoroughly to the satisfaction of the Engineer. The surface shall be given a uniform application of tack coat using asphaltic

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materials of this specification. This tack coat shall be applied, as directed by the Engineer, with an approved sprayer at a rate not to exceed 0.2 liter residual

asphalt per square meter of surface. Where the mixture will adhere to the surface on which it is to be placed without the use of a tack coat, the tack coat may be eliminated by the Engineer. All contact surfaces of curbs and structures and all joints shall be painted with a thin uniform application of tack coat. During the application of tack coat, care shall be taken to prevent splattering of adjacent pavement, curb and gutter and structures. The tack coat shall be rolled with a pneumatic tire roller when directed by the Engineer.

(3) Transporting Asphaltic Concrete. The asphaltic mixture shall be hauled to the work site in tight vehicles previously cleaned of all foreign material. The dispatching of the vehicles shall be arranged so that all material delivered is placed and all rolling completed during daylight hours unless otherwise shown on the plans. In cool weather or for long hauls, covering and insulating of the truck bodies may be required. If necessary, to prevent the mixture from adhering to the body, the inside of the truck may be given a light coating of release agent satisfactory to the Engineer.

(4) Placing.

(a) The asphaltic mixture shall be dumped and spread on the approved prepared surface with the spreading and finishing machine. When properly compacted, the finished pavement shall be smooth, of uniform texture and density and shall meet the requirements of the typical cross sections and the surface tests. In addition, the placing of the asphaltic mixture shall be done without tearing, shoving, gouging or segregating the mixture and without producing streaks in the mat.

Unloading into the finishing machine shall be controlled so that bouncing or jarring the spreading and finishing machine shall not occur and the required lines and grades shall be obtained without resorting to hand finishing, except as shown under Section 340.6.(4)(d).

Unless otherwise shown on the plans, dumping of the asphaltic mixture in a windrow and then placing the mixture in the finishing machine with windrow pick-up equipment will be permitted. The windrow pick-up equipment shall be operated in such a manner that substantially all the mixture deposited on the roadbed is picked up and loaded into the finishing machine without contamination by foreign material. The windrow pick-up equipment will be so operated that the finishing machine will obtain the required line, grade and surface without resorting to hand finishing. Any

operation of the windrow pick-up equipment resulting in the accumulation and subsequent shedding of accumulated material into the asphaltic mixture will not be permitted.

(b) When approved by the Engineer, level-up courses may be spread with a motor grader.

(c) The spreading and finishing machine shall be operated at a uniform forward speed consistent with the plant production rate, hauling capability, and roller train capacity to result in a continuous operation. The speed shall be slow enough that stopping between trucks is not ordinarily required. If, in the opinion of the Engineer, sporadic delivery of material is adversely affecting the mat, the Engineer may require paving operations to cease until acceptable methods are provided to minimize starting and stopping of the paver.

The hopper flow gates of the spreading and finishing machine shall be adjusted to provide an adequate and consistent flow of material. These shall result in enough material being delivered to the augers so that they are operating approximately 85 percent of the time or more. The augers shall provide means to supply adequate flow of material to the center of the paver. Augers shall supply an adequate flow of material for the full width of the mat, as approved by the Engineer. Augers should be kept approximately one-half to three-quarters full of mixture at all times during the paving operation.

(d) When the asphaltic mixture is placed in a narrow strip along the edge of an existing pavement, or used to level up small areas of an existing pavement, or placed in small irregular areas where the use of a finishing machine is not practical, the finishing machine may be eliminated when authorized by the Engineer.

(e) Adjacent to flush curbs, gutters and structures, the surface shall be finished uniformly high so that when compacted it will be slightly above the edge of the curb or structure.

(f) Construction joints of successive courses of asphaltic material shall be offset at least 150 millimeters. Construction joints on surface courses shall coincide with lane lines, or as directed by the Engineer.

(g) If a pattern of surface irregularities or segregation is detected, the Contractor shall make an investigation into the causes and immediately take the necessary corrective action. With the approval of the Engineer,

placement may continue for no more than one full production day from the time the Contractor is first notified and while corrective actions are being taken. If the problem still exists after that time, paving shall cease until the Contractor further investigates the causes and the Engineer approves further corrective action to be taken.

(5) Compacting.

(a) The pavement shall be compacted thoroughly and uniformly with the necessary rollers to obtain the compaction and cross section of the finished paving mixture meeting the requirements of the plans and specifications.

(b) When rolling with the three-wheel, tandem or vibratory rollers, rolling shall start by first rolling the joint with the adjacent pavement and then continue by rolling longitudinally at the sides and proceed toward the center of the pavement, overlapping on successive trips by at least 300 millimeters, unless otherwise directed by the Engineer. Alternate trips of the roller shall be slightly different in length. On super-elevated curves, rolling shall begin at the low side and progress toward the high side, unless otherwise directed by the Engineer.

When rolling with vibratory steel-wheel rollers, equipment operation shall be in accordance with Item 217, "Rolling (Vibratory)", and the manufacturer's recommendations, unless otherwise directed by the Engineer. Vibratory rollers shall not be left vibrating while not rolling or when changing directions. Unless otherwise shown on the plans or approved by the Engineer, vibratory rollers shall not be allowed in the vibrating mode on mats with a plan depth of less than 40 millimeters.

The motion of the rollers shall be slow enough to avoid other than usual initial displacement of the mixture. If any displacement occurs, it shall be corrected to the satisfaction of the Engineer. The roller shall not be allowed to stand on pavement which has not been fully compacted. To prevent adhesion of the surface mixture to the steel-wheel rollers, the wheels shall be kept thoroughly moistened with water, but an excess of water will not be permitted. Necessary precautions shall be taken to prevent the dropping of diesel, gasoline, oil, grease or other foreign matter on the pavement, either when the rollers are in operation or when standing.

(c) The edges of the pavement along curbs, headers and similar structures, and all places not accessible to the roller, or in such positions as will not allow thorough compaction with the rollers, shall be thoroughly compacted with lightly oiled tamps.

(d) Rolling with a trench roller will be required on widened areas, in trenches and other limited areas where satisfactory compaction cannot be obtained with the approved rollers.

(6) In-Place Compaction Control. In-place compaction control is required for all mixtures. Unless otherwise shown on the plans, air void control shall be required.

(a) Air Void Control. The Contractor shall be responsible for determining the number and type of rollers to be used to obtain compaction to within the air void range required herein. The rollers shall be operated in accordance with the requirements of this specification and as approved by the Engineer.

Unless otherwise shown on the plans, rolling with a pneumatic-tire roller to seal the surface shall be provided. Rolling with a tandem or other steel-wheel roller shall be provided if required to iron out any roller marks.

Asphaltic concrete shall be placed and compacted to contain from five (5) to nine (9) percent air voids. The percent air voids will be calculated using the maximum theoretical specific gravity of the mixture determined according to Test Method Tex-227-F. Roadway specimens, which shall be either cores or sections of asphaltic pavement, will be tested according to Test Method Tex-207-F. The nuclear-density gauge or other methods which correlate satisfactorily with results obtained from project roadway specimens may be used when approved by the Engineer. Unless otherwise shown on the plans, the Contractor shall be responsible for obtaining the required roadway specimens at his expense and in a manner and at locations selected by the Engineer.

If the percent air voids in the compacted placement is greater than nine (9) percent but is 10 percent or less, production may proceed with subsequent changes in the construction operations and/or mixture. If the air void content is not reduced to between five (5) and nine (9) percent within one production day from the time the Contractor is notified, production shall cease. At that point, a test section as described below shall be required.

If the percent air voids is more than 10 percent, production shall cease immediately and a test section shall be required as described below.

In either case, the Contractor shall only be allowed to place a test section of one lane width, not to exceed 300 meters in length, to demonstrate that compaction to between five (5) and nine (9) percent air voids can be obtained. This procedure will continue until a test section with five (5) to nine (9) percent air voids can be produced. Only two (2) test sections per day will be allowed. When a test section producing satisfactory air void content is placed, full production may then resume.

Increasing the asphalt content of the mixture in order to reduce pavement air voids will not be allowed.

If the percent air voids is determined to be less than five (5) percent, immediate adjustments shall be made to the plant production by the Contractor, as approved by the Engineer, within the tolerances as outlined in Subarticle 340.3.(4), so that an adequate air void level results.

The Contractor is encouraged to perform supplemental compaction testing for his own information.

(b) Ordinary Compaction Control. When the requirement of air void control has been removed by plan note, one (1) three-wheel roller, one (1) pneumatic-tire roller, and one (1) tandem roller shall be furnished for each compaction operation except as provided below or approved by the Engineer. The use of a tandem roller may be waived by the Engineer when the surface is already adequately smooth and further steel-wheel rolling is shown to be ineffective. With approval of the Engineer, the Contractor may substitute a vibratory roller for the three-wheel roller and/or the tandem roller. Use of at least one (1) pneumatic-tire roller is required. Additional or heavier rollers shall be furnished if required by the Engineer.

Rolling patterns shall be established by the Contractor as outlined in Test Method Tex-207-F, Part IV, to achieve the maximum compaction, unless otherwise directed by the Engineer. The selected rolling pattern shall be followed unless changes in the mixture or placement conditions occur which affect compaction. When changes in the mixture or placement conditions occur, a new rolling pattern shall be established.

(c) Compaction Cessation Temperature. Regardless of the method required for in-place compaction control, all rolling for compaction shall be completed before the mixture temperature drops below 80 °C.

(7) Ride Quality. Unless otherwise shown on the plans, Ride Quality will be required in accordance with Item 585, "Ride Quality for Pavement Surfaces".

(8) Opening to Traffic. The pavement shall be opened to traffic when directed by the Engineer. The Contractor's attention is directed to the fact that all construction traffic allowed on the pavement open to the public will be subject to the State laws governing traffic on highways.

If the surface ravels, flushes, ruts or deteriorates in any manner prior to final acceptance of the work, it will be the Contractor's responsibility to correct this condition at his expense, to the satisfaction of the Engineer and in conformance with the requirements of this specification.

340.7. Measurement. The quantity of asphaltic concrete will be measured by the composite mass or composite volumetric method.

(1) Composite Mass Method. Asphaltic concrete will be measured by the megagram of the composite "Asphaltic Concrete" of the type actually used in the completed and accepted work in accordance with the plans and specifications for the project. The composite asphaltic concrete mixture is hereby defined as the asphalt, aggregate, RAP and additives as noted in the plans and/or approved by the Engineer.

If mixing is done by a drum-mix plant or specialized recycling plant, measurement will be made on scales as specified herein.

If mixing is done by a weigh-batch plant or modified weigh-batch plant, measurement will be determined on the batch scales unless surge-storage is used. Records of the number of batches, batch design and the mass of the composite "Asphaltic Concrete" shall be kept. Where surge-storage is used, measurement of the material taken from the surge-storage bin will be made on truck scales or suspended hopper scales.

(2) Composite Volumetric Method. The asphaltic concrete will be measured by the cubic meter of compacted "Asphaltic Concrete" of the type actually used in the completed and accepted work in accordance with the plans and specifications for the project. The composite asphaltic concrete mixture is hereby defined as the asphalt, aggregate, RAP and additives as noted in the plans and/or approved by the Engineer. The volume of the composite asphaltic concrete mixture shall be calculated by the following formula:

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$$V = \frac{W}{1000\ G_a}$$

V = Cubic meters of compacted "Asphaltic Concrete"
W = Total mass of asphaltic concrete in kilograms
G_a = Average actual specific gravity of three (3) molded specimens as prepared by Test Method Tex-206-F and determined in accordance with Test Method Tex-207-F.

If mixing is done by a drum-mix plant or specialized recycling plant, the mass "W" will be determined by scales as specified herein.

If mixing is done by a weigh-batch plant or modified weigh-batch plant and surge-storage is not used, mass will be determined by batch scales and records of the number of batches, batch designs and mass of asphalt and aggregate shall be kept. Where surge-storage is used, measurement of the material taken from the surge-storage bin will be made on truck scales or suspended hopper scales.

(3) Ride Quality. Ride quality will be measured as described in Item 585, "Ride Quality for Pavement Surfaces".

340.8. Payment.

(1) The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for the "Asphaltic Concrete" of the type specified.

Measurement Method	Bid Item	Unit of Measure
Composite Mass	Asphaltic Concrete	Megagram
Composite Volumetric	Asphaltic Concrete	Cubic Meter

The payment based on the unit bid price shall be full compensation for quarrying, furnishing all materials, additives, freight involved, for all heating, mixing, hauling, cleaning the existing base course or pavement, tack coat, placing, rolling and finishing asphaltic concrete mixture, transporting RAP from designated sources, transporting any excess RAP to locations shown on the plans, and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work.

342.1 to 342.2

(2) When surface Test Type-B, as specified in Item 585, "Ride Quality for Pavement Surfaces", is used, a bonus or deduction for each 0.1609 kilometer section of each travel lane will be calculated in dollars and cents. A running total of this will be determined for each day's production. The bonus or deduction for ride quality will be paid for separately from the payment for the material placed.

(3) All templates, straightedges, core drilling equipment, scales and other weighing and measuring devices necessary for the proper construction, measuring and checking of the work shall be furnished, operated and maintained by the Contractor at his expense.

(4) State owned RAP from sources designated on the plans will be available at no cost to the Contractor.

ITEM 342

PLANT MIX SEAL

342.1. Description. This Item shall govern for the construction of a wearing surface composed of a compacted mixture of aggregate and asphalt cement mixed hot in a mixing plant, in accordance with the details shown on the plans and the requirements herein.

342.2. Materials. The Contractor shall furnish materials to the project meeting the following requirements prior to mixing. Additional test requirements affecting the quality of individual materials or the plant mix seal mixture shall be required when indicated on the plans.

(1) Aggregate.

(a) Description. Except for gradation limitations, aggregates shall conform to the material requirements of Item 302, "Aggregates for Surface Treatments", or Item 303, "Aggregate for Surface Treatments (Lightweight)". Gravel used as coarse aggregate shall be so crushed as to have a minimum of 85 percent of the particles retained on the 4.75 millimeter sieve having two (2) or more mechanically induced crushed faces, as determined by Test Method Tex-460-A, Part I.

When aggregate requiring polish value is supplied from a source that is rated by the Materials and Tests Division, the Rated Source Polish Value (RSPV) catalog will be used to determine polish value compliance.

342.2

When aggregate is supplied from a source that is not rated, the aggregate will be

sampled and tested prior to use. The procedures will be in accordance with Test Methods Tex-400-A and Tex-438-A, Part I. The test value will not be less than the value shown on the plans.

Blending of aggregates to achieve polish value will not be permitted, unless otherwise shown on the plans. If blending is allowed, Test Method Tex-438-A, Part II, Method B will be used to determine the required blend percentages.

(b) Grades. The aggregate gradation shall conform to the master gradation limits for the grade shown on the plans:

		Percent by Mass or Volume
Grade 1:	Retained on 16.0 mm sieve	0
	Retained on 12.5 mm sieve	0-5
	Retained on 9.5 mm sieve	20-50
	Retained on 4.75 mm sieve	92-100
	Retained on 2.00 mm sieve	96-100
*Grade 2:	Retained on 16.0 mm sieve	0
	Retained on 12.5 mm sieve	0-5
	Retained on 9.5 mm sieve	20-50
	Retained on 4.75 mm sieve	80-95
	Retained on 2.00 mm sieve	85-95

Grade 3: As shown on plans

* Grade 2 aggregate may include fine aggregate meeting the requirements of Section 340.2.(1)(c). A maximum of 10.0 percent by mass or volume of fine aggregate may be required by the Engineer. The bulk specific gravity will be determined for each aggregate to be used in the mixture. If the determined values vary by 0.300 or more, the mixture proportions will be by the Volumetric Method, Test Method Tex-204-F, Part II.

Unless otherwise shown on the plans, the gradation of the aggregate determined in accordance with Test Method Tex-200-F (Dry Sieve Analysis) shall meet the above requirements prior to plant mixing with asphaltic material.

342.3

(2) Asphaltic Materials.

(a) The asphaltic material for plant mix seal shall be asphalt cement meeting the requirements of Item 300, "Asphalts, Oils and Emulsions". The

grade of asphalt shall be designated by the Engineer after design tests have been made with the proposed aggregates. The Contractor shall notify the Engineer of the source of asphaltic material prior to design of the plant mix seal. This source shall not be changed during the course of the project, except on written permission by the Engineer.

(b) Tack Coat. Asphaltic materials shown on the plans or approved by the Engineer shall meet the requirements of Item 300, "Asphalts, Oils and Emulsions".

(3) Additives. Additives to facilitate mixing and/or improve the quality of the plant mix seal or tack coat shall be used when noted on the plans or may be used with the authorization of the Engineer.

Unless otherwise shown on the plans, the Contractor may choose to use either lime or a liquid antistripping agent to reduce the moisture susceptibility of the aggregate. The evaluation and addition of antistripping agents will be in accordance with Item 301, "Asphalt Antistripping Agents".

342.3. Plant Mix Seal Surfacing Mixture.

(1) General. The mixture shall be uniform and consist of aggregate and asphalt cement. The Engineer will select the asphalt content to be used in the mixture after tests have been made with the proposed aggregates.

Unless otherwise shown on the plans, the mixture of aggregate, asphalt and additives proposed for use will be evaluated in the design stage for moisture susceptibility in accordance with Item 301, "Asphalt Antistripping Agents". The Engineer may waive this test if a similar design, using the same ingredients, has proven satisfactory.

(2) Tolerances. The gradation of the aggregate shall not vary from the master gradation limits for the specified grade. The asphalt content of the mixture shall not vary from the asphalt content selected by the Engineer by more than 0.7 percent by mass or 1.7 percent by volume, when tested in accordance with Test Method Tex-210-F or Test Method Tex-228-F. If the plant mix seal produced varies from the asphalt content tolerance, adjustments shall be made by the Contractor until the plant mix seal meets this requirement.
342.4

342.4. Equipment.

(1) General. All equipment for the handling of all materials, mixing, placing and compacting of the plant mix seal shall be maintained in good repair and operating condition and subject to the approval of the Engineer. Any equipment found to be defective and potentially having a negative effect on the

quality of the plant mix seal will not be allowed.

(2) Mixing Plants. Mixing plants may be the weigh-batch type, the modified weigh-batch type, or the drum-mix type. All plants shall be equipped with satisfactory conveyors, power units, mixing equipment, aggregate handling equipment, bins and dust collectors.

Automatic proportioning devices are required for all plants and shall be in accordance with Item 520, "Weighing and Measuring Equipment".

It shall be the Contractor's responsibility to provide safe and accurate means to enable inspection forces to take all required samples, to provide permanent means for checking the output of any specified metering device, and to perform calibration and mass checks as required by the Engineer.

When using fuel oil heavier than Grade No. 2, or waste oil, the Contractor shall insure that the fuel delivered to the burner is at a viscosity of 100 SSU or less, when tested in accordance with Test Method Tex-534-C, to insure complete burning of the fuel. Higher viscosities will be allowed if recommended by the burner manufacturer. If necessary, the Contractor shall preheat the oil to maintain the required viscosity.

The Contractor shall provide means for obtaining a sample of the fuel, just prior to entry into the burner, in order to perform the viscosity test. The Contractor shall perform this test or provide a laboratory test report that will establish the temperature of the fuel necessary to meet the viscosity requirements. There shall be an in-line thermometer to check the temperature of the fuel delivered to the burner.

Regardless of the burner fuel used, the burner or combination of burners and types of fuel used shall provide a complete burn of the fuel and not leave any fuel residue that will adhere to the heated aggregate.

(a) Weigh-Batch Type.

Cold Aggregate Bin Unit and Proportioning Device. The cold aggregate bin unit shall have a separate bin for each aggregate which is of sufficient size to store the amount of aggregate required to keep the plant in continuous operation and of proper design to prevent overflow of material from one bin to another. There shall be vertical partitions between each bin and on each end of the bins of sufficient height so that any overflow will be to the front and back, and not allow overflow to the sides or between bins. Overflow that might occur shall not fall onto any feeder belt. The proportioning device shall provide a uniform and continuous flow of aggregate in the desired proportion to the dryer. Each aggregate shall be proportioned from a separate bin.

Dryer. The dryer shall continually agitate the aggregate during heating. The temperature shall be controlled so that the aggregate will not be damaged in the drying and heating operations. The dryer shall be of sufficient size to keep the plant in continuous operation.

Screening and Proportioning. The screening capacity and size of the hot aggregate bins shall be sufficient to screen and store the amount of aggregate required to properly operate the plant and keep the plant in continuous operation at full capacity. The hot bins shall be constructed so that oversize and overloaded material will be discarded through overflow chutes. Provisions shall be made to enable inspection forces to have easy and safe access to the proper location on the mixing plant where representative samples may be taken from the hot bins for testing.

Aggregate Weigh Box and Batching Scale. The aggregate weigh box and batching scales shall be of sufficient capacity to hold and weigh a complete batch of aggregate. The weigh box and scales shall conform to the requirements of Item 520, "Weighing and Measuring Equipment".

Asphaltic Material Measuring System. If an asphaltic material bucket and scales are used, they shall be of sufficient capacity to hold and weigh the necessary asphaltic material for one batch. The bucket and scales shall conform to the requirements of Item 520, "Weighing and Measuring Equipment".

If a pressure type flow meter is used to measure the asphaltic material, the requirements of Item 520, "Weighing and Measuring Equipment", shall apply. This system shall include an automatic temperature compensation device to insure a constant percent by mass of asphaltic material in the plant mix seal.

Provisions of a permanent nature shall be made for checking the accuracy of the asphaltic material measuring device. The asphalt line to the measuring device shall be protected with a jacket of hot oil or other approved means to maintain the temperature of the line near the temperature specified for the asphaltic material.

Mixer. The mixer shall be of the pugmill type and shall have a capacity of not less than 1350 kilograms (of natural-aggregate mixture) in a single batch, unless otherwise shown on the plans. Any mixer that has a tendency to segregate the aggregate or fails to secure a thorough and uniform mixture with the asphaltic material shall not be used. All mixers shall be provided with an automatic timer that will lock the discharge doors of the mixer for the required mixing period. The dump door or doors and the shaft seals of the mixer shall be tight enough to prevent spilling of aggregate or mixture from the pugmill.

Surge-Storage System and Scales. A surge-storage system may be used to minimize the production interruptions during the normal day's operations. A device such as a gob hopper or other device approved by the Engineer to prevent segregation in the surge-storage bin shall be used. The plant mix seal shall be weighed upon discharge from the surge-storage system.

When a surge-storage system is used, scales shall be standard platform truck scales or other equipment such as weigh hopper (suspended) scales and shall conform to Item 520, "Weighing and Measuring Equipment". If truck scales are used, they shall be placed at a location approved by the Engineer. If other weighing equipment is used, the Engineer may require mass checks by truck scales for the basis of approval of the equipment.

Recording Device and Record Printer. The plant mix seal shall be weighed for payment. If a surge-storage system is used, an automatic recording device and a digital record printer shall be provided to indicate the date, project identification number, vehicle identification, total mass of the load, tare mass of the vehicle, the mass of plant mix seal in each load and the number of loads for the day, unless otherwise indicated on the

plans. When surge-storage is not used, batch mass shall be used as the basis for payment and automatic recording devices and automatic digital record printers in accordance with Item 520, "Weighing and Measuring Equipment", shall be required.

(b) Modified Weigh-Batch Type.

General. This plant is similar to the weigh-batch type plant. The hot bin screens shall be removed and the aggregate control is placed at the cold feeds. The cold feed bins will be the same as those required for the drum-mix type plant.

Cold-Aggregate Bin Unit and Feed System. The number of bins in the cold-aggregate bin unit shall be equal to or greater than the number of stockpiles of individual materials to be used.

The bins shall be of sufficient size to store the amount of aggregate required to keep the plant in continuous operation and of proper design to prevent overflow of material from one bin to another. There shall be vertical partitions between each bin and on each end of the bins of sufficient height so that any overflow will be to the front and back and not allow overflow to the sides or between bins. Overflow that might occur shall not fall onto any feeder belt. The feed system shall provide a uniform and continuous flow of aggregate in the desired proportion to the dryer. The Contractor shall furnish a chart indicating the calibration of each cold bin in accordance with the manufacturer's recommendation, or other methods of cold bin calibration acceptable to the Engineer, when more than one bin is to be used.

Scalping Screen. A scalping screen shall be required after the cold feeds and ahead of the hot aggregate surge bins.

Dryer. The dryer shall continually agitate the aggregate during heating. The temperature shall be controlled so that the aggregate will not be damaged in the drying and heating operations. The dryer shall be of sufficient size to keep the plant in continuous operation.

Screening and Proportioning. The hot aggregate shall not be separated into sizes after being dried. There shall be one or more surge bins provided between the dryer and the weigh hopper. Surge bins shall be of sufficient size to hold enough combined aggregate for one complete batch of plant mix seal.

Aggregate Weigh Box and Batching Scale. The aggregate weigh box and batching scales shall be of sufficient capacity to hold and weigh a complete batch of aggregate. The weigh box and scales shall conform to the requirements of Item 520, "Weighing and Measuring Equipment".

Asphaltic Material Measuring System. If an asphaltic material bucket and scales are used, they shall be of sufficient capacity to hold and weigh the necessary asphaltic material for one batch. The bucket and scales shall conform to the requirements of Item 520, "Weighing and Measuring Equipment".

If a pressure type flow meter is used to measure the asphaltic material, the requirements of Item 520, "Weighing and Measuring Equipment", shall apply. This system shall include an automatic temperature compensation device to insure a constant percent by mass of asphaltic material in the mixture.

Provisions of a permanent nature shall be made for checking the accuracy of the asphaltic material measuring device. The asphalt line to the measuring device shall be protected with a jacket of hot oil or other approved means to maintain the temperature of the line near the temperature specified for the asphaltic material.

Mixer. The mixer shall be of the pugmill type and shall have a capacity of not less than 1350 kilograms (of natural-aggregate mixture) in a single batch, unless otherwise shown on the plans. Any mixer that has a tendency to segregate the aggregate or fails to secure a thorough and uniform mixture with the asphaltic material shall not be used. All mixers shall be provided with an automatic timer that will lock the discharge doors of the mixer for the required mixing period. The dump door or doors and the shaft seals of the mixer shall be tight enough to prevent spilling of aggregate or mixture from the pugmill.

Surge-Storage System and Scales. A surge-storage system may be used to minimize the production interruptions during the normal day's operations. A device such as a gob hopper or other device approved by the Engineer to prevent segregation in the surge-storage bin shall be used. The plant mix seal shall be weighed upon discharge from the surge-storage system.

When a surge-storage system is used, scales shall be standard platform truck scales or other equipment such as weigh hopper (suspended) scales and shall conform to Item 520, "Weighing and Measuring Equipment". If truck scales are used, they shall be placed at a location approved by the Engineer. If other weighing equipment is used, the Engineer may require mass checks by truck scales for the basis of approval of the equipment.

Recording Device and Record Printer. The plant mix seal shall be weighed for payment. If a surge-storage system is used, an automatic recording device and a digital record printer shall be provided to indicate the date, project identification number, vehicle identification, total mass of the load, tare mass of the vehicle, the mass of plant mix seal in each load and the number of loads for the day, unless otherwise indicated on the plans. When surge-storage is not used, batch mass shall be used as the basis for payment and automatic recording devices and automatic digital record printers in accordance with Item 520, "Weighing and Measuring Equipment", shall be required.

(c) Drum-Mix Type.

General. The plant shall be adequately designed and constructed for the process of mixing aggregates and asphalt. The plant shall be equipped with satisfactory conveyors, power units, aggregate-handling equipment and feed controls.

Cold-Aggregate Bin Unit and Feed System. The number of bins in the cold-aggregate bin unit shall be equal to or greater than the number of stockpiles of individual materials to be used.

The bins shall be of sufficient size to store the amount of aggregate required to keep the plant in continuous operation and of proper design to prevent overflow of material from one bin to another. There shall be vertical partitions between each bin and on each end of the bins of sufficient height so that any overflow will be to the front and back and not allow overflow to the sides or between bins. Overflow that might occur shall not fall onto any feeder belt. The feed system shall provide a uniform and continuous flow of aggregate in the desired proportion to the mixer. The Contractor shall furnish a chart indicating the calibration of each cold bin in accordance with the manufacturer's recommendation, or other methods of cold bin calibration acceptable to the Engineer, when more than one bin is used.

The system shall provide positive mass measurement of the combined cold-aggregate feed by use of belt scales or other approved devices. Provisions of a permanent nature shall be made for checking the accuracy of the measuring device as required by Item 520, "Weighing and Measuring Equipment". When a belt scale is used, plant mix seal production shall be maintained so that the scale normally operates between 50 percent and 100 percent of its rated capacity. Belt scale operation below 50 percent of the rated capacity may be allowed by the Engineer if accuracy checks show the scale to meet the requirements of Item 520, "Weighing and Measuring Equipment", at the selected rate. It shall be satisfactorily demonstrated to the Engineer that plant mix seal uniformity and quality have not been adversely affected.

Scalping Screen. A scalping screen shall be required after the cold feeds and ahead of the combined aggregate belt scales.

Asphaltic Material Measuring System. An asphaltic material measuring device meeting the requirements of Item 520, "Weighing and Measuring Equipment", shall be placed in the asphalt line leading to the mixer so that the cumulative amount of asphalt used can be accurately determined. Provisions of a permanent nature shall be made for checking the accuracy of the measuring device output. The asphalt line to the measuring device shall be protected with a jacket of hot oil or other approved means to maintain the temperature of the line near the temperature specified for the asphaltic material. The measuring system shall include an automatic temperature compensation device to maintain a constant percent by mass of asphaltic material in the plant mix seal.

Synchronization Equipment for Feed-Control Systems. The asphaltic material feed-control shall be coupled with the total aggregate mass measuring device to automatically vary the asphalt-feed rate in order to maintain the required proportion.

Mixing System. The mixing system shall control the temperature so that the aggregate and asphalt will not be damaged in the drying, heating and mixing operations. A continuously recording thermometer shall be provided which will indicate the temperature of the plant mix seal as it leaves the mixer.

Surge-Storage System and Scales. A surge-storage system shall be used to minimize the production interruptions during the normal day's operations. A device such as a gob hopper or other device approved by the Engineer to prevent segregation in the surge-storage bin shall be used. The

plant mix seal shall be weighed upon discharge from the surge-storage system.

Scales shall be standard platform truck scales or other equipment such as weigh hopper (suspended) scales and shall conform to Item 520, "Weighing and Measuring Equipment". If truck scales are used, they shall be placed at a location approved by the Engineer. If other weighing equipment is used, the Engineer may require mass checks by truck scales for the basis of approval of the equipment.

Recording Device and Record Printer. Automatic recording devices and automatic digital record printers shall be provided to indicate the date, project identification number, vehicle identification, total mass of the load, tare mass of the vehicle, the mass of plant mix seal in each load and the number of loads for the day in accordance with Item 520, "Weighing and Measuring Equipment", unless otherwise shown on the plans.

(3) Asphaltic Material Heating Equipment. Asphaltic material heating equipment shall be adequate to heat the required amount of asphaltic material to the desired temperature. The heating apparatus shall be equipped with a continuously recording thermometer with a 24-hour chart that will record the temperature of the asphaltic material at the location of highest temperature.

(4) Spreading and Finishing Machine. The spreading and finishing machine shall be approved by the Engineer and shall meet the requirements indicated below.

(a) Screed Unit. The spreading and finishing machine shall be equipped with a heated compacting screed. It shall produce a finished surface meeting the requirements of the typical cross sections.

Extensions added to the screed shall be provided with the same compacting action and heating capability as the main screed unit, except for use on variable depth tapered areas and/or as approved by the Engineer.

The spreading and finishing machine shall be equipped with an approved automatic dual longitudinal screed control system and automatic transverse screed control system. The longitudinal controls shall be capable of operating from any longitudinal grade reference including a stringline, ski, mobile stringline, or matching shoe.

342.4

The Contractor shall furnish all equipment required for grade reference. It shall be maintained in good operating condition by personnel trained in the use of this type of equipment.

The grade reference used by the Contractor may be of any type

approved by the Engineer. Control points, if required by the plans, shall be established for the finished profile in accordance with Item 5, "Control of the Work". These points shall be set at intervals not to exceed 15 meters. The Contractor shall set the grade reference from the control points. The grade reference shall have sufficient support so that the maximum deflection shall not exceed two (2) millimeters between supports.

(b) Tractor Unit. The tractor unit shall be equipped with a hydraulic hitch sufficient in design and capacity to maintain contact between the rear wheels of the hauling equipment and the pusher rollers of the finishing machine while the plant mix seal is being unloaded.

No portion of the mass of hauling equipment, other than the connection, shall be supported by the asphalt paver. No vibrations or other motions of the loading equipment, which could have a detrimental effect on the riding quality of the completed pavement, shall be transmitted to the paver.

The use of any vehicle which requires dumping directly into the finishing machine and which the finishing machine cannot push or propel to obtain the desired lines and grades without resorting to hand finishing will not be allowed.

(5) Rollers. Rollers provided shall meet the requirements for their type as follows:

(a) Two-Axle Tandem Roller. This roller shall be an acceptable self-propelled tandem roller.

(b) Three-Wheel Roller. This roller shall be an acceptable self-propelled three wheel roller.

(c) Three-Axle Tandem Roller. This roller shall be an acceptable self-propelled three axle roller.

(6) Straightedges and Templates. When directed by the Engineer, the Contractor shall provide acceptable 3-meter straightedges for surface testing. Satisfactory templates shall be provided as required by the Engineer.

(7) Alternate Equipment. When permitted by the Engineer, equipment other than that specified herein which will consistently produce satisfactory results may be used.

342.5. Stockpiling, Storage and Mixing.

(1) Stockpiling of Aggregates. Prior to stockpiling of aggregates, the area shall be cleaned of trash, weeds, grass and shall be relatively smooth and well drained. The stockpiling shall be done in a manner that will minimize aggregate degradation, segregation, mixing of one stockpile with another, and will not allow contamination with foreign material.

The plant shall have at least a two-day supply of aggregates on hand before production can begin and at least a two-day supply shall be maintained through the course of the project, unless otherwise directed by the Engineer.

No stockpile shall contain aggregate from more than one source.

When required by the Engineer, additional material shall not be added to stockpiles that have previously been sampled for approval.

Equipment of an acceptable size and type shall be furnished to work the stockpiles and prevent segregation and degradation of the aggregates.

(2) Storage and Heating of Asphaltic Materials. The asphaltic material storage capacity shall be ample to meet the requirements of the plant. Asphalt shall not be heated to a temperature in excess of that specified in Item 300, "Asphalts, Oils and Emulsions". All equipment used in the storage and handling of asphaltic material shall be kept in a clean condition at all times and shall be operated in such a manner that there will be no contamination with foreign matter.

(3) Feeding and Drying of Aggregate. The feeding of various sizes of aggregate to the dryer shall be done through the cold aggregate bins and the proportioning device in such a manner that a uniform and constant

flow of materials in the required proportions will be maintained. The aggregate shall be dried and heated to the temperature necessary to produce a plant mix seal having the specified temperature.

(4) Mixing and Storage.

(a) Weigh-Batch Plant. In introducing the batch into the mixer, all aggregate shall be introduced first and shall be mixed thoroughly for a minimum period of five (5) seconds to uniformly distribute the various sizes throughout the batch before the asphaltic material is added. The asphaltic material shall then be added and the mixing continued for a wet mixing period of not less than 15 seconds. The mixing period shall be increased if, in the opinion of the Engineer, the plant mix seal is not uniform or the aggregates are not properly coated.

Temporary storing or holding of the plant mix seal by the surge-storage system will be permitted during the normal day's operation. The plant mix seal coming out of the surge-storage bin shall be of equal quality to that coming out of the mixer.

(b) Modified Weigh-Batch Plant. The mixing and storage requirements shall be the same as is required for a standard weigh-batch plant.

(c) Drum-Mix Plant. The amount of aggregate and asphaltic material entering the mixer and the rate of travel through the mixing unit shall be so coordinated that a uniform mixture of the specified grading and asphalt content will be produced.

Temporary storing or holding of the plant mix seal by the surge-storage system will be required during the normal day's operation. The plant mix seal coming out of the surge-storage bin shall be of equal quality to that coming out of the mixer.

(d) Discharge Temperature. The plant mix seal shall be at a temperature between 80 °C and 130 °C when discharged from the mixer. The Engineer will designate the temperature within the above limitations, and the mixture when discharged from the mixer shall not vary from this selected temperature more than 5 °C. The temperature of the plant mix seal shall not be less than 80 °C when placed on the road.

(e) Moisture Content. The plant mix seal shall have a moisture content not greater than three (3) percent by mass when discharged from the mixer, unless otherwise shown on the plans and/or approved by the Engineer. The moisture content shall be determined in accordance with Test Method Tex-212-F.

342.6. Construction Methods. Tack coat and/or plant mix seal may be placed only when the temperature of the surface to be overlaid is 15 °C or more, and the air temperature is above 10 °C and rising, but shall not be placed when the air temperature is below 15 C and falling. The air temperature will be taken in the shade away from artificial heat. It is further provided that the tack coat or plant mix seal shall be placed only when the humidity, general weather conditions and moisture condition of the pavement surface, in the opinion of the Engineer, are suitable.

(1) Tack Coat. Before the plant mix seal is laid, the surface upon which the tack coat is to be placed shall be cleaned thoroughly to the satisfaction of the Engineer. The surface shall be given a uniform application of tack coat using asphaltic materials of this specification. This tack coat shall be applied, as directed by the Engineer, with an approved sprayer at a rate not to exceed 0.3 liter per square meter of surface area. Where the plant mix seal will adhere to the surface on which it is to be placed without the use of a tack coat, the tack coat may be eliminated by the Engineer. The tack coat shall be rolled with a pneumatic tire roller when directed by the Engineer.

(2) Transporting Plant Mix Seal Surfacing Mixture. The plant mix seal, prepared as specified above, shall be hauled to the work site in tight vehicles previously cleaned of all foreign material. The dispatching of vehicles shall be arranged so that all material delivered may be placed and all rolling shall be completed during daylight hours. Covers and insulated truck beds shall be required, unless otherwise shown on the plans. If necessary to prevent the plant mix seal from adhering to the bed, the inside of the truck bed shall be given a light coating of release agent satisfactory to the Engineer.

(3) Placing. The plant mix seal shall be dumped directly into the specified spreading and finishing machine and spread on the approved prepared surface in such a manner that, when properly compacted, the finished surface will be smooth and of uniform texture and density. The spreading and finishing machine shall be operated at a speed satisfactory to the Engineer. If, in the opinion of the Engineer, sporadic delivery of plant mix seal adversely affects the quality of the work or unduly lengthens the

time the traffic is restricted from full use of the through lanes, laying operations shall cease and traffic shall be fully restored to the through lanes until consistent delivery of the plant mix seal is provided by the Contractor. During application of tack coat and plant mix seal, care shall be taken to prevent splattering of adjacent pavement, curb and gutter and structures.

(4) Compacting. Immediately following placement of the plant mix seal, the surface shall be rolled with a tandem or three wheel roller of such mass as to accomplish a good seating without excessive breakage of the aggregate. The speed and motion of the rollers shall be such as to avoid displacement of the plant mix seal. If any displacement occurs, it shall be corrected to the satisfaction of the Engineer. To prevent adhesion of the plant mix seal to the roller, the wheels shall be kept thoroughly moistened with a soap-water solution. Necessary precautions shall be taken to prevent the dropping of gasoline, oil, grease or other foreign matter on the pavement, either when the rollers are in operation or when standing. Sprinkling of the fresh mat shall be required when directed by the Engineer, to expedite opening the roadway to traffic. Sprinkling shall be with water or lime-water solution, as directed by the Engineer.

342.7. Measurement. The plant mix seal will be measured separately by the megagram of "Asphalt" and by the cubic meter or by the megagram, shown on the plans, of dry, loose "Aggregate" of the types and/or grades used in the completed and accepted work in accordance with the plans and specifications for the project.

Asphalt. The mass of asphalt cement will be calculated from the measured mass of plant mix seal surfacing mixture using the selected percentages of asphalt.

Aggregate by Volume. The volume of aggregate will be calculated from the measured mass of the plant mix seal surfacing mixture by use of the following formula:

$$V = \frac{(W - A)}{K}$$

Where:

V = Volume of dry, loose aggregate in cubic meters.

W = Total mass of plant mix seal surfacing mixture in kilograms, less any moisture contained in the mixture as determined by Test Method Tex-212-F, Part II.

A = Mass of asphalt cement in kilograms.

K = Oven dry unit weight of aggregate in kilograms per cubic meter.

The value "K" will be determined by Method A, unless otherwise shown on the plans.

Method A

The oven dry unit weight will be determined in accordance with Test Method Tex-404-A, "Determination for Unit Weight of Aggregate". The moisture content of the aggregate will be determined by Test Method Tex-212-F, Part II.

Method B

The oven dry unit weight will be determined by obtaining the mass and volume of a three (3) cubic meter or larger size sample of aggregate. This may be accomplished by placing the aggregate in the bed of a haul truck, or other acceptable container, and uniformly leveling the material across the top of the container. The moisture content of the aggregate will be determined by Test Method Tex-212-F, Part II.

The value "K" shall be checked at the following intervals:

Method A. Each 800 cubic meters of aggregate, minimum of one per day.

Method B. Each 2300 cubic meters of aggregate.

This value will be used for the day in which the sample is taken and will be used until the next sample is tested. If more than one test is run per day, the results will be averaged for computations.

The mass, "W", if mixing is done by a drum mixer, will be determined by truck scales or suspended hopper scales. The mass, if batched, will be determined on batch scales, and records of the number of batches, batch designs and mass of "Asphalt" and "Aggregate" shall be kept.

Aggregate by Mass. Aggregate will be measured by the megagram of the type used in the completed and accepted work. The aggregate mass will be determined from the total mass of plant mix seal surfacing mixture, in kilograms, less the selected percentage of asphalt and less the percentage of moisture as determined by Test Method Tex-212-F, Part II.

342.8. Payment.

(1) The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement", will be paid for at the unit price bid for "Asphalt" and for "Aggregate", of the types and/or grades specified, which prices shall be full compensation for quarrying, furnishing all materials and freight involved; for all heating, mixing, hauling, cleaning the existing pavement, placing tack coat and plant mix seal surfacing mixture, rolling, finishing, and sprinkling the finished surface; and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work.

(2) All templates, straightedges, scales and other weighing and measuring devices necessary for the proper construction, measuring and checking of the work shall be furnished, operated and maintained by the Contractor at his expense.

ITEM 345

ASPHALT STABILIZED BASE
(Plant Mix)

345.1. Description. This Item shall govern for the construction of a base course, subbase course or foundation course, each course being composed of a compacted mixture of aggregate and asphalt cement mixed hot in a mixing plant, in accordance with the details shown on the plans and the requirements herein.

345.2

345.2. Materials. The Contractor shall furnish materials to the project meeting the following requirements prior to mixing. Additional test requirements affecting the quality of individual materials, or the stabilized base, may be required when indicated on the plans.

(1) Aggregate.

(a) Description. The aggregate shall be composed of one or more virgin (not previously used in construction) aggregates and/or reclaimed asphalt pavement (RAP). Samples of each aggregate shall be submitted for approval in accordance with Item 6, "Control of Materials".

(b) Combined Materials. Where more than one virgin aggregate is used, test samples of each virgin aggregate will be proportionately combined prior to testing for Table 1 requirements, except for Los Angeles Abrasion, and crushed face requirements, unless otherwise shown on the plans.

(c) Quality. Virgin aggregate for Grades 1 through 3 shall meet the quality requirements shown in Table 1. Grade 4 aggregate shall meet the quality requirements shown on the plans. Aggregate contained in RAP will not be required to meet Table 1 requirements except as shown on the plans.

TABLE 1
Aggregate
Quality Requirements*

Requirement	Test Method	Value
Los Angeles Abrasion**, percent, maximum	Tex-410-A	50
Wet Ball Mill Value***, maximum	Tex-116-E	50
Maximum increase Passing 425 µm		20
Plasticity Index, maximum****	Tex-106-E	10
Liquid Limit, maximum****	Tex-104-E	40
Sand Equivalent Value, minimum	Tex-203-F	40

* Sampled during delivery to the plant, from the stockpile or from the cold feed, unless otherwise shown on the plans.
** Determined on individual materials when more than one material is to be used.
*** May be used in lieu of Los Angeles Abrasion when shown on the plans.
**** Sample preparation will be in accordance with Test Method Tex-101-E.

(d) Crushed Faces. When shown on the plans, virgin gravel shall be so crushed as to have a minimum of 60 percent of the particles retained on the 4.75 millimeter sieve with two or more mechanically induced crushed faces, as determined by Test Method Tex-460-A (Part I).

(e) Reclaimed Asphalt Pavement (RAP). RAP is defined as a salvaged, milled, pulverized, broken or crushed asphaltic pavement. The RAP to be used in the mix shall be crushed or broken to the extent that 100 percent will pass the 50 millimeter sieve.

The stockpiled RAP shall not be contaminated by dirt or other objectionable materials. Unless otherwise shown on the plans, stockpiled, crushed RAP must have either a decantation of no more than five (5) percent, or a plasticity index of no more than ten (10), when tested in accordance with Test Method Tex-406-A, Part I, or Test Method Tex-106-E, respectively. This requirement applies to stockpiled RAP from which the asphalt has not been removed by extraction.

State-owned RAP sources that are designated on the plans will be available for use by the Contractor. Only RAP from state-owned sources will be allowed in mixes using more than 35 percent RAP, unless otherwise shown on the plans. When RAP sources are designated, either in stockpile or existing pavements, the approximate gradation, asphalt content, and asphalt cement properties of this material will be shown on the plans for material existing in pavements, or in a special provision "Local Material Sources for Reclaimed Asphaltic Pavement" for material in existing stockpiles.

Any Contractor-owned RAP that is to be used on this project shall remain the property of the Contractor while stockpiled and shall not be intermingled with state-owned RAP stockpiles. Any unused Contractor-owned RAP material shall be removed from the project site upon completion of the project.

Excess RAP removed from designated sources will remain the property of the State and will be delivered to stockpile locations shown on the plans.

(2) Asphaltic Material.

(a) Asphaltic Stabilized Mixture. Asphalt cement for the asphaltic stabilized mixture shall be of the grade shown on the plans or designated by the Engineer and shall meet the requirements of Item 300, "Asphalts, Oils

and Emulsions". The Contractor shall notify the Engineer of the source of the asphaltic material prior to design of the asphaltic stabilized mixture. This source shall not be changed during the course of the project without the authorization of the Engineer. Should the source of asphaltic material be changed, the moisture resistance of the new material combination will be evaluated to verify that the requirements of Subarticle 345.3(1) are met.

(b) RAP Stabilized Mixture. When more than 35 percent RAP is used in the produced mixture, the asphalt in the RAP shall be restored to the properties indicated below. Restoration will be made by adding asphalt recycling agent and/or virgin asphalt cement meeting the requirements of Item 300, "Asphalts, Oils and Emulsions".

The mixture design will include recovery of asphalt from the RAP in accordance with Test Method Tex-211-F. The recovered asphalt shall be blended in the laboratory with the amount of asphalt cement and/or asphalt recycling agent selected for the project. The following tests shall be performed on the laboratory blend:

1. Viscosity, 60 °C, Pa·s - Test Method Tex-528-C
2. Thin Film Oven Aging Test - Test Method Tex-510-C
3. Viscosity, 60 °C, Pa·s, on residue from the Thin Film Oven Aging Test - Test Method Tex-528-C
4. Penetration at 25 °C, 100 g, 5 s, (0.1 mm) on the residue from the Thin Film Oven Aging Test - Test Method Tex-502-C

The viscosity in poises equivalent to the residue penetration at 25 °C shall be calculated as set forth in Test Method Tex-535-C. The viscosity index of the residue shall then be calculated as follows:

$$\text{Residue Viscosity Index} = \frac{\text{Residue Viscosity, Pa·s, equivalent to Penetration at 25 °C, (0.1 mm)}}{\text{Residue Viscosity, 60 °C, Pa·s}}$$

The aging index of the laboratory blended asphalt shall be determined as follows:

$$\text{Aging Index} = \frac{\text{Residue Viscosity, 60 °C, Pa·s}}{\text{Original Viscosity, 60 °C, Pa·s}}$$

The laboratory blended asphalt shall meet the following requirements:

Residue Viscosity Index, maximum.....1500
Aging Index, maximum.....3.0

Samples of asphalt recovered from plant produced mix shall show the asphalt to meet the following requirement when tested in accordance with Test Methods Tex-211-F and Tex-502-C.

	Minimum	Maximum
Penetration, 25 °C 100 g, 5 s, (0.1 mm)	30	55

(c) Tack Coat. Asphaltic materials shown on the plans or approved by the Engineer shall meet the requirements of Item 300, "Asphalts, Oils and Emulsions".

(3) Additives. Additives to facilitate mixing and/or improve the quality of the asphaltic mixture or tack coat shall be used when noted on the plans or may be used with the authorization of the Engineer.

Unless otherwise shown on the plans, the Contractor may choose to use either lime or liquid antistripping agent to reduce the moisture susceptibility of the aggregate. The evaluation and addition of antistripping agent will be in accordance with Item 301, "Asphalt Antistripping Agents".

345.3. Asphalt Stabilized Mixtures. The asphalt stabilized mixtures shall consist of a uniform mixture of aggregate, hot asphalt cement, and additives if allowed or required.

An asphalt mixture design is a laboratory process which includes the determination of the quality of the asphalt and the aggregates, and the testing of the combined mixture.

(1) Mixture Design. The Contractor shall furnish the Engineer with representative samples of the materials to be used in production. Using these materials, the mix will be designed in accordance with Test Method Tex-126-E to conform with the requirements herein. The Engineer will furnish the mix design for the mixture. The Engineer may accept a design from the Contractor which was derived using these design procedures.

The second and subsequent mixture designs or partial designs for each grade of stabilized mixture which are necessitated by changes in the material or at the request of the Contractor will be charged to the Contractor when a rate is shown on the plans.

When properly proportioned, for the grade specified, the blend of aggregates shall produce an aggregate gradation which will conform to the limits of the master grading shown in Table 2. The gradation of the aggregate will be determined in accordance with Test Method Tex-200-F, Part I (Dry Sieve Analysis).

Unless otherwise shown on the plans, the mixture of aggregate, asphalt and additives proposed for use will be evaluated in the design stage for moisture susceptibility, in accordance with Item 301, "Asphalt Antistripping Agents". The Engineer may waive this test if a similar design, using the same ingredients, has proven satisfactory.

To substantiate the design, trial mixtures shall be produced and tested using all of the proposed project materials and equipment prior to any placement. The Engineer may waive trial mixtures if similar designs have proven satisfactory.

The mixture shall contain between 3.0 and 9.0 percent asphalt when designed in accordance with Test Method Tex-126-E. At optimum asphalt content, the design specimens shall have the following minimum strength when tested in accordance with Test Method Tex-126-E:

GRADE	SLOW STRENGTH, kPa
1	345
2	275
3	205
4*	205

* Unless a higher minimum strength is shown on the plans

(2) Grades. The aggregate gradation shall conform to the master grading limits shown in Table 2 for the grade of mix specified on the plans.

TABLE 2
MASTER GRADING
Percent Passing by Mass

Sieve Size	GRADE			
	1	2	3	4
45 mm		100	100	AS SHOWN ON PLANS
37.5 mm	100	90-100		
25.0 mm	90-100			
9.5 mm	45-70			
4.75 mm	30-55	25-55		
425 µm	15-30	15-40	15-40	

(3) Tolerances. Gradation approval may be based on stockpile samples if a single stockpile is used. If more than one stockpile is used, the mixture will be tested in accordance with Test Method Tex-210-F or Test Method Tex-228-F will be used in conjunction with combined cold feed belt samples tested in accordance with Test Method Tex-229-F. Other methods of proven accuracy may be used. The method of test will be determined by the Engineer. However, mixtures produced by weigh-batch plants and all mixtures containing RAP will be tested for gradation in accordance with Test Method Tex-210-F. The gradation of the aggregate shall not vary from the master grading limits for the specified grade except that a tolerance of two (2) percent is allowed on the sieve size for each mixture grade which shows 100 percent passing in Table 2.

The asphalt content shall not vary by more than 0.5 percent from that designated by the Engineer using Test Method Tex-210-F or Test Method Tex-228-F.

When disagreements concerning determination of specification compliance occur between allowed sampling and testing procedures, extracted aggregate testing shall take precedence over cold feed belt sampling.

If the mixture produced varies from the master grading limits and/or the asphalt content tolerance, adjustments shall be made by the Contractor until the mixture meets these requirements.

345.4. Equipment.

(1) General. All equipment for the handling of all materials, mixing, placing and compacting of the mixture shall be maintained in good repair and operating condition and subject to the approval of the Engineer. Any equipment found to be defective and potentially having a negative effect on the quality of the paving mixture will not be allowed.

(2) Mixing Plants. Mixing plants may be the weigh-batch type, the modified weigh-batch type, the drum-mix type, or the specialized recycling type. All plants shall be equipped with satisfactory conveyors, power units, mixing equipment, aggregate handling equipment, bins and dust collectors.

Automatic proportioning devices are required for all plants and shall be in accordance with Item 520, "Weighing and Measuring Equipment".

It shall be the Contractor's responsibility to provide safe and accurate means to enable inspection forces to take all required samples, to provide permanent means for checking the output of any specified metering device, and to perform calibration and mass checks as required by the Engineer. When cold feed belt sampling is to be used for gradation testing, occasional stoppage of the belt may be necessary unless other means of sampling are approved by the Engineer.

When using fuel oil heavier than Grade No. 2, or waste oil, the Contractor shall insure that the fuel delivered to the burner is at a viscosity of 100 SSU or less, when tested in accordance with Test Method Tex-534-C, to insure complete burning of the fuel. Higher viscosities will be allowed if recommended by the burner manufacturer. If necessary, the Contractor shall preheat the oil to maintain the required viscosity.

The Contractor shall provide means for obtaining a sample of the fuel, just prior to entry into the burner, in order to perform the viscosity test. The Contractor shall perform this test or provide a laboratory test report that will establish the temperature of the fuel necessary to meet the viscosity requirements. There shall be an in-line thermometer to check the temperature of the fuel delivered to the burner.

Regardless of the burner fuel used, the burner or combination of burners and types of fuel used shall provide a complete burn of the fuel and not leave any fuel residue that will adhere to the heated aggregate or become mixed with the asphalt.

(a) Weigh-Batch Type.

Cold Aggregate Bin Unit and Proportioning Device. The cold aggregate bin unit shall be of sufficient size to store the amount of aggregate required to keep the plant in continuous operation and of proper design to prevent overflow of material from one bin to another. There shall be vertical partitions between each bin and on each end of the bins of sufficient height so that any overflow will be to the front and back and not allow overflow to the sides or between bins. Overflow that might occur shall not fall onto any feeder belt. The proportioning device shall provide a uniform and continuous flow of aggregate in the desired proportion to the dryer. Each aggregate shall be proportioned from a separate bin.

If RAP is used, a separate cold bin shall be required. The RAP feed system shall be equipped with a scalping screen to remove particles over 50 millimeters in size. The cold bin system shall supply the proper amount of RAP to the weigh box. RAP will not be allowed in the hot bins.

Dryer. The dryer shall continually agitate the aggregate during heating. The temperature shall be controlled so that the aggregate will not be damaged in the drying and heating operations. The dryer shall be of sufficient size to keep the plant in continuous operation.

Screening and Proportioning. The screening capacity and size of the hot aggregate bins shall be sufficient to screen and store the amount of aggregate required to properly operate the plant and keep the plant in continuous operation at full capacity. The hot bins shall be constructed so that oversize and overloaded material will be discarded through overflow chutes. Provisions shall be made to enable inspection forces to have easy and safe access to the proper location on the mixing plant where representative samples may be taken from the hot bins for testing. The plant shall be equipped with at least three hot bins. The aggregate shall be separated into the number of bins indicated on the plans or as directed by the Engineer.

Aggregate Weigh Box and Batching Scale. The aggregate weigh box and batching scales shall be of sufficient capacity to hold and weigh a complete batch of aggregate. The weigh box and scales shall conform to the requirements of Item 520, "Weighing and Measuring Equipment".

Asphaltic Material Measuring System. If an asphaltic material bucket and scales are used, they shall be of sufficient capacity to hold and weigh the necessary asphaltic material for one batch. The bucket and scales shall conform to the requirements of Item 520, "Weighing and Measuring Equipment".

If a pressure type flow meter is used to measure the asphaltic material, the requirements of Item 520, "Weighing and Measuring Equipment", shall apply. This system shall include an automatic temperature compensation device to insure a constant percent by mass of asphaltic material in the mixture.

Provisions of a permanent nature shall be made for checking the accuracy of the asphaltic material measuring device. The asphalt line to the measuring device shall be protected with a jacket of hot oil or other approved means to maintain the temperature of the line near the temperature specified for the asphaltic material.

Mixer. The mixer shall be of the pugmill type and shall have a capacity of not less than 1350 kilograms (of natural-aggregate mixture) in a single batch, unless otherwise shown on the plans. Any mixer that has a tendency to segregate the aggregate or fails to secure a thorough and uniform mixture with the asphaltic material shall not be used. All mixers shall be provided with an automatic timer that will lock the discharge doors of the mixer for the required mixing period. The dump door or doors and the shaft seals of the mixer shall be tight enough to prevent spilling of aggregate or mixture from the pugmill.

Surge-Storage System and Scales. A surge-storage system may be used to minimize the production interruptions during the normal day's operations. A device such as a gob hopper or other device approved by the Engineer to prevent segregation in the surge-storage bin shall be used. The mixture shall be weighed upon discharge from the surge-storage system.

When a surge-storage system is used, scales shall be standard platform truck scales or other equipment such as weigh hopper (suspended) scales and shall conform to Item 520, "Weighing and Measuring Equipment". If truck scales are used, they shall be placed at a location approved by the Engineer. If other weighing equipment is used, the Engineer may require mass checks by truck scales for the basis of approval of the equipment.

Recording Device and Record Printer. The mixture shall be weighed for payment. If a surge-storage system is used, an automatic recording device and a digital record printer shall be provided to indicate the date, project identification number, vehicle identification, total mass of the load, tare mass of the vehicle, the mass of asphaltic mixture in each load and the number of loads for the day, unless otherwise indicated on the plans. When surge-storage is not used, batch mass will be used as the basis for payment and automatic recording devices and automatic digital record printers in accordance with Item 520, "Weighing and Measuring Equipment", shall be required.

(b) Modified Weigh-Batch Type.

General. This plant is similar to the weigh-batch type plant. The hot bin screens shall be removed and the aggregate controls placed at the cold feeds. The cold feed bins shall be the same as those required for the drum-mix type plant.

Cold-Aggregate Bin Unit and Feed System. The number of bins in the cold-aggregate bin unit shall be equal to or greater than the number of stockpiles of individual materials to be used.

The bins shall be of sufficient size to store the amount of aggregate required to keep the plant in continuous operation and of proper design to prevent overflow of material from one bin to another. There shall be vertical partitions between each bin and on each end of the bins of sufficient height so that any overflow will be to the front and back and not allow overflow to the sides or between bins. Overflow that might occur shall not fall onto any feeder belt. When required by the Engineer, an approved stationary scalping screen shall be placed on top of the field sand bin to eliminate roots and other objectionable material. The feed system shall provide a uniform and continuous flow of aggregate in the desired proportion to the dryer. The Contractor shall furnish a chart indicating the calibration of each cold bin in accordance with the manufacturer's recommendations or in a method acceptable to the Engineer.

If RAP is used, a separate cold bin shall be required. The RAP feed system shall be equipped with a scalping screen to remove particles over 50 millimeters in size. The cold bin system shall supply a uniform and proper amount of RAP to the mixture. The RAP shall be added to the hot aggregate either prior to or at the weigh box. If added prior to the weigh box, the system shall include means acceptable to the Engineer to verify that the correct amount of RAP is continuously being fed.

Scalping Screen. A scalping screen shall be required after the cold feeds and ahead of the hot aggregate surge bins.

Dryer. The dryer shall continually agitate the aggregate during heating. The temperature shall be controlled so that the aggregate will not be damaged in the drying and heating operations. The dryer shall be of sufficient size to keep the plant in continuous operation.

Screening and Proportioning. The hot aggregate shall not be separated into sizes after being dried. There shall be one or more surge bins provided between the dryer and the weigh hopper. Surge bins shall be of sufficient size to hold enough combined aggregate for one complete batch of mixture.

Aggregate Weigh Box and Batching Scale. The aggregate weigh box and batching scales shall be of sufficient capacity to hold and weigh a complete batch of aggregate. The weigh box and scales shall conform to the requirements of Item 520, "Weighing and Measuring Equipment".

Asphaltic Material Measuring System. If an asphaltic material bucket and scales are used, they shall be of sufficient capacity to hold and weigh the necessary asphaltic material for one batch. The bucket and scales shall conform to the requirements of Item 520, "Weighing and Measuring Equipment".

If a pressure type flow meter is used to measure the asphaltic material, the requirements of Item 520, "Weighing and Measuring Equipment", shall apply. This system shall include an automatic temperature compensation device to insure a constant percent by mass of asphaltic material in the mixture.

Provisions of a permanent nature shall be made for checking the accuracy of the asphaltic material measuring device. The asphalt line to the measuring device shall be protected with a jacket of hot oil or other approved means to maintain the temperature of the line near the temperature specified for the asphaltic material.

Mixer. The mixer shall be of the pugmill type and shall have a capacity of not less than 1350 kilograms (of natural-aggregate mixture) in a single batch, unless otherwise shown on the plans. Any mixer that has a tendency to segregate the aggregate or fails to secure a thorough and uniform mixture with the asphaltic material shall not be used. All mixers shall be provided with an automatic timer that will lock the discharge doors

of the mixer for the required mixing period. The dump door or doors and the shaft seals of the mixer shall be tight enough to prevent spilling of aggregate or mixture from the pugmill.

Surge-Storage System and Scales. A surge-storage system may be used to minimize the production interruptions during the normal day's operations. A device such as a gob hopper or other device approved by the Engineer to prevent segregation in the surge-storage bin shall be used. The mixture shall be weighed upon discharge from the surge-storage system.

When a surge-storage system is used, scales shall be standard platform truck scales or other equipment such as weigh hopper (suspended) scales and shall conform to Item 520, "Weighing and Measuring Equipment". If truck scales are used, they shall be placed at a location approved by the Engineer. If other weighing equipment is used, the Engineer may require mass checks by truck scales for the basis of approval of the equipment.

Recording Device and Record Printer. The mixture shall be weighed for payment. If a surge-storage system is used, an automatic recording device and a digital record printer shall be provided to indicate the date, project identification number, vehicle identification, total mass of the load, tare mass of the vehicle, the mass of asphaltic mixture in each load and the number of loads for the day, unless otherwise indicated on the plans. When surge-storage is not used, batch mass will be used as the basis for payment and automatic recording devices and automatic digital record printers in accordance with Item 520, "Weighing and Measuring Equipment", shall be required.

(c) Drum-Mix Type.

General. The plant shall be adequately designed and constructed for the process of mixing aggregates and asphalt. The plant shall be equipped with satisfactory conveyors, power units, aggregate-handling equipment and feed controls.

Cold-Aggregate Bin Unit and Feed System. The number of bins in the cold-aggregate bin unit shall be equal to or greater than the number of stockpiles of individual materials to be used.

The bins shall be of sufficient size to store the amount of aggregate required to keep the plant in continuous operation and of proper design to prevent overflow of material from one bin to another. There shall be

vertical partitions between each bin and on each end of the bins of sufficient height so that any overflow will be to the front and back and not allow overflow to the sides or between bins. Overflow that might occur shall not fall onto any feeder belt. When required by the Engineer, an approved stationary scalping screen shall be placed on top of the field sand bin to eliminate roots and other objectionable material. The feed system shall provide a uniform and continuous flow of aggregate in the desired proportion to the mixer. The

Contractor shall furnish a chart indicating the calibration of each cold bin in accordance with the manufacturer's recommendations or in a method acceptable to the Engineer.

The system shall provide positive mass measurement of the combined cold-aggregate feed by use of belt scales or other approved devices. Provisions of a permanent nature shall be made for checking the accuracy of the measuring device as required by Item 520, "Weighing and Measuring Equipment". When a belt scale is used, mixture production shall be maintained so that the scale normally operates between 50 percent and 100 percent of its rated capacity. Belt scale operation below 50 percent of the rated capacity may be allowed by the Engineer if accuracy checks show the scale to meet the requirements of Item 520, "Weighing and Measuring Equipment", at the selected rate. It shall be satisfactorily demonstrated to the Engineer that mixture uniformity and quality have not been adversely affected.

If RAP is used, a separate cold bin shall be required. The RAP feed system shall be equipped with a scalping screen to remove particles over 50 millimeters in size prior to the weighing device. There shall be adequate cold bin controls to provide a uniform amount of RAP to the mixture.

When RAP is used, positive mass measurement of RAP shall be provided by the use of belt scales or other approved devices.

Scalping Screen. A scalping screen shall be required after the cold feeds and ahead of the combined aggregate belt scales.

Asphaltic Material Measuring System. An asphaltic material measuring device meeting the requirements of Item 520, "Weighing and Measuring Equipment", shall be placed in the asphalt line leading to the mixer so that the cumulative amount of asphalt used can be accurately determined. Provisions of a permanent nature shall be made for checking the accuracy of the measuring device output. The asphalt line to the measuring device shall be protected with a jacket of hot oil or other approved means to maintain the temperature of the line near the temperature **345.4**

specified for the asphaltic material. The measuring system shall include an automatic temperature compensation device to maintain a constant percent by mass of asphaltic material in the mixture.

Synchronization Equipment for Feed-Control Systems. The asphaltic material feed-control shall be coupled with the total aggregate mass measuring device to automatically vary the asphalt-feed rate in order to maintain the required proportion.

Mixing System. The mixing system shall control the temperature so

that the aggregate and asphalt will not be damaged in the drying, heating and mixing operations. A continuously recording thermometer shall be provided which will indicate the temperature of the mixture as it leaves the mixer.

Surge-Storage System and Scales. A surge-storage system shall be used to minimize the production interruptions during the normal day's operations. A device such as a gob hopper or other device approved by the Engineer to prevent segregation in the surge-storage bin shall be used. The mixture shall be weighed upon discharge from the surge-storage system.

Scales shall be standard platform truck scales or other equipment such as weigh hopper (suspended) scales and shall conform to Item 520, "Weighing and Measuring Equipment". If truck scales are used, they shall be placed at a location approved by the Engineer. If other weighing equipment is used, the Engineer may require mass checks by truck scales for the basis of approval of the equipment.

Recording Device and Record Printer. Automatic recording devices and automatic digital record printers shall be provided to indicate the date, project identification number, vehicle identification, total mass of the load, tare mass of the vehicle, the mass of asphaltic mixture in each load and the number of loads for the day in accordance with Item 520, "Weighing and Measuring Equipment", unless otherwise shown on the plans.

(d) Specialized Recycling Type.

General. Alternate methods of heating may be used which will not abnormally age the asphalt cement. This type of plant shall be capable of continually producing a minimum of 136 megagrams per hour of completed asphalt mixture that will meet all the requirements of this specification.

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Cold-Aggregate Bin Unit and Feed System. The cold-aggregate feed system and controls shall meet all the requirements as listed under the drum-mix type plant.

Scalping Screen. A scalping screen shall be required after the cold feeds and ahead of the combined aggregate belt scales.

Dryer. The dryer shall continually agitate the RAP and aggregate during heating. The temperature shall be controlled so that the aggregate and asphalt will not be damaged in the drying and heating operations. The dryer shall be of sufficient size to keep the plant in continuous operation.

Asphalt Material Measuring System. An asphaltic material measuring device meeting the requirements of Item 520, "Weighing and Measuring

Equipment", shall be placed in the asphalt line leading to the mixer so that the cumulative amount of asphalt used can be accurately determined. Provisions of a permanent nature shall be made for checking the accuracy of the measuring device output. The asphalt line to the measuring device shall be protected with a jacket of hot oil or other approved means to maintain the temperature of the line near the temperature specified for the asphaltic material. The measuring system shall include an automatic temperature compensation device to maintain a constant percent by mass of asphaltic material in the mixture.

Synchronization Equipment for Feed-Control Systems. The asphaltic material feed-control shall be coupled with the total aggregate mass measuring device to automatically vary the asphalt-feed rate in order to maintain the required proportion.

Mixer. The mixer shall be of the continuous mechanical mixing type. Any mixer that has a tendency to segregate the mixture or fails to secure a thorough and uniform mixture shall not be used. A continuously recording thermometer shall be provided which will indicate the temperature of the mixture as it leaves the mixer.

Surge-Storage System and Scales. A surge-storage system shall be used to minimize the production interruptions during the normal day's operations. A device such as a gob hopper or other device approved by the Engineer to prevent segregation in the surge-storage bin shall be used. The mixture shall be weighed upon discharge from the surge-storage system.

Scales shall be standard platform truck scales or other equipment such as weigh hopper (suspended) scales and shall conform to Item 520, "Weighing and Measuring Equipment". If truck scales are used, they shall be placed at a location approved by the Engineer. If other weighing equipment is used, the Engineer may require mass checks by truck scales for the basis of approval of the equipment.

Recording Device and Record Printer. Automatic recording devices and automatic digital record printers shall be provided to indicate the date, project identification number, vehicle identification, total mass of the load, tare mass of the vehicle, the mass of asphaltic mixture in each load and the number of loads for the day in accordance with Item 520, "Weighing and Measuring Equipment", unless otherwise shown on the plans.

(3) Asphaltic Material Heating Equipment. Asphaltic material heating equipment shall be adequate to heat the required amount of asphaltic material to the desired temperature. The heating apparatus shall be equipped with a continuously recording thermometer with a 24-hour chart that will record the temperature of the asphaltic material at the location of highest temperature.

(4) Spreading and Finishing Machine. The spreading and finishing machine shall be approved by the Engineer and shall meet the requirements indicated below.

(a) Screed Unit. The spreading and finishing machine shall be equipped with a heated compacting screed. It shall produce a finished surface meeting the requirements of the typical cross sections and the surface tests.

Extensions added to the screed shall be provided with the same compacting action and heating capability as the main screed unit, except for use on variable depth tapered areas and/or as approved by the Engineer.

The spreading and finishing machine shall be equipped with an approved automatic dual longitudinal screed control system and automatic transverse screed control system. The longitudinal controls shall be capable of operating from any longitudinal grade reference including a stringline, ski, mobile stringline, or matching shoe.

The Contractor shall furnish all equipment required for grade reference. It shall be maintained in good operating condition by personnel trained in the use of this type of equipment.

The grade reference used by the Contractor may be of any type approved by the Engineer. Control points, if required by the plans, shall be established for the finished profile in accordance with Item 5, "Control of the Work". These points shall be set at intervals not to exceed 15 meters The Contractor shall set the grade reference from the control points. The grade reference shall have sufficient support so that the maximum deflection shall not exceed two (2) millimeters between supports.

(b) Tractor Unit. The tractor unit shall be equipped with a hydraulic hitch sufficient in design and capacity to maintain contact between the rear wheels of the hauling equipment and the pusher rollers of the finishing machine while the mixture is being unloaded.

No portion of the mass of hauling equipment, other than the connection, shall be supported by the asphalt paver. No vibrations or other motions of the loading equipment, which could have a detrimental effect on the riding quality of the completed pavement, shall be transmitted to the paver.

The use of any vehicle which requires dumping directly into the finishing machine and which the finishing machine cannot push or propel to obtain the desired lines and grades without resorting to hand finishing will not be allowed.

(5) Material Transfer Equipment. Equipment to transfer mixture from the hauling units or the roadbed to the spreading and finishing machine will be allowed unless otherwise shown on the plans. A specific type of material transfer equipment shall be required when shown on the plans.

(a) Windrow Pick-Up Equipment. Windrow pick-up equipment shall be constructed in such a manner that substantially all the mixture deposited on the roadbed is picked up and loaded into the spreading and finishing machine. The mixture shall not be contaminated with foreign material. The loading equipment shall be designed so that it does not interfere with the spreading and finishing machine in obtaining the required line, grade and surface without resorting to hand finishing.

(b) Material Feeding System. Material feeding systems shall be designed to provide a continuous flow of uniform mixture to the spreading and finishing machine. When use of a material feeding system is required on the plans, it shall meet the storage capacity, remixing capability, or other requirements shown on the plans.

(6) Motor Grader. The motor grader, when used, shall be a self-propelled power motor grader and shall be equipped with smooth tread pneumatic tired wheels, unless otherwise directed. It shall have a blade length of not less than 3.6 meters and a wheelbase of not less than 4.9 meters.

(7) Rollers. Rollers provided shall meet the requirements for their type as follows:

(a) Pneumatic-Tire Roller. The roller shall be an acceptable medium pneumatic tire roller conforming to the requirements of Item 213, "Rolling (Pneumatic Tire)", Type A, unless otherwise specified on the plans. Pneumatic-tire rollers used for compaction shall provide a minimum 550 kilopascals ground contact pressure. When used for kneading and sealing the surface only, they shall provide a minimum of 380 kilopascals ground contact pressure.

(b) Two-Axle Tandem Roller. This roller shall be an acceptable self-propelled tandem roller weighing not less than 7.2 megagrams.

(c) Three-Wheel Roller. This roller shall be an acceptable self-propelled three wheel roller weighing not less than 9.1 megagrams.

(d) Three-Axle Tandem Roller. This roller shall be an acceptable self-propelled three axle roller weighing not less than 9.1 megagrams.

(e) Trench Roller. This roller shall be an acceptable self-propelled trench roller equipped with a sprinkler for keeping the wheels wet and an adjustable road wheel so that the roller may be kept level during rolling. The drive wheel shall be not less than 500 millimeters wide. The roller under working conditions shall produce not less than 5803 kilograms per meter of roller width and be so geared that a speed of approximately three (3) kilometers per hour is obtained in low gear.

(f) Vibratory Steel-Wheel Roller. This roller shall have a minimum mass of 5.4 megagrams. The compactor shall be equipped with amplitude and frequency controls and shall be specifically designed to compact the material on which it is used.

(8) Straightedges and Templates. When directed by the Engineer, the Contractor shall provide acceptable 3-meter straightedges for surface testing. Satisfactory templates shall be provided as required by the Engineer.

(9) Alternate Equipment. When permitted by the Engineer, equipment other than that specified herein which will consistently produce satisfactory results may be used.

345.5. Stockpiling, Storage and Mixing.

(1) Stockpiling of Aggregates. Prior to stockpiling of aggregates, the area shall be cleaned of trash, weeds, grass and shall be relatively smooth and well drained. The stockpiling shall be done in a manner that will minimize aggregate degradation, segregation, mixing of one stockpile with another, and will not allow contamination with foreign material.

The plant shall have at least a two-day supply of aggregates on hand before production can begin and at least a two-day supply shall be maintained through the course of the project, unless otherwise approved by the Engineer.

No stockpile shall contain aggregate from more than one source.

Prior to starting RAP stockpiling operations, the Contractor shall develop and submit in writing to the Engineer an acceptable stockpile production procedure and management plan which will ensure that a homogeneous stockpile of RAP is available. Stockpiles of Contractor-owned RAP material shall be completely established at the plant site prior to submission of mixture design samples and shall be of sufficient quantity to meet the material requirements of the project for which they are prepared. When shown on the plans, plant site stockpiles composed of RAP from designated sources shall be of the minimum size shown on the plans prior to submission of mixture design samples.

When required by the Engineer, additional material shall not be added to stockpiles that have previously been sampled for approval.

Equipment of an acceptable size and type shall be furnished to work the stockpiles and prevent segregation and degradation of the aggregates.

(2) Storage and Heating of Asphaltic Materials. The asphaltic material storage capacity shall be ample to meet the requirements of the plant. Asphalt shall not be heated to a temperature in excess of that specified in Item 300, "Asphalts, Oils and Emulsions". All equipment used in the storage and handling of asphaltic material shall be kept in a clean condition at all times and shall be operated in such a manner that there will be no contamination with foreign matter.

(3) Feeding and Drying of Aggregate. The feeding of various sizes of aggregate and RAP, if applicable, to the dryer shall be done through the cold aggregate bins and the proportioning device in such a manner that a uniform and constant flow of materials in the required proportions will be maintained. The aggregate shall be dried and heated to the temperature necessary to produce a mixture having the specified temperature.

(4) Mixing and Storage.

(a) Weigh-Batch Plant. In introducing the batch into the mixer, all aggregate shall be introduced first and shall be mixed thoroughly for a minimum period of five seconds to uniformly distribute the various sizes throughout the batch before the asphaltic material is added. The asphaltic material shall then be added and the mixing continued for a wet mixing period of not less than 15 seconds. The mixing period shall be increased if, in the opinion of the Engineer, the mixture is not uniform or the aggregates are not properly coated.

Temporary storing or holding of the asphaltic mixture by the surge-storage system will be permitted during the normal day's operation. Overnight storage will not be permitted unless authorized in the plans or in writing by the Engineer. The mixture coming out of the surge-storage bin shall be of equal quality to that coming out of the mixer.

(b) Modified Weigh-Batch Plant. The mixing and storage requirements shall be the same as is required for a standard weigh-batch plant.

(c) Drum-Mix Plant. The amount of aggregate and asphaltic material entering the mixer and the rate of travel through the mixing unit shall be so coordinated that a uniform mixture of the specified grading and asphalt content will be produced.

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Temporary storing or holding of the asphaltic mixture by the surge-storage system will be required during the normal day's operation. Overnight storage will not be permitted unless authorized on the plans or by the

Engineer. The mixture coming out of the surge-storage bin shall be of equal quality to that coming out of the mixer.

(d) Specialized Recycling Plant. The mixing and storage requirements shall be the same as that stated for the drum-mix plant.

(e) Discharge Temperature. The Engineer will select the target discharge temperature of the mixture between 110 °C and 175 °C. The mixture, when discharged from the mixer, shall not vary from this selected temperature more than 15 °C, but in no case shall the temperature exceed 180 °C.

(f) Moisture Content. The mixture produced from each type of mixer shall have a moisture content not greater than one (1) percent by mass when discharged from the mixer, unless otherwise shown on the plans and/or approved by the Engineer. The moisture content will be determined in accordance with Test Method Tex-212-F.

(g) RAP. If RAP is used, it shall be mixed and blended so that there is no evidence of unseparated particles in the mixture as it leaves the mixer.

345.6. Construction Methods.

(1) General. It shall be the responsibility of the Contractor to produce, transport, place and compact the specified paving mixture in accordance with the requirements herein.

The asphaltic mixture, when placed with a spreading and finishing machine, or the tack coat shall not be placed when the air temperature is below 10 °C and is falling, but it may be placed when the air temperature is above 5 °C and is rising.

The asphaltic mixture, when placed with a motor grader, shall not be placed when the air temperature is below 15 °C and is falling, but may be placed when the air temperature is above 10 °C and is rising.

The air temperature will be taken in the shade away from artificial heat.

It is further provided that the tack coat or asphaltic mixture shall be placed only when the humidity, general weather conditions and temperature and moisture condition of the base, in the opinion of the Engineer, are suitable.

If, after being discharged from the mixer and prior to placing, the

temperature of the asphaltic mixture is 10 °C or more below the selected discharge temperature established by the Engineer, all or any part of the load may be rejected and payment will not be made for the rejected material.

(2) Tack Coat. The surface upon which the tack coat is to be placed shall be cleaned thoroughly to the satisfaction of the Engineer. The surface shall be given a uniform application of tack coat using asphaltic materials of this specification. This tack coat shall be applied, as directed by the Engineer, with an approved sprayer at a rate not to exceed 0.45 liter residual asphalt per square meter of surface. Where the mixture will adhere to the surface on which it is to be placed without the use of a tack coat, the tack coat may be eliminated by the Engineer. All contact surfaces of curbs and structures and all joints shall be painted with a thin uniform application of tack coat. During the application of tack coat, care shall be taken to prevent splattering of adjacent pavement, curb and gutter and structures. The tack coat shall be rolled with a pneumatic tire roller when directed by the Engineer.

(3) Transporting. The asphaltic mixture shall be hauled to the work site in tight vehicles previously cleaned of all foreign material. The dispatching of the vehicles shall be arranged so that all material delivered is placed and all rolling completed during daylight hours unless otherwise shown on the plans. In cool weather or for long hauls, covering and insulating of the truck bodies may be required. If necessary, to prevent the mixture from adhering to the body, the inside of the truck may be given a light coating of release agent satisfactory to the Engineer.

(4) Placing.

(a) The asphaltic mixture shall be dumped and spread on the approved prepared surface with the spreading and finishing machine. When properly compacted, the finished pavement shall be smooth, of uniform texture and density and shall meet the requirements of the typical cross sections and the surface tests. In addition, the placing of the asphaltic mixture shall be done without tearing, shoving, gouging or segregating the mixture.

Unloading into the finishing machine shall be controlled so that bouncing or jarring the spreading and finishing machine shall not occur and the required lines and grades shall be obtained without resorting to hand finishing, except as shown under Subarticle 345.6.(4)(d).

Unless otherwise shown on the plans, dumping of the asphaltic mixture in a windrow and then placing the mixture in the finishing machine with windrow pick-up equipment will be permitted. The windrow pick-up equipment shall be operated in such a manner that substantially all the mixture deposited on the roadbed is picked up and loaded into the finishing machine without

contamination by foreign material. The windrow pick-up equipment will be so operated that the finishing machine will obtain the required line, grade and surface without resorting to hand finishing. Any operation of the windrow pick-up equipment resulting in the accumulation and subsequent shedding of accumulated material into the asphaltic mixture will not be permitted.

(b) When approved by the Engineer, level-up courses may be spread with a motor grader.

(c) The spreading and finishing machine shall be operated at a uniform forward speed consistent with the plant production rate, hauling capability, and roller train capacity to result in a continuous operation. The speed shall be slow enough that stopping between trucks is not ordinarily required. If, in the opinion of the Engineer, sporadic delivery of material is adversely affecting the mat, the Engineer may require paving operations to cease until acceptable methods are provided to minimize starting and stopping of the paver.

The hopper flow gates of the spreading and finishing machine shall be adjusted to provide an adequate and consistent flow of material. These shall result in enough material being delivered to the augers so that they are operating approximately 85 percent of the time or more. The augers shall provide means to supply adequate flow of material to the center of the paver. Augers shall supply an adequate flow of material for the full width of the mat, as approved by the Engineer. Augers should be kept approximately one-half to three-quarters full of mixture at all times during the paving operation.

(d) When the asphaltic mixture is placed in a narrow strip along the edge of an existing pavement, or used to level up small areas of an existing

pavement, or placed in small irregular areas where the use of a finishing machine is not practical, the finishing machine may be eliminated when authorized by the Engineer.

(e) If a pattern of surface irregularities or segregation is detected, the Contractor shall make an investigation into the causes and immediately take the necessary corrective action. With the approval of the Engineer, placement may continue for no more than one full production day from the time the Contractor is first notified and while corrective actions are being taken. If the problem still exists after that time, paving shall cease until the Contractor further investigates the causes and the Engineer approves further corrective action to be taken.

(5) Compacting.

(a) The pavement shall be compacted thoroughly and uniformly with the necessary rollers to obtain the compaction and cross section of the finished paving mixture meeting the requirements of the plans and specifications.

(b) When rolling with the three-wheel, tandem or vibratory rollers, rolling shall start by first rolling the joint with the adjacent pavement and then continue by rolling longitudinally at the sides and proceed toward the center of the pavement, overlapping on successive trips by at least 0.3 meter, unless otherwise directed by the Engineer. Alternate trips of the roller shall be slightly different in length. On super-elevated curves, rolling shall begin at the low side and progress toward the high side, unless otherwise directed by the Engineer.

When rolling with vibratory steel-wheel rollers, equipment operation shall be in accordance with Item 217, "Rolling (Vibratory)" and the manufacturer's recommendations, unless otherwise directed by the Engineer. Vibratory rollers shall not be left vibrating while not rolling or when changing directions. Unless otherwise shown on the plans or approved by the Engineer, vibratory rollers shall not be allowed in the vibrating mode on mats with a plan depth of less than 40 millimeters.

The motion of the rollers shall be slow enough to avoid other than normal initial displacement of the mixture. If any displacement occurs, it shall be corrected to the satisfaction of the Engineer. The roller shall not be allowed to stand on pavement which has not been fully compacted. To prevent adhesion of the surface mixture to the steel-wheel rollers, the wheels shall be kept thoroughly moistened with water, but an excess of

water will not be permitted. Necessary precautions shall be taken to prevent the dropping of diesel, gasoline, oil, grease or other foreign matter on the pavement, either when the rollers are in operation or when standing.

(c) The edges of the pavement along curbs, headers and similar structures, and all places not accessible to the roller, or in such positions as will not allow thorough compaction with the rollers, shall be thoroughly compacted with lightly oiled tamps.

(d) Rolling with a trench roller will be required on widened areas, in trenches and other limited areas where satisfactory compaction cannot be obtained with the approved rollers.

(6) In-Place Compaction Control. In-place compaction control is required for all mixtures. Unless otherwise shown on the plans, density control shall be required.

(a) Density Control. The material shall be placed and compacted to a minimum density as determined by Test Method Tex-126-E or as specified on the plans. The gyratory density shall be determined from material sampled from the mixing plant and molded in accordance with Test Method Tex-126-E. Procedures and methods outlined in Test Method Tex-126-E shall also be used in determining the actual in-place density, unless determined otherwise by the Engineer. The field specimens utilized for the in-place density testing may be either cores or sections of asphalt stabilized base tested according to Test Method Tex-207-F. The nuclear-density gauge or other methods of determining in-place compaction which correlate satisfactorily with those results obtained through the use of Test Method Tex-126-E may be used.

Unless otherwise shown on the plans, the Contractor shall be responsible for obtaining the required roadway specimens at his expense and in a manner and at locations selected by the Engineer.

The Contractor shall be responsible for determining the number and type of rollers to be used to obtain the required density. The rollers shall be operated in accordance with the requirements of this specification and as approved by the Engineer.

If the in-place density falls 0.1 to 1.0 percentage points below the minimum density from Test Method Tex-126-E, the Contractor shall investigate the causes and make the necessary corrections. Production may proceed for not more than one full day while corrections to the construction **345.6**

operations or mixture are being made to obtain the minimum density. If the minimum density is not obtained after one day, production shall cease. The Contractor shall further investigate the cause. At that point a test strip as

described below shall be required.

If the in-place density is more than 1.0 percent below the minimum density, production shall cease immediately and a test strip as described below shall be required.

In either case, the Contractor shall only be allowed to place a test section of one lane width, not to exceed 300 meters in length, to demonstrate that the minimum density can be obtained. This procedure will continue until a test section meeting the minimum density requirement is produced. Only two (2) test sections per day will be allowed. When a test section producing satisfactory density is placed, full production may then resume.

Increasing the asphalt content of the mixture in order to increase in-place density shall not be allowed.

The Contractor is encouraged to perform supplemental compaction testing for his own information.

(b) Ordinary Compaction Control. When the requirement of density control has been removed by plans note, one (1) three-wheel roller, one (1) pneumatic-tire roller, and one (1) tandem roller shall be furnished for each compaction operation except as provided below or approved by the Engineer. The use of a tandem roller may be waived by the Engineer when the surface is already adequately smooth and further steel-wheel rolling is shown to be ineffective. With approval of the Engineer, the Contractor may substitute a vibratory roller for the three-wheel roller and/or the tandem roller. Use of at least one (1) pneumatic-tire roller is required. Additional or heavier rollers shall be furnished if required by the Engineer.

Rolling patterns shall be established by the Contractor as outlined in Test Method Tex-207-F, Part IV, to achieve the maximum compaction, unless otherwise directed by the Engineer. The selected rolling pattern shall be followed unless changes in the mixture or placement conditions occur which affect compaction. When changes in the mixture or placement conditions occur, a new rolling pattern shall be established.

(c) Compaction Cessation Temperature. Regardless of the method required for in-place compaction control, all rolling for compaction shall be completed before the mixture temperature drops below 80 °C.

(7) Surface Finish. The compacted material shall conform to the typical

cross sections, lines and grades shown on the plans, and as directed by the Engineer, and shall have a smooth surface.

The surface shall be tested with a 3-meter straightedge at locations selected by the Engineer.

The variation of the surface from the testing edge shall not exceed three (3) millimeters between any two (2) contacts, when measured longitudinally or transversely.

(8) Opening to Traffic. The completed asphalt stabilized base course shall be opened to traffic when directed by the Engineer. The Contractor's attention is directed to the fact that all construction traffic allowed on the pavement open to the public will be subject to the State laws governing traffic on highways.

If the surface ravels, flushes, ruts or deteriorates in any manner prior to final acceptance of the work, it will be the Contractor's responsibility to correct this condition at his expense, to the satisfaction of the Engineer and in conformance with the requirements of this specification.

345.7. Measurement. The quantity of asphalt stabilized base will be measured by the composite mass method.

Asphalt stabilized base will be measured by the megagram of the composite "Asphalt Stabilized Base" of the grade actually used in the completed and accepted work in accordance with the plans and specifications for the project. The composite asphalt stabilized base mixture is hereby defined as the asphalt, aggregate, RAP and additives as noted in the plans and/or approved by the Engineer.

If mixing is done by a drum-mix plant or specialized recycling plant, measurement will be made on scales as specified herein.

If mixing is done by a weigh-batch plant or modified weigh-batch plant, measurement will be determined on the batch scales unless surge-storage is used. Records of the number of batches, batch design and the mass of the composite "Asphalt Stabilized Base" shall be kept. Where

surge-storage is used, measurement of the material taken from the surge-storage bin will be made on truck scales or suspended hopper scales.

345.8. Payment.

(1) The work performed and materials furnished in accordance with this

Item and measured as provided under "Measurement" will be paid for at the unit price bid for the "Asphalt Stabilized Base" of the grade specified.

The payment based on the unit bid price shall be full compensation for quarrying, furnishing all materials, additives, freight involved, for all heating, mixing, hauling, cleaning the existing base course or pavement, tack coat, placing, rolling and finishing asphalt stabilized mixture, transporting RAP from designated sources, transporting any excess RAP to locations shown on the plans, and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work.

(2) All templates, straightedges, core drilling equipment, scales and other weighing and measuring devices necessary for the proper construction, measuring and checking of the work shall be furnished, operated and maintained by the Contractor at his expense.

(3) State-owned RAP from sources designated on the plans will be available, at no cost, to the Contractor.

ITEM 351

REPAIRING EXISTING FLEXIBLE PAVEMENT STRUCTURE

351.1. Description. This Item shall govern for the repair of localized failures of existing sections of stabilized or unstabilized base that are surfaced with asphaltic concrete pavement or asphalt surface treatment. Sections shall be repaired to the specified depth, with the type of materials, and in conformance with the details shown on the plans. The minimum repair dimension shall be one (1) meter in both length and width.

When shown on the plans, salvaged asphaltic concrete pavement and/or asphalt stabilized base, including any accompanying surface treatment, plant mix seal and microsurfacing, may be allowed or required for use in other construction items of this project. If not used in other construction items of this project, these materials shall be stockpiled by the Contractor at the location shown on the plans or approved by the Engineer and shall remain the property of the State.

351.2

351.2. Materials. Materials used shall meet the following requirements and will be subject to the approval of the Engineer in regard to quality. For small quantities of materials, testing of materials may be waived by the Engineer. Unless otherwise shown on the plans, existing material removed from the roadway shall not be reused under this construction Item.

When opening to traffic is adversely delayed by the curing requirements

for the specified material(s), the Engineer may approve the use of base materials listed below which require less curing than those shown on the plans.

(1) Flexible Base. Unless otherwise shown on the plans, flexible base shall conform to the material requirements of Item 247, "Flexible Base" of the type and grade shown on the plans.

(2) Stabilized Base. Stabilized base materials shall conform to the pertinent material requirements of the following Items:

Item 262, "Lime Treatment for Base Courses (Road Mixed)"
Item 275, "Portland Cement Treated Materials (Road Mixed)"
Item 276, "Portland Cement Treated Base (Plant Mixed)"
Item 345, "Asphalt Stabilized Base (Plant Mix)"

(3) Asphaltic Concrete Pavement. Asphaltic concrete pavement shall conform to the pertinent material requirements of the following Items:

Item 330, "Limestone Rock Asphalt Pavement (Class A)"
Item 334, "Hot Mix-Cold Laid Asphaltic Concrete Pavement"
Item 340, "Hot Mix Asphaltic Concrete Pavement"

(4) Surface Treatments. Surface treatments shall conform to the material requirements of Item 316, "Surface Treatments".

(5) Prime Coat. Prime coats shall conform to the pertinent material requirements of the following Items:

Item 310, "Prime Coat (Cutback Asphaltic Material)"
Item 315, "Emulsified Asphalt Seal"

351.3. Construction Methods.

(1) Removal of Existing Pavement Structure. The existing pavement structure shall be broken or scarified and excavated for the length, width and depth as shown on the plans or as determined by the Engineer, leaving neat vertical faces around the perimeter. The minimum repair dimension shall be one (1) meter in both length and width. Care shall be taken to avoid loosening or disturbing material below the specified depth for removal.

Loose asphaltic paving material resulting from the operation which is not used in other construction items of this project, as shown on the plans, shall remain the property of the State and shall be stockpiled at the sites and in the manner shown on the plans or as approved by the Engineer. Salvaged asphaltic paving material shall be kept as free as possible from contamination by nonasphaltic materials during its removal, transportation, and storage. The stockpile areas shall be cleaned of trash, weeds and grass. The Engineer may require separate stockpiling of salvaged asphaltic paving materials of differing type or quality. Silt fencing around stockpile areas shall be provided when shown on the plans. Unless otherwise shown on the plans, nonasphaltic materials removed from the existing pavement structure shall become the property of the Contractor for disposition.

Where failure of the subgrade has occurred, the unstable subgrade material shall be removed to the depth specified by the Engineer and replaced with approved material.

Unless otherwise shown on the plans or approved by the Engineer, areas of removed pavement shall be repaired to a stage suitable to open to traffic within the same day.

(2) Preparation of the Subgrade. All holes, ruts or depressions shall be filled with an approved material, and if required, the subgrade shall be thoroughly wetted with water, reshaped and compacted as directed in order to place the subgrade in an acceptable condition to receive the base material.

(3) Mixing and Placing Base Material. Flexible base or stabilized base shall be mixed at locations approved by the Engineer. The material shall be spread and compacted in uniform layers to produce the depth specified on the plans.

(a) Flexible Base. Each layer shall be sprinkled as required and rolled or tamped as directed until a uniform compaction is secured. All irregularities, depressions or weak spots which develop shall be corrected immediately by scarifying the areas affected, adding suitable material as required, reshaping and recompacting by sprinkling and rolling or tamping.

Unless otherwise shown on the plans, the surface of the cured flexible base shall be protected by the application of a prime coat. The prime coat shall be of the type and grade and at the rate shown on the plans.

(b) Lime Stabilized Base. Unless otherwise shown on the plans, the minimum lime content will be three percent by mass of the total mixture. The base shall be thoroughly mixed with the required amount of lime and water and spread in uniform layers. Each layer shall be sprinkled as required and rolled or tamped as directed until a uniform compaction is secured. All irregularities, depressions or weak spots which develop shall be corrected immediately by scarifying the areas affected, adding suitable material as required, reshaping and recompacting by sprinkling and rolling or tamping.

Unless otherwise shown on the plans, the surface of the completed lime stabilized base shall be protected against rapid drying by the application of a prime coat. The prime coat shall be of the type and grade and at the rate shown on the plans.

(c) Cement Stabilized Base. Unless otherwise shown on the plans, the minimum cement content will be four percent by mass of the total mixture. The cement and base material shall be uniformly mixed with the water necessary to provide the optimum moisture, as determined by the Engineer, and spread in uniform layers. The cement stabilized base shall be rolled or tamped as directed until a uniform compaction is secured. Compaction shall begin immediately after mixing and spreading operations and shall be completed within two (2) hours from the time water is added to the mixture. All irregularities, depressions or weak spots which develop shall be corrected immediately by scarifying the areas affected, adding suitable material as required, reshaping and recompacting.

Unless otherwise shown on the plans, the surface of the completed cement stabilized base shall be protected against rapid drying by the application of a prime coat. The prime coat shall be of the type and grade and at the rate shown on the plans.

351.4

(d) Asphalt Stabilized Base and/or Asphaltic Concrete Pavement. The asphalt stabilized base material or asphaltic concrete pavement shall be spread in uniform layers. Each layer shall be rolled or tamped as directed until a uniform compaction is secured. All irregularities, depressions or weak spots which develop shall be corrected immediately by removing and replacing or adding material as required, and compacting.

(4) Curing and Traffic. Curing of all base material in repair work will be required as approved by the Engineer.

Completed sections of base may be opened immediately to local traffic and to construction equipment. All traffic will be allowed after the curing period, provided the mixture has hardened sufficiently to prevent marring or distorting of the surface by traffic.

(5) Surfacing. The completed sections of cured base shall be thoroughly cleaned and surfaced with the material shown on the plans.

(a) Asphaltic Concrete Pavement. When completed sections of base are to be surfaced with asphaltic concrete pavement, the base shall be cleaned to the satisfaction of the Engineer and shall be given a uniform application of tack coat using asphaltic materials of the type and grade indicated on the plans. The tack coat shall be applied in a manner approved by the Engineer with an approved sprayer at a rate not to exceed 0.2 liter per square meter of surface area. Tack coat may be eliminated by the Engineer when, in his opinion, it is unnecessary for a satisfactory bond between the base and the asphaltic concrete pavement.

The asphaltic concrete mixture shall be spread and compacted by equipment approved by the Engineer and in conformity with the existing roadway section or typical section shown on the plans, and to the lines and grades established by the Engineer. The asphaltic concrete shall be compacted as directed by the Engineer.

(b) Surface Treatments. When the completed sections of base are to be surfaced with a surface treatment, the base shall be cleaned and surfaced with the type and grade of asphalt and aggregate as shown on the plans in accordance with Item 316, "Surface Treatments".

351.4. Measurement. This Item will be measured by the square meter of the completed section for the depth specified. In those areas where material is excavated, at the direction of the Engineer, to depths

greater than those specified on the plans, measurement will be made by dividing the actual depth of such area by the plan depth, and then multiplying this figure

by the area in square meters of work performed. Calculations for each repaired area shall be rounded up to the nearest 0.1 square meter.

351.5. Payment. The work performed and the material furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Repairing Existing Flexible Pavement Structure", of the specified depth. This price shall be full compensation for scarifying or breaking the existing pavement structure; for the removal, hauling, spreading, disposal or stockpiling of existing pavement structure; for the removal of any objectionable or unstable material; for furnishing all materials, including prime coat, tack coat and surfacing; and for all hauling, sprinkling, spreading, compaction, and all other manipulations, labor, tools and incidentals necessary to complete the work.

When the plans call for the installation of silt-fencing protection around stockpile areas, the fencing will be measured and paid for directly under the pertinent specification item.

ITEM 352

CLEANING AND/OR SEALING JOINTS AND CRACKS (ASPHALTIC CONCRETE)

352.1. Description. This Item shall govern for the cleaning and sealing of joints and cracks that are two (2) millimeters or greater in width in asphaltic concrete pavement, in accordance with the details on the plans or as directed by the Engineer.

352.2. Materials. Joints and/or cracks shall be sealed with the materials shown on the plans. Materials shall meet the requirements shown below.

Material	Specification	Recommended Use
Polymer Modified Emulsion	Subarticle 300.2.(8)	Fine Cracks
Rubber-Asphalt Crack Sealing Compound	Subarticle 300.2.(8)	Cracks
352.3		
Hot Poured Rubber	Article 433.2	Joints and Cracks
Self-Leveling Low Modulus Silicone	Article 433.2	Joints

Fine aggregate used to cover the crack sealing compound shall meet with the approval of the Engineer.

352.3. Equipment. Equipment, tools and machinery necessary for proper prosecution of the work shall be on the project and approved by the Engineer prior to beginning of the joint and crack cleaning and sealing operations.

(1) Heating and Application Equipment.

(a) Polymer Modified Emulsion. Polymer modified emulsion may be heated in a conventional asphalt distributor or in an asphalt heater equipped with an agitator to insure that the emulsified asphalt is circulated during the heating process to achieve a uniform temperature rise. Temperature gauges shall be provided at strategic locations to enable the operator to accurately control the temperature of the emulsion to avoid overheating the material. The unit shall be equipped with a gear-driven asphalt pump with adequate pressure to dispense the emulsion in joints and cracks.

(b) Rubber-Asphalt Crack Sealing Compound and Hot Poured Rubber. These sealants shall be heated in a double jacketed heater using a heat transfer oil so that no direct flame comes in contact with the shell of the vessel containing the sealing compound. The heater reservoir shall be equipped with an agitator to insure that the sealing compound is circulated during the heating process to achieve a uniform temperature rise and to maintain the desired temperature. Accurate temperature gauges shall be provided to monitor the temperature of the vessel contents and avoid overheating the material. The heater shall be equipped with a gear-driven asphalt pump with adequate pressure to dispense the rubber-asphalt crack sealing compound or the hot poured rubber.

(c) Self-Leveling Low Modulus Silicone. This sealant shall be prepared and dispensed using the manufacturer's recommended equipment.

(2) Joint and Crack Cleaning Equipment. All equipment used in cleaning joints and cracks shall be capable of delivering a sufficient volume of filtered air, free of oil, water or other contaminants, to remove all loose debris from the joints or cracks to be sealed.

(3) Joint Router. When specified on the plans, joints shall be routed. The router shall be of sufficient size to rout the joints to the widths and depths shown on the plans.

352.4. Construction Methods. All joints and cracks shall be cleaned of infiltrated material with compressed air or other methods approved by the Engineer to a depth at least twice the joint or crack width. When routing of the joints is indicated on the plans, the joints shall be routed and blown clean with filtered compressed air. All material removed from joints and cracks shall be removed from the paved surface of the roadway.

The joint or crack sealing material shall be applied using a pressure nozzle. Polymer modified emulsion, rubber-asphalt crack sealing compound and hot poured rubber shall penetrate and completely fill each crack and/or joint. The amount of sealing compound used shall be limited so that after the squeegee has been applied, the finished band shall not be more than 40 millimeters wide and shall not exceed a depth of three (3) millimeters above the pavement surface. All cracks and/or joints filled with these materials shall be squeegeed. Self-leveling low modulus silicone joint sealing compound shall be applied so that it penetrates the joint and fills so that the top of the sealant shall be six (6) millimeters to ten (10) millimeters below the pavement surface.

When directed by the Engineer, a light coating of fine aggregate shall be applied to the cracks and joints prior to opening to traffic to prevent tracking.

When the number of cracks is so great that crack sealing in the described manner is impractical, the area shall be squeegee sealed. When all cracks in the area have been cleaned, the crack sealing material shall be applied and the excess shall be squeegeed over the area between the cracks. Areas to be squeegee sealed will be determined and marked by the Engineer. All polymer modified emulsion or hot poured rubber squeegee sealed areas shall be covered immediately with a light coating of fine aggregate.

No sealing of any joints or cracks shall be done when the joints or cracks are damp, unless drying of the joints and cracks with compressed air can be demonstrated and meets with the approval of the Engineer.

352.5. Measurement. This Item will be measured by one or more of the following methods as shown on the plans.

Square Meter Method (Squeegee Seal). When cleaning and sealing of joints and cracks is either by the meter method or the lane kilometer method, squeegee-sealed areas will be measured by the square meter of surface area sealed. The square meter calculations for squeegee seal will be based on the neat dimensions of the sealed area.

Meter Method. Measurement will be made by the meter of joints and cracks cleaned and sealed, excluding squeegee sealed areas. Squeegee sealed areas are to be paid for separately.

Lane Kilometer Method. Measurement will be made by the lane kilometer for cleaning and sealing all joints and cracks in the entire lane width and length, including lane lengths with squeegee sealed areas. Squeegee sealed areas are to be paid for separately. The shoulder shall be considered as an additional lane.

Kilogram Method. Measurement will be made by the kilograms of rubber-asphalt crack sealing compound or hot poured rubber used for cleaning and sealing joints and cracks, including squeegee sealed areas.

Liter Method. Measurement will be by the liters of polymer modified emulsion or self-leveling low modulus silicone used for cleaning and sealing joints and cracks, including squeegee sealed areas.

352.6. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Joint and Crack Sealing", of the type of sealant specified; "Joint and Crack Sealing (Squeegee);" or "Joint and Crack Sealing". This price shall be full compensation for routing, cleaning and sealing all joints and cracks, for furnishing and placing all materials including fine aggregate and for all labor, equipment, tools and incidentals necessary to complete the work.

ITEM 354

PLANING AND/OR TEXTURING PAVEMENT

354.1. Description. This Item shall govern for the planing or the planing and texturing of existing asphaltic concrete pavement, asphalt stabilized base and/or portland cement concrete pavement and the texturing of bridge deck surfaces at the locations shown on the plans or as directed by the Engineer and in accordance with the requirements herein.

When shown on the plans, salvaged asphaltic concrete pavement and/or asphalt stabilized base, including any accompanying surface treatment, plant mix seal and microsurfacing, may be allowed or required for use in other construction items of this project. If not used in other construction items of this project, these materials shall be stockpiled by the Contractor at the location shown on the plans or approved by the Engineer and shall remain the property of the State.

354.2. Equipment. The equipment for removing the pavement surface shall be a power operated planing machine with a minimum 1.8 meter cutting width. For detail work and for cutting widths less than 1.8 meters, equipment with less than 1.8 meters cutting widths will be allowed. The equipment shall be self-propelled with sufficient power, traction and stability to maintain accurate depth of cut and slope. The equipment shall be capable of cutting 100 millimeters of asphaltic concrete pavement, 25 millimeters of portland cement concrete pavement, or a combination of 50 millimeters of asphaltic concrete pavement and 15 millimeters portland concrete pavement in one continuous operation.

The equipment shall be equipped with an approved automatic dual longitudinal grade control system and a transverse control system unless otherwise directed by the Engineer or shown on the plans. The longitudinal controls shall be capable of operating from any longitudinal grade reference, including stringline, ski, mobile stringline, or matching shoe. The transverse controls shall have an automatic system for controlling cross slope at a given rate.

The grade reference used by the Contractor may be of any type approved by the Engineer. Control points, if required by the plans, shall be established for the finished profile and in accordance with Item 5, "Control of the Work". These points shall be set at intervals not to exceed

15 meters. The Contractor shall set the grade reference from the control points. The grade reference shall have sufficient support so that the maximum deflection shall not exceed two (2) millimeters between supports.

The machine shall have a manual system providing for uniformly varying the depth of cut while the machine is in motion, thereby making it possible to cut flush to all inlets, manholes, or other obstructions within the paved area. The speed of the machine shall be variable in order to leave the desired grid pattern specified under Article 354.4 of this Item.

The machine shall be equipped with integral loading and reclaiming devices to immediately remove material being cut from the surface of the roadway and discharge the cuttings into a truck, all in one operation. The machine shall be equipped with devices to control dust created by the cutting action.

Various machines may be permitted to make trial runs to demonstrate to the Engineer the capabilities of that machine. Any machine that is incapable of meeting the requirements of this Item, in the opinion of the Engineer, will not be permitted.

A street sweeper equipped with a water tank, spray assembly to control dust, a pick-up broom, a gutter broom, and a dirt hopper shall be provided by the Contractor. The street sweeper shall be capable of removing cuttings and debris from the planed or textured pavement. Other sweeping equipment may be provided in lieu of the street sweeper when approved by the Engineer in writing.

The Contractor shall provide any other equipment and personnel necessary for proper operation of the planing machine, to minimize dust and to remove cuttings.

354.3. Construction Methods. The pavement surface shall be removed for the length, depth and width and to the typical section shown on the plans, and to the line and grades established by the Engineer. The planed surface shall provide a satisfactory riding surface free from gouges, continuous longitudinal grooves, ridges, oil film and other imperfections of workmanship and shall have a uniform textured appearance.

When removing an asphaltic concrete pavement from an underlying portland cement concrete pavement, all of the asphaltic concrete pavement shall be removed, leaving a uniform surface of portland cement concrete, unless otherwise directed by the Engineer.

Any vertical or near vertical longitudinal face exceeding 30 millimeters in height in the pavement surface open to traffic at the end of a work period shall be sloped a minimum of 1:1. Transverse faces that are present at the end of a work period shall be tapered in a manner acceptable to the Engineer.

Loose portland cement concrete material resulting from the operation shall be stockpiled at sites shown on the plans or shall be disposed of at sites obtained by the Contractor and approved by the Engineer in writing. Loose asphaltic paving material resulting from the operation which is not used in other construction items of this project, as shown on the plans, shall remain the property of the State and shall be stockpiled at the sites and in the manner shown on the plans or approved by the Engineer. Salvaged asphaltic paving material shall be kept as free as possible from contamination by nonasphaltic materials during its removal, transportation and storage. The stockpile areas shall be cleaned of trash, weeds and grass. The Engineer may require separate stockpiling of salvaged asphaltic paving materials of differing type or quality. Silt fencing around stockpile areas shall be provided when shown on the plans.

Pavement that is not removed by the planing machine adjacent to steep curbs, inlets, manholes or other obstructions shall be removed by other methods acceptable to the Engineer.

The pavement and curb surfaces shall be swept with a street sweeper or other sweeping equipment approved by the Engineer to remove all debris leaving a clean and presentable condition.

354.4. Surface Texture and Tests. In areas where traffic will be permitted, the texture produced shall be a grid pattern or any other pattern with discontinuous longitudinal striations that will provide, in the opinion of the Engineer, a satisfactory riding surface.

When the planed pavement is not to be overlaid, the minimum texture depth resulting from the number of measurements directed by the Engineer shall not be less than 1.25 millimeters, unless otherwise shown on the plans. When these texture requirements are not met, the Contractor shall cease operations until the Engineer is satisfied that changes in the texturing procedures will produce an acceptable texture. In no case shall the texture depth on bridge deck structures exceed five (5) millimeters into the original bridge deck surface. Additionally, care shall be taken to prevent damage to armor joints, sealed expansion joints and/or other appurtenances.

354.5 to 354.6

The surface of the pavement, after planing, shall have a smooth riding

quality and shall be true to the established line, grade and cross section. The pavement surface, when tested with a 3-meter straightedge placed parallel to the centerline of the roadway or tested by other equivalent or acceptable means, shall not have any deviation greater than three (3) millimeters in three (3) meters. The deviations shall be measured from the top of the texture. Any point in the surface not meeting this requirement shall be corrected as directed by the Engineer at the Contractor's expense.

354.5. Measurement. Planing or planing and texturing pavement will be measured by the square meter of surface area for each pavement type. Pavement types are asphaltic concrete pavement, portland cement concrete pavement and bridge decks. Square meter calculations will be based on the neat dimensions shown on the plans or as adjusted by the Engineer.

Measurement will be based on the depth shown for each bid item, within the limits shown on the plans, regardless of the actual thickness removed or the number of passes required. Only one bid item for each pavement type will be applicable to any one location.

When planing asphaltic concrete pavement from an underlying portland cement concrete pavement, the planing of any portland cement concrete pavement to remove all asphaltic concrete pavement as required under Article 354.3 will be considered subsidiary to the planing of asphaltic concrete pavement of the depth shown on the plans and will not be paid for directly.

354.6. Payment. The work performed in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Planing and Texturing Asphaltic Concrete Pavement", "Planing and Texturing Portland Cement Concrete Pavement", "Planing Asphaltic Concrete Pavement", or "Planing Portland Cement Concrete Pavement" of the various depths specified or "Texturing Bridge Decks". This price shall be full compensation for removing all material to the depth shown, texturing the pavement surface (when texturing is shown in the bid item description), loading, hauling, unloading, and satisfactory storing or disposing of the material, for all sweeping, and for all labor, tools, equipment, manipulation and incidentals necessary to complete the work, except as shown below.

Tapering or sloping of the longitudinal or transverse joints as described under Article 354.3 will be considered subsidiary to this Item and will not be paid for directly.

No payment will be made for work done by any machine on a trial run to demonstrate its ability to meet the requirements of this Item unless the work performed is acceptable under this Item.

When the plans call for the installation of silt fencing protection around stockpile areas, the fencing will be measured and paid for directly.

ITEM 356

FABRIC UNDERSEAL

356.1. Description. This Item shall govern for furnishing and placing a fabric underseal consisting of a single application of asphalt cement covered with one layer of an approved fabric with or without sand or screenings, in accordance with the details shown on the plans and the requirements herein.

356.2. Materials.

(1) Fabric. The fabric shall meet the requirements of Departmental Materials Specification D-9-6220, "Fabric for Underseals".

(2) Asphalt Cement. Asphalt cement shall be of the grade shown on the plans or as designated by the Engineer and shall meet the requirements of Item 300, "Asphalts, Oils, and Emulsions".

(3) Sand or Screenings. Sand or screenings shall meet requirements as shown on the plans or approved by the Engineer.

356.3. Construction Methods. The area on which the underseal is to be placed shall be cleaned of dirt, dust or other deleterious material by sweeping or other approved methods. Asphalt cement shall be applied on the clean surface by an approved self-propelled pressure distributor. The distributor shall apply the asphalt cement, at the application rate directed by the Engineer, evenly and smoothly under a pressure necessary for proper distribution. The Contractor shall provide all necessary facilities for determining the temperature of the asphaltic material.

Calibration of the distributor shall be in accordance with Item 316, "Surface Treatments".

All equipment used in storing or handling asphalt cement shall be kept clean and in good operating condition at all times, and they shall be operated in such a manner that there will be no contamination of the asphalt cement. The Contractor shall provide and maintain a recording thermometer to continuously indicate the asphalt cement temperature at the storage heating unit.

The Engineer will select a temperature of application within the limits recommended in Item 300, "Asphalts, Oils and Emulsions". The Contractor shall apply the asphalt at a temperature within 8 °C of the temperature selected.

The underseal shall not be applied when the air temperature is below 15° C and is falling, but may be applied when the air temperature is above 10 °C and is rising, the air temperature being taken in the shade away from artificial heat. In addition, the underseal shall not be applied when the temperature of the surface on which the underseal is to be placed is below 15 °C. Neither the asphalt cement nor the fabric shall be placed when general weather conditions, in the opinion of the Engineer, are not suitable.

Asphalt cement shall be applied ahead of the fabric placement in widths approximately 150 millimeters wider than the fabric, unless otherwise directed by the Engineer. The asphalt cement shall be applied at the approximate rate shown on the plans or as directed by the Engineer.

String lines shall be set for alignment as required by the Engineer.

Immediately upon application of the asphalt cement, the fabric shall be aligned and carefully broomed and/or rolled onto the asphalt cement with equipment approved by the Engineer. In the event the initial alignment is not satisfactory and causes the fabric to wrinkle during placement, the fabric shall be cut and realigned overlapping the previous material and proceeding as before. If the edges of the fabric tend to be displaced because of air currents, the Engineer may require that the edges be secured to the pavement at five (5) meter intervals. In the event this procedure does not prove satisfactory, then work will be suspended until conditions are more favorable.

All transverse joints shall be overlapped a minimum of 150 millimeters. Laps shall be in the direction of travel when traffic is allowed directly on the underseal. In lapping joints, the top fabric shall be folded back to allow application of a light coat of asphalt cement. The top fabric is then placed back onto the asphalt cement, broomed and squeegeed out smoothly. Rolling and/or brooming the fabric into the asphalt cement at the joints shall be accomplished in such a way that air bubbles which form under the fabric will be removed. This may be accomplished by brooming from the center of the fabric toward the outer edges. The fabric shall be neatly cut and contoured at all joints as directed by the Engineer.

Adjacent longitudinal rolls of the fabric shall overlap a minimum of 100 millimeters. Additional asphalt cement shall be applied to make these longitudinal joints.

Turning of equipment shall be gradual and kept to a minimum to avoid damage to the fabric. When required by the Engineer, fabric underseal shall be covered with a thin layer of clean sand or clean crusher screenings at a rate sufficient to absorb any excess asphalt cement.

356.4. Measurement.

(1) Asphalt Cement. Asphalt cement will be measured as follows and as shown on the plans.

(a) Volume. Asphalt cement will be measured at the point of application on the road in liters at the applied temperature. The quantity to be measured for payment shall be the number of liters used, as directed, in the accepted fabric underseal.

(b) Mass. Asphalt cement will be measured at the point of origin in megagram. Weighing will be done by a certified weigher and the transporting vehicle shall have a seal attached to the draining device and other openings. The Contractor shall provide an acceptable means of measuring the amount of asphalt cement received to assure that all material measured at the point of origin is received and used on the project. Upon completion of the prescribed work, any excess asphalt cement will be weighed by a certified weigher or shall be measured by volume in a calibrated distributor or calibrated tank and the quantity to be converted to megagrams with respect to the measured temperature. The quantity to be measured for payment shall be the number of megagrams received minus the number of megagrams remaining after all directed work is complete minus the amount used for other Items.

356.5 to 358.3

(2) Fabric Underseal. This Item will be measured by the square meter based on the calculated quantity shown on the contract plans with no allowance made for overlapping at joints.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

356.5. Payment. The work performed and materials furnished in accordance with this Item, and measured as provided under "Measurement", will be paid for at the unit prices bid for "Asphalt" and "Fabric Underseal". These prices shall each be full compensation for cleaning and preparing the existing pavement; for furnishing, preparing, hauling and placing all materials, including sand or crusher screenings; for all freight involved; for all manipulation, including rolling and brooming and for all labor, tools, equipment and incidentals necessary to complete the work.

ITEM 358

ASPHALTIC CONCRETE SURFACE REHABILITATION

358.1. Description. This Item shall govern for asphaltic concrete surface rehabilitation, a process that consists of softening the existing asphaltic concrete surface with heat, scarifying to the depth shown on the plans, and thoroughly remixing, leveling and compacting the material. Scarified material shall be blended with fresh hot asphaltic concrete mixture, and when required, with an asphalt recycling agent.

358.2. Materials. All materials shall conform to the pertinent requirements of the following Items:

Item 300, "Asphalt, Oils and Emulsions"
Item 340, "Hot Mix Asphaltic Concrete Pavement"

The fresh hot mix asphaltic concrete mixture shall meet the requirements shown on the plans or as directed by the Engineer. The materials used to produce the fresh hot mix asphaltic mixture shall meet the requirements of Article 340.2.

358.3. Equipment.

358.4

(1) Processing Equipment. The equipment for heating, scarifying mixing, placing and finishing shall be as approved by the Engineer. The equipment shall consist of the following:

(a) A heating mechanism capable of heating the asphaltic con-crete pavement to a temperature high enough to allow scarification of the material to the desired depth without breaking aggregate particles, without charring the existing asphalt, and without producing undesirable pollutants. The heating mechanism shall be so equipped that heat application shall be under an enclosed or shielded hood.

(b) Scarifier sections capable of uniformly loosening the asphaltic concrete pavement to the depth specified and, when shown on the plans, equipped with separate automatic height adjustments in order to clear utility manholes and other obstructions in the pavement surface.

(c) A system for adding and uniformly blending an asphalt recycling agent during the mixing operation. The system shall be synchronized to provide a uniform application at the specified rate.

(d) A unit capable of gathering the heated and scarified asphaltic concrete pavement, adding and uniformly mixing fresh asphaltic concrete, and distributing the blended mixture over the width being processed.

(e) A spreading and finishing system capable of producing a smooth surface which meets the requirements of the typical cross section.

(f) An onboard pugmill, if required on the plans.

(2) Rollers. Rollers shall be in accordance with Subarticle 340.4.(7).

(3) Mobile Testing Laboratory. When shown on the plans, a mobile testing laboratory and a laboratory technician shall be furnished by the Contractor. These shall meet the requirements shown on the plans.

358.4. Construction Methods.

(1) General. The pavement surface to be rehabilitated shall be cleaned of all dirt and other objectionable material by blading, brooming or other approved methods, prior to beginning heater-scarification operations.

358.4

(2) Heating, Scarifying and Placing. The pavement surface shall be evenly heated, scarified and reworked to the widths and depths shown on the

plans. Heating shall be controlled to assure uniform heat penetration without causing differential softening of the pavement. Charring of the asphalt will not be permitted. The scarified material shall be gathered
mixed and laid. The asphalt recycling agent, when required, shall be applied uniformly to the scarified material prior to mixing and leveling unless otherwise approved by the Engineer. The rate of application shall be as selected by the Engineer based on laboratory tests on pavement samples. The required amount of fresh hot mix asphaltic concrete shall be added and thoroughly mixed with the scarified material, and the blend shall be leveled and compacted.

All work under this Item shall be in conformity with the typical sections shown on the plans and to the lines and grades as established by the Engineer.

The heated and scarified material shall have a temperature between 110 °C and 130 °C as measured immediately behind the scarifier.

There shall be no burning of trees, shrubs, or other landscaping adjacent to the pavement. It shall be the responsibility of the Contractor to protect the adjacent landscape from heat damage.

When a pass is made adjacent to a previously placed mat, the longitudinal joint shall extend at least 50 millimeters horizontally into the previously placed mat, unless otherwise directed by the Engineer.

(3) Compaction. Compaction shall begin before the material temperature drops below 90 °C. All rolling shall be completed before the mixture temperature drops below 80 °C unless determined by the Engineer that a higher minimum temperature is required for proper compaction.

Rolling shall be continued until no further compaction can be obtained and all roller marks are eliminated. One (1) tandem roller, one (1) pneumatic-tire roller and at least one (1) three-wheel roller shall be provided for each work site unless otherwise directed by the Engineer.

The Contractor may, with permission from the Engineer, operate other compacting equipment that will produce equivalent compaction as the specified equipment. If the substituted compaction equipment fails to produce the compaction expected of the specified equipment, as determined by the Engineer, its use shall be discontinued.

358.5 to 360.1

The edges of the pavement along curbs, headers and similar structures, and all places not accessible to the roller, or in such locations as will not allow thorough compaction with the rollers, shall be thoroughly compacted with lightly-oiled tamps.

358.5. Measurement. Asphaltic concrete surface rehabilitation will be measured by the square meter of surface area of completed and accepted work. Asphalt recycling agent will be measured by the liter. The fresh hot mix asphaltic concrete shall be measured in accordance with Item 340, "Hot Mix Asphaltic Concrete Pavement".

358.6. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for as follows:

(1) Asphaltic Concrete Surface Rehabilitation. Asphaltic concrete surface rehabilitation will be paid for at the unit price bid for "Asphaltic Concrete Surface Rehabilitation" of the depth specified. This price shall be full compensation for cleaning existing pavement, all heating, scarifying, mixing, relaying, rolling, finishing, and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work.

(2) Asphalt Recycling Agent. Recycling agent will be paid for at the unit price bid for "Recycling Agent". This price shall be full compensation for furnishing, hauling, applying and mixing the material; and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work.

(3) Fresh Hot Mix Asphaltic Concrete. All fresh hot mix asphaltic concrete shall be paid for in accordance with Item 340, "Hot Mix Asphaltic Concrete Pavement".

ITEM 360

CONCRETE PAVEMENT

360.1. Description. This Item shall govern for the construction of portland cement concrete pavement with or without monolithic curbs on a prepared subgrade or subbase course, in accordance with the typical sections shown on the plans, the lines and grades established by the Engineer and the requirements herein.

360.2. Paving Construction Plan. The Contractor shall submit a paving construction plan for approval by the Engineer prior to beginning pavement construction operations. The plan shall contain the mix design, methods of construction, description of equipment to be used in mixing, placing, finishing, curing, lighting and miscellaneous materials, and early usage of concrete pavement.

The plan also shall include location, sequence, and construction methods for leaveouts which are shown on the plans or due to the Contractor's operations.

Revision to the paving construction plan may be requested by either party and the revision shall be submitted to the Engineer for approval.

360.3. Materials. Unless otherwise shown on the plans or required herein, all materials shall conform to the requirements of the pertinent Items as follows:

Item 300, "Asphalts, Oils and Emulsions"
Item 420, "Concrete Structures"
Item 421, "Portland Cement Concrete"
Item 433, "Joint Sealants and Fillers"
Item 437, "Concrete Admixtures"
Item 440, "Reinforcing Steel"
Item 526, "Membrane Curing"

except for the following:

(1) Portland Cement Concrete. Classification and mix design shall conform to Class "P" portland cement concrete as defined in Item 421, "Portland Cement Concrete", unless otherwise shown on the plans.

The Contractor shall obtain written permission from the Engineer prior to the use of Type III cement when Type III cement is not shown on the plans.

(2) Joint Sealants and Fillers. These materials shall be of the size, shape and type shown on the plans.

Unless otherwise shown on the plans, the joint sealant materials to be used shall conform to the requirements of Class 5 joint sealant as described in Item 433, "Joint Sealants and Fillers".

(3) Dowels for Expansion and Contraction Joints. Dowels shall be smooth, straight steel dowels of the size and type shown on the plans and shall conform to the requirements of ASTM A 615, Grade 400. The free end of dowels shall be smooth and free of burrs.

Unless otherwise shown on the plans, the entire length of each dowel shall be coated with a hot applied asphalt cement. Cut-back asphalts and emulsions shall not be used.

Unless otherwise shown on the plans, the asphalt coated end of each dowel to be used in an expansion joint shall be encased in an approved cap having an inside diameter of two (2) millimeters greater than the diameter of the dowel. The cap shall be of such strength, durability and design as to provide free movement of the dowels and shall be approved by the Engineer prior to use. The end of the cap shall be filled with a soft compressible material or shall be void in order to permit free movement of the dowel for a distance equivalent to 150 percent of the width of the joint used. The dowel caps and dowels shall be held securely in place by ties as shown on the plans, or as approved by the Engineer.

(4) Positioning and Support Devices for Reinforcement and Joint Assemblies. These devices shall be of sufficient structural quality to prevent movement of the dowels or steel reinforcement during concrete placement and finishing. Devices shall be of a type approved by the Engineer.

Positioning and supporting devices (chairs) for steel reinforcement bars shall be either plastic or metal and of sufficient number to maintain the position of the bars within the allowable tolerances.

Metal positioning and supporting devices for expansion and contraction joint assemblies (such as welded wire bar chairs, bar stakes, etc.) where used shall be as shown on the plans or may be similar devices of equivalent or greater strength, approved by the Engineer. The support devices shall secure the joint assembly and dowels within the allowable tolerances while providing no restraint against joint movement. Dowels used in joint assemblies shall be secured in parallel position by a transverse metal brace of the type and design shown on the plans, or may be secured by other devices approved by the Engineer. The devices shall provide positive mechanical connection between the brace and each unit (other than by wire tie) and prevent transverse movement of each load transmission device.

360.4

(5) Reinforcing Steel. ASTM A 616 Grade 400 will be permitted for straight bars only. Reinforcing steel that requires bending shall be ASTM A 615

Grade 300 with the spacing reduced to 2/3 of that shown for Grade 400 reinforcing steel. When shown on the plans, corrosion protection shall be applied to dowels and tiebars.

(a) Tie Bars. Tie bars at weakened plane longitudinal joints shall be straight reinforcing bars. Tie bars at longitudinal construction joints shall be either multiple piece tie bars or straight reinforcing bars, when equipment or conditions permit. Bent reinforcing bars may be used for longitudinal construction joints unless otherwise shown on the plans.

(b) Multiple Piece Tie Bars. Multiple piece tie bars (threaded coupling or other adequate devices) shall develop a tensile strength over their entire length equal to 1 1/4 times the yield strength of the tie bars shown. Each end of multiple piece tie bars shall consist of deformed reinforcement of at least the size shown on the plans, conforming to Item 440, "Reinforcing Steel". The deformed portion of each end of multiple piece tie bars shall be at least 1/2 of the length of the tie bars shown on the plans. Unless otherwise shown on the plans, the spacing for multiple piece tie bars shall be equal to or less than that of the transverse bars shown.

(6) Curing Materials. Curing material shall conform to Type 2 Class A curing compound or emulsified asphalt of the type and grade as shown on the plans.

360.4. Equipment.

(1) General. All equipment shall be maintained in good condition and approved by the Engineer before the Contractor will be permitted to begin construction of the pavement.

(2) Weighing and Measuring Equipment. Scales, bins and meters shall conform to the requirements of Item 520, "Weighing and Measuring Equipment".

(3) Mixer. The mixer furnished shall conform to the requirements of Item 522, "Portland Cement Concrete Plants", and shall be either a paving mixer (operated at the construction site or centrally located), stationary mixer (central mixer), or truck mounted paving mixer.

A transit mixer, conforming to Item 522, "Portland Cement Concrete Plants", may be used for mixing concrete for pavement only when permitted on the plans.

A transit mixer will be allowed for curbs, irregular sections and/or small placements such as turn outs and leave outs.

(4) Hauling Equipment. Hauling equipment shall conform to one (1) of the following:

(a) Wet Batch (Central Mixed) Hauling Equipment. When a central mixer is used, concrete shall be transported to the point of delivery in either agitator trucks or nonagitating trucks.

The hauling equipment shall be capable of delivering the concrete to the work site in a thoroughly mixed and uniform mass and discharging the concrete at a satisfactory controlled rate without segregation.

(i) Agitator Trucks. Agitator trucks shall conform to one (1) of the following types:

(1) Alternate agitating hauling equipment approved by the Engineer in writing.

(2) Horizontal axis, revolving drum.

(3) Inclined axis, revolving drum.

(4) Open top, revolving blade or paddle.

The drum, revolving blades or paddles shall be actuated by an engine mounted as an integral part of the unit. When the truck agitator is equipped with a transmission that will govern the speed of the drum or revolving blades or paddles within the specified rpm, no separate engine for rotating the drum will be required. The engine or engine/transmission combination shall be in satisfactory working condition and capable of accurately controlling the agitation speed of the unit.

Agitator trucks shall be equipped with facilities to readily permit access for inspection, cleaning and repair of blades or paddles.

Each agitator truck shall have attached, in a prominent place, a metal plate or plates on which are plainly marked the various uses for which the

unit is designed. The data shall include the manufacturer's recommended agitating speed of the rotating element and the capacity of the unit. If a truck mounted paving mixer is used, the mixer may transport the concrete only after mixing is complete.

(ii) Non Agitator Trucks. Non agitator trucks shall have a smooth, mortar-tight, metal bed.

(5) Grade Control Equipment. When concrete pavement is not formed, equipment used in the spreading and finishing of concrete pavement shall be designed to be operated on a prepared track grade controlled by electronic sensor systems. The systems used on a prepared track grade shall operate from an adequately supported string line or equivalent system approved by the Engineer.

(6) Planers and Templates. Planers and templates shall operate on forms or use approved grade control equipment. Other methods of controlling the planer or template may be used if approved by the engineer in writing.

Planers and templates shall be of such strength and rigidity that, under a test made by changing the support from the wheels to the center, a deflection of not more than three (3) millimeters will develop.

(a) Planers. Planers shall be designed for use on subgrade or unstabilized subbases and shall have adjustable cutting blades which shall trim the subgrade to the section shown on the plans.

When the concrete pavement is to be formed, the planer shall be mounted on visible rollers which are designed to ride on the forms. The planer frame shall be sufficiently heavy to as to maintain contact with the forms at all times during use.

(b) Templates. A template for checking the contour of the subbase or subgrade, using approved grade control equipment, shall be provided with adjustable rods spaced at 300 millimeter intervals projecting downward to the subgrade or subbase. These rods shall be adjusted to the required cross section of the bottom of the slab when the template is resting upon the side forms.

(7) Forms.

(a) Side Forms. Side forms shall be of metal except as otherwise

provided herein and shall be of approved cross section. The length of form sections shall not be less than three (3) meters, and each section shall provide for staking in position with not less than three (3) pins. Forms shall be of ample strength and shall be provided with adequate devices to secure them in place so the forms will withstand, without visible springing or settlement, the impact and vibration of the spreading and finishing machinery. In no case shall the base of the form be less than 200 millimeters wide for a form depth of 200 millimeters or more in height. The forms shall be free from warps, bends or kinks, and shall be sufficiently true to provide a reasonably straight edge on the concrete. The top of each form section, when tested with a straight edge, shall conform to the requirements specified for the surface of the completed pavement. A sufficient number of forms shall be provided for satisfactory prosecution of the work.

Flexible or curved forms of wood or metal of proper radius shall be used for curves of 30 meter radius or less.

The preferred depth of the form shall be equal to the required edge thickness of the pavement. Forms with depth greater or less than the required edge thickness of the pavement will be permitted provided the difference between the form depth and the edge thickness is not greater than 50 millimeters, and further provided that:

Figure 1

NOTE:

Shims are <u>not</u> to be used to compensate for deviations in the subgrade or subbase profiles.

(i) Forms of a depth greater than the pavement edge may be used if the supporting material is planed to construct a form trench.

(ii) Forms of a depth less than the pavement edge shall be brought to the required edge thickness by securely attaching metal strips or wood shims of approved section to the full width and length of the base of the form, as shown in Figure 1.

(b) Curb Forms. Outside curb forms shall be of wood or metal of a section satisfactory to the Engineer, straight, free of warp, and shall be of a depth at least equal to the depth of the curb. They shall be securely mounted on the paving forms and maintained in true position during the placing of the concrete. Inside curb forms, if required, shall be of approved material and of such design as to provide the curb required and shall be rigidly attached to the outside curbs forms.

(8) Concrete Spreader. A mechanical concrete spreader shall conform to the following requirements:

Be a self propelled machine having sufficient power and traction to spread and strike off concrete without slippage,

Be equipped with a power driven device, either a reciprocating blade, screw conveyor or a belt conveyor, for spreading the concrete uniformly,

And be capable of striking off the concrete slab at the depth and grade required.

Mechanically-operated concrete spreaders of other designs, which uniformly distribute the concrete with minimal segregation, may be used when approved by the Engineer in writing.

(9) Slipform Paver. Slipform pavers shall be equipped to spread the concrete uniformly and strike off the concrete to the required section, using a power driven device, either a reciprocating blade, a screw conveyor, or a belt conveyor, without loss of traction.

The slipform paver shall have an electronic sensor system or equivalent to provide grade control for the paver, unless otherwise shown on the plans.

The slipform paver shall be equipped with consolidation equipment in

accordance with Subarticle 360.4.(11) (a) or (c).

(10) Floats. Floats shall be either mechanically operated oscillating longitudinal floats or tube floats capable of producing a uniformly smooth surface.

Tube floats shall be designed to operate at an angle of greater than 30 degrees from normal when rotated either direction. The tube float shall extend across the pavement to the side forms and/or the edge of the concrete pavement. The tube float shall be equipped to provide a fine light fog mist.

(11) Mechanical Vibratory Equipment. Mechanical vibrating equipment shall conform to the following:

(a) Immersion (Internal) Vibrators. Immersion vibrators shall be spaced at not more than 600 millimeters and shall be equipped with synchronized vibratory units. Separate vibratory units shall be spaced at sufficiently close intervals to provide uniform vibration and consolidation to the entire depth and width of the pavement. The frequency in air of the immersion vibrator units shall be not less than 8000 cycles per minute. The Contractor shall have a satisfactory tachometer available for checking the vibratory elements.

(b) Hand Operated Immersion Vibrators. Approved hand operated immersion vibrators shall be furnished in sufficient number for proper consolidation of the concrete along forms, at joints and in areas not covered by mechanically controlled vibrators. These vibrators shall be sufficiently rigid to insure control of the operating position of the vibrating head.

(c) Pan (Surface) Vibrators. Pan vibrators shall apply vibration directly to the surface of the concrete. The operating frequency shall be not less than 3500 cycles, nor more than 4200 cycles per minute in air. The Contractor shall have a satisfactory tachometer available for checking the speed of the vibratory elements.

(12) Finishing Equipment.

(a) Finishing Machine. The transverse finishing machine shall have two (2) screeds accurately adjusted to the crown of the pavement finishing machine. The transverse finishing machine shall be capable of striking off **360.4**

and consolidating the concrete. It shall be equipped with consolidation equipment in conformance with Subarticle 360.4.(11) and shall be self-propelled and mounted in a substantial frame equipped to ride on the forms, or may be a slipform finisher.

(b) Manually Operated Finishing Screed. A manually operated

finishing screed shall be a strike template and a tamping template or a vibratory screed at least 600 millimeters longer than the width of the pavement. Both templates shall be capable of conforming to the crown of the pavement.

(c) Straightedges. The Contractor shall furnish at least two (2) standard three (3) meter steel or magnesium straightedges.

(d) Work Bridges. The Contractor shall furnish a sufficient number of bridges capable of spanning the pavement for finishing operations and for the installation and finishing of joints.

(13) Mechanical Dowel and Reinforcement Inserting Equipment. This equipment shall be capable of accurately inserting and positioning the dowels and/or reinforcement in the plastic concrete parallel to the profile grade and horizontal alignment and in accordance to the plan details.

(14) Texturing Equipment. Texturing equipment shall consist of the following:

(a) Carpet Drag. Carpet drag shall be mounted on a workbridge or a movable support system capable of varying the area of carpet in contact with the pavement. The carpet drag shall be a single piece of carpet long enough to span the full width of the pavement being placed and adjustable so as to have up to a 1.2 meter longitudinal length of carpet in contact with the concrete being placed. The carpeting used shall be an artificial grass type having a molded polyethylene pile face with a blade length of 15 millimeter to 25 millimeter and a minimum mass of two (2) kilograms per square meter. The backing shall be a strong, durable material not subject to rot, and shall be adequately bonded to the facing to withstand use as specified.

(b) Transverse Metal Tining Device. The transverse metal tine device shall be mechanized and be equipped with 100 to 150 millimeters steel tines, spaced nominally at 25 millimeters, center to center, approximately one (1) millimeter by two (2) millimeters (tine cross section),

adjustable so as to obtain randomized grooves approximately five (5) millimeters deep, with a minimum depth of three (3) millimeters.

The texturing equipment shall be operated independent from the spreading, finishing and curing equipment and from the curing operation. Hand operated texturing equipment may be approved by the Engineer for use on small or irregular shaped areas, provided an equivalent texture is obtained.

360.5. Quality of Concrete. The quality of concrete shall be in accordance with Item 421, "Portland Cement Concrete", and the additional requirements herein.

Appropriate changes in the mix design shall be made when the average seven (7) day flexural strength of the concrete, as indicated by the last ten (10) flexural strength values (modulus of rupture) obtained from tests of beams made from concrete of the same water-cement ratio, departs from the desired minimum average strength as defined in Article 421.9 by more than four (4) percent.

The Engineer, at his option, may reject as non-representative any individual flexural strength value in each group of ten where strengths more than ten (10) percent above or below the average for the group are indicated and compute the average flexural strength on the basis of the remaining values.

Should tests consistently indicate a considerable departure from the specified minimum average strength, even though within the above limits, appropriate changes in the water-cement ratio and mix proportions shall be made.

When the concrete fails to meet any of the specified requirements for workability as defined in Subarticle 360.8.(2), the Engineer will require correction of this condition. When it becomes necessary to change aggregates, to use an additional aggregate or to use admixtures, preliminary strength tests will be required.

Unless otherwise shown on the plans, test beams for flexural strength will be prepared and tested in accordance with Test Method Tex-448-A. The Contractor shall furnish, maintain and clean all beam and/or cylinder forms at the Contractor's cost. Beam and/or cylinder forms shall conform to the requirements of Test Method Tex-448-A.

Additional flexural strength test specimens may be made as required by concrete placing conditions or for adequately determining the strength of the concrete where the early opening of the pavement to traffic is dependent upon concrete strength tests. The flexural strength test is for process control and not for acceptance or rejection of concrete pavement. For early opening to traffic, the flexural strength specimens shall be cured at the same time and in the same manner as the pavement.

360.6. Subgrade, Subbase and Forms.

(1) Preparation of Subgrade or Subbase. The concrete pavement shall be constructed on a prepared surface, either subgrade, unstabilized subbase or stabilized subbase as shown on the plans.

When slipform equipment is used, a firm subgrade or subbase (stabilized or unstabilized) shall be maintained outside the limits of the pavement for the support of the slipform equipment.

(a) Stabilized Subbase. A template shall be used to verify the final contour of the subbase.

(b) Subgrade or Unstabilized Subbase. When a stabilized subbase is not required, the subgrade shall be excavated as required, all unstable or otherwise objectionable material removed, and all holes, ruts and depressions filled with approved material.

Rolling and sprinkling shall be performed in accordance with the governing specifications and as directed by the Engineer. The roadbed shall be completed to the plane of the typical sections shown on the plans and the lines and grades established by the Engineer. Drainage of the roadbed shall be maintained at all times. Sealed or treated subgrade cut in the preparation of the subgrade or setting of pavement forms shall be restored to the original condition as directed by the Engineer.

The subgrade or unstabilized subbase shall be maintained in a smooth, compacted condition in conformity with the required section and established grade until the pavement is placed and shall be kept thoroughly wetted sufficiently in advance of placing any pavement. When it is necessary to operate equipment on the prepared subgrade, all damage to the prepared subgrade shall be corrected by the Contractor at the Contractor's expense.

(2) Placing and Removing Forms. The subgrade under the forms shall be firm and cut to grade so that each form section when placed is firmly in contact with the subgrade for its whole length and base width.

Any subgrade or subbase, under the forms, below established grade shall be corrected using acceptable material, placed, sprinkled and rolled as directed by the Engineer. Where minor irregularities exist, forms shall be leveled using a stabilized material approved by the Engineer. The stabilized material shall be sufficiently plastic to insure filling the voids underneath the side forms. Paving equipment will not be permitted on the forms until the stabilized material has cured completely.

Forms shall be staked with at least three (3) pins for each 3-meter section. A pin shall be placed at each side of every joint. Form sections shall be tightly joined and keyed to prevent relative displacement. Forms shall be cleaned and oiled prior to each use.

Side forms shall be set for a sufficient distance in advance of the point where concrete is being placed to permit a finished and approved subgrade length of generally not less than 90 meters ahead of the spreader. Conformity of the grade, alignment and stability of forms shall be checked immediately prior to placing concrete, and all necessary corrections shall be made. If forms settle and/or deflect over three (3) millimeters under finishing operations, paving operations shall be stopped and the forms shall be reset to line and grade and the concrete surface refinished to correct grade. The Engineer may allow suitable stakes driven to the grade of the bottom of the forms to afford additional support.

Side forms shall remain in place for not less than eight (8) hours after the concrete has been placed. The forms shall be carefully removed in such a manner that minimal or no damage will be done to the edge of the pavement. All damage resulting from this operation and any honeycombed areas shall be repaired with a mortar mix within 24 hours after form removal unless otherwise approved by the Engineer.

After a bulkhead for a transverse construction joint has been removed, the joint face shall be cleaned, and any honeycombed areas repaired with mortar within 24 hours unless otherwise approved by the Engineer.

All mortar shall conform to Item 421, "Portland Cement Concrete".

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After repairs are complete, the form trench, if used, shall be promptly filled with a suitable material and compacted in such manner as to shed water from the edge of the pavement.

(3) Gradeline Revisions. All adjustments to the plan gradeline will require written approval of the Engineer.

(a) Where measurement of concrete pavement is by the square meter, the grade line may be adjusted to provide the minimum thickness shown on the plans in lieu of trimming the subgrade or unstabilized subbase to grade where high spots occur. When pavement grades are reset at a higher grade, the revised grade shall be gradually transitioned to the established grade. Proper pavement cross slopes shall be maintained. When forms are used, the raised forms shall rest on stabilized material as approved by the Engineer.

(b) Where measurement of concrete pavement is to be made by the cubic meter, the subgrade or subbase shall be tested to insure that the required pavement thickness will be obtained. Where high areas occur in the subgrade or subbase, the pavement grade line may be reset at a higher grade. The revised grade shall be secured with gradual transitions to the established grade at each end while maintaining a proper drainage grade in
the pavement. Allowable grade revisions as provided herein shall in no way affect the governing finishing and surface requirements of the completed pavement.

360.7. Placement of Reinforcing Steel and Joint Assemblies. All reinforcing steel, including steel wire fabric reinforcement, tie bars, dowel bars, and load transmission devices shall be accurately placed and secured in position in accordance with Item 440, "Reinforcing Steel", and the additional requirements herein and details and the requirements shown on the plans.

The dowels shall be placed at a depth of d/2 in the pavement, and parallel to the surface and pavement edge, with a tolerance for such alignment of ± five (5) millimeters per dowel.

Within any area bounded by 0.6 meter of pavement length measured parallel to the centerline and 3.6 meters of pavement length measured perpendicular to the pavement centerline, not over 33 percent of the longitudinal steel shall be spliced.

Coated dowel bars shall be free of dirt or other foreign matter at the time of installation in the concrete. Removal of rust on reinforcing steel shall be in

accordance with Article 440.5.

(1) Manual Placements. Reinforcing bars shall be securely wired together at alternate intersections and at all splices, and shall be securely wired to each dowel intersected. When wire fabric is used, it shall be securely wired together at all splices and to each dowel and/or tie bar intersected.

(2) Mechanical Placement. Mechanical placement of reinforcing steel and tie bars will be permitted unless otherwise shown on the plans. If this method results in steel misalignment, poor concrete consolidation around the steel, or segregation of concrete or other inadequacies, the work shall be completed using manual methods.

(3) Placing Reinforcement at Joints. Where the plans require an assembly of parts at pavement joints, the assembly shall be completed, placed at the required location and elevation, and all parts rigidly secured in the required position by the methods and devices shown on the plans or by approved methods and devices equivalent thereto. Dowel bars shall be accurately installed in joint assemblies in accordance with the plans, parallel to the pavement surface and to the centerline of the pavement, and rigidly secured in the required position by such means (as shown on the plans, or approved equivalent thereto) that will prevent their displacement during placing and finishing of the concrete. Header boards, joint filler and other material used for forming joints shall be accurately notched to receive each load transmission device. All load transmission devices and assemblies shall be substantially free of rust and clean when the concrete is placed.

Mechanical methods of implanting dowel bars or load transmission devices in the plastic concrete may be used unless prohibited on the plans. If a mechanical installing device fails to place the dowels and/or load transmission devices as specified above the use of this equipment will be discontinued.

Unless otherwise shown on the plans, tiebars for the longitudinal construction joints may be inserted into the plastic concrete. If this method results in tiebar misalignment, poor concrete consolidation around the tiebars, or if slumping of the concrete surface or edge results from insertion of the tiebars, this method shall be discontinued and the work shall be completed using other approved methods.

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Tiebars must develop a pull-out resistance equal to a minimum of three-fourths of the required yield strength of the steel by using a tension test similar to ASTM E 488 after the concrete has cured for seven (7) days. The Contractor shall demonstrate the effectiveness of the method by testing fifteen tiebars selected by the Engineer from the initial production using this method.

If the test results meet the required minimum pull-out strength, additional testing will be at the discretion of the Engineer. If the test results do not meet the required minimum pull-out strength, the Contractor shall perform corrective measures to provide equivalent pull-out resistance. Acceptable corrective measures include, but are not limited to, additional or longer tiebars. All corrective work shall be at the Contractor's expense.

When the placing of concrete is intentionally stopped and load transmission devices are required, the complete joint assembly shall be installed and rigidly secured in the required position by a bulkhead. When no load transmission devices are required the construction joint shall consist of tie bars of the same length, size, and spacing as the tie bars used for the longitudinal joints.

At construction joints the reinforcing steel or load transmission device immediately beyond the joint will be protected against vibration or impact by the Contractor until paving resumes.

360.8. Concrete Mixing and Placing.

(1) Mixing. Concrete mixing shall be in conformance with Items 421, "Portland Cement Concrete", and 522, "Portland Cement Concrete Plants".

(2) Workability of Concrete. The concrete shall be workable, cohesive, possess satisfactory finishing qualities, and have a consistency conforming to the specified slump requirements. If detrimental bleeding occurs and this condition cannot be corrected by reasonable reproportioning of the ingredients, the bleeding shall be immediately corrected by one (1) or more of the following listed measures:

Redesign of the batch.
Addition of mineral filler to fine aggregate.
Increase of cement content.
Use of appropriate approved admixture.

When, in the opinion of the Engineer, excessive bleeding occurs and corrective actions do not satisfactorily reduce bleeding, concrete placement operations shall cease until the concrete mixture has been redesigned.

When the method of transporting concrete produces excessive segregation and/or bleed water on the surface of the concrete, the method used shall be discontinued and a satisfactory method shall be provided. Such segregated concrete will be subject to rejection as directed by the Engineer.

(3) Placing. Unless otherwise shown on the plans, the concrete shall be placed using either forms or a slipform paver. Any concrete not placed as herein prescribed within the time limits specified will be rejected.

Temperature-Time Requirements

Concrete Temp (at point of placement)	Max Time (No Retarding Agent) Minutes	Max Time (1) (With Retarding Agent) Minutes
	Non-Agitated Concrete	
All temperatures	30	45
	Agitated Concrete	
Above 32 °C	45	75
Above 24 °C thru 32 °C	60	90
24 °C and Below	90	120

(1) Normal dosage of retarder

The Contractor shall provide a system satisfactory to the Engineer for determining that concrete delivered to the road meets the specified requirements for mixing and time of placing.

The concrete shall be placed as near as possible to its final location and in such manner as to minimize segregation and rehandling. Where hand spreading is necessary, concrete shall be distributed to the required depth by use of shovels. The use of rakes will not be permitted.

Paving equipment and mixers shall not be located on completed pavement, except as herein provided. The paving equipment and mixer

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may be located and operated on completed pavement, when the concrete has aged for seven (7) curing days and provided suitable protection to the pavement

is provided.

Concrete shall be placed, consolidated and finished to conform to the required section and grade.

The pavement edge shall not deviate from the established paving line by more than 15 millimeters at any point as shown on plans.

Unless otherwise shown on the plans or approved by the Engineer, concrete shall not be placed before sunrise and shall not be placed later than such time which will permit the completion of all finishing operations during sufficient natural light.

When concrete mixing and finishing is done in other than daylight hours, provisions shall be made to adequately light the entire placement site. The Engineer will approve the adequacy of such lighting before operations are begun.

(a) Double Strike-off Method. Unless otherwise shown on the plans, when concrete placement is accomplished in two (2) lifts (double strike-off method) to allow placing the reinforcement after the first lift, the first lift shall be uniformly spread and/or struck off so that the final position of the longitudinal steel will be within 15 millimeters of the position shown on the plans. The second lift shall be placed as soon as the reinforcing steel is in place and prior to initial set of the first lift. The second lift shall not be placed later than 20 minutes after strike-off of the first lift.

(b) Placing Curbs. Where curbs are placed monolithically concrete for monolithic curbs shall be the same as for the pavement and must be placed while the pavement concrete is still plastic.

Where curbs are placed separately they shall be placed in conformance with Item 529, "Concrete Curb, Gutter and Combined Curb and Gutter".

When sawed joints are used in the pavement, curbs shall be doweled into the pavement as shown on the plans and placed after sawing the slab.

(4) Consolidation. All concrete placed for pavement shall be consolidated by approved mechanical vibrators operated ahead of the finishing machine. Unless otherwise shown on the plans, pan type vibrators **360.9**

shall be used for double lift placement of concrete and the immersion type vibrators shall be used for full-depth placement, unless otherwise approved by the Engineer. Vibratory equipment shall extend across the pavement, but shall not come in contact with the side forms. Mechanically-operated vibrators shall be mounted and operated in such manner as to not interfere with the transverse

or longitudinal joints. Hand operated vibrators shall be used to consolidate concrete in areas not accessible to the machine mounted vibrators.

The method of operation of vibrators shall be as approved by the Engineer.

The vibrators shall not be operated for more than five (5) seconds while the machine upon which they are installed is standing still.

(5) Cold Weather Precautions. Except by specific written authorization of the Engineer, concrete shall not be placed when the ambient temperature is below 5 °C and falling. Concrete may be placed when the ambient temperature is above 2 °C and rising, the ambient temperature being taken in the shade and away from artificial heat.

The Contractor shall have available a sufficient supply of approved cotton mats, polyethylene sheeting or other approved covering materials to immediately protect concrete if the air temperature falls to 0 °C, or below, before concrete has been in place for less than four (4) hours. Such protection shall remain in place during the period the temperature continues below 0 °C, or for a period of not more than five (5) days. Neither salt nor other chemical admixtures shall be added to the concrete to prevent freezing. The Contractor shall be responsible for the quality and strength of concrete under cold weather conditions and any concrete damaged by freezing shall be removed and replaced at the Contractor's expense.

360.9. Joints.

(1) General. All transverse and longitudinal joints, when required in the pavement, shall be of the type or alternate type shown on the plans and shall be constructed at the required location and alignment, in relationship to the tie bars and joint assemblies, and in accordance with details shown on the plans. Stakes, braces, brackets or other devices shall be used as necessary to keep the entire joint assembly in true vertical and horizontal position. Where concrete base is overlaid by asphaltic concrete the joints shall be prepared as specified herein, but joint sealing will not be required unless shown on the plans.

Careful workmanship shall be exercised in the construction of all joints to insure that the concrete sections are completely separated by an open joint or by the joint materials and to insure that the joints will be true to the required section. Joints shall be cleaned and sealed in accordance with Item 438, "Cleaning And/Or Sealing Joints and Cracks (Portland Cement Concrete)". The sequence of construction of joints is to be approved by the

Engineer.

Excessive spalling of the joint groove shall be repaired to the satisfaction of the Engineer prior to the installation of the sealant.

All joints shall be sawed and sealed before placing concrete in adjacent lanes and before permitting traffic to use the pavement.

When sawed joints are used, they shall be sawed to the depth as shown on the plans as soon as sawing can be accomplished without damage to the pavement. Once sawing has commenced it shall be continued until completed and all such sawing must be completed within 12 hours of placement. Sawing must be accomplished even in rain and cold weather. Should the sawing for any day's placement fail to be completed within 12 hours, the following concrete placement shall be limited to the amount that was sawed on time. This limitation shall continue until the sawing crew demonstrates it can handle a larger volume of sawing. If marring of the surface occurs the Engineer may extend the 12 hour limit.

The Contractor shall keep a standby power driven concrete saw on the project at all times when concrete operations are under way.

When membrane curing is used, the part of the seal which has been disturbed by sawing operations shall be resprayed by the Contractor with additional curing compound.

(2) Expansion Joints. Transverse expansion joints shall be constructed in accordance with the details shown on the plans. After the finishing machine and before the carpet drag and tining machines have passed over the joint the Contractor shall inspect the joint filler for correctness of position. The Contractor shall make any required adjustment in position of the filler and shall install the joint seal space form in accordance with the plans. The concrete faces of the joint seal space shall be left true to line and section throughout the entire length of the joint.

(3) Weakened Plane Joints. Weakened plane joints shall consist of transverse contraction joints and longitudinal joints. Unless otherwise

shown on the plans, the transverse joints shall be formed or sawed perpendicular to the centerline and surface of the pavement.

The joints shall be constructed in the sequence of operations, as shown on the plans.

Chalk line, string line, sawing template or other approved methods shall

be used to provide a true joint alignment.

When the flex plane type longitudinal joint is used, it shall be placed behind the longitudinal float.

(4) Transverse Construction Joints.

When the placing of concrete is stopped, a bulkhead of sufficient cross sectional area to prevent deflection, accurately notched to receive the load transmission devices and shaped accurately to the cross section of the pavement shall be provided.

Intentional stoppage of the placing of the concrete shall be at either an expansion joint or at a weakened plane joint, when load transmission devices are shown on the plans. When the design for load transmission does not include dowels, intentional stoppage shall be in the middle of a slab.

When an unintended stoppage of the placing of concrete occurs, the Contractor shall immediately place the available concrete to a line and install the above described bulkhead at right angles to the centerline of the pavement, perpendicular to the surface and at the required elevation. Concrete shall be placed and finished to this bulkhead. Any concrete remaining on the subgrade ahead shall be removed and disposed of as directed by the Engineer. When placement of concrete is resumed before the concrete has set to the extent that the concrete will stand on removal of the bulkhead, the new concrete shall be consolidated with the first. The edge created by construction joints of this type shall have a joint seal space and shall be sealed as required for contraction joints.

At transverse construction joints in continuously reinforced concrete pavement, the reinforcement or load transmission device immediately beyond the joint will be protected against vibration or impact by the Contractor until paving resumes.

(5) Longitudinal Construction Joints. Longitudinal construction joints shall be of the type and at the locations shown on the plans.

(6) Joint Filler Boards. Joint filler boards shall be of the size, shape and type as shown on the plans. Boards shall be anchored as shown on the plans.

(7) Curb Joints. Joints in the curb shall be provided and shall be of the same type and location as the adjacent pavement. The expansion joint material shall be of the same thickness, type and quality as specified for the pavement and

shall be of the section as shown for the curb. All expansion joints shall be carried through the curb.

When transverse sawed joints are provided for the pavement, the curb placement shall be delayed until all transverse joints in the pavement have been sawed. Dowel bars shall be placed as shown on the plans while the pavement concrete is still plastic, unless otherwise approved by the Engineer. The weakened plane joint in the monolithic curbs may be formed or sawed.

Curb joints shall be constructed in accordance with Item 529, "Concrete Curb, Gutter and Combined Curb and Gutter", and the details shown on the plans.

360.10. Spreading and Finishing.

(1) Machine-Finishing. All concrete pavement shall be finished with approved self-propelled machines, except as herein provided.

Machine-finishing of pavement shall include the use of power-driven spreaders, power-driven vibrators, power-driven strike-off, and screed, or such alternate equipment as may be substituted and approved under Article 360.4.

The transverse finishing machine shall first be operated to compact and strike-off the concrete to the required section and grade, without surface voids. The machine shall be operated over each area as many times and at such intervals as needed to consolidate and shape the surface. After completion of finishing with the transverse finishing machine a float may be used.

The consistency of the concrete as placed should allow the completion of all finishing operations without the addition of water to the

surface. When field conditions require additional moisture for the final concrete surface finishing operation, the water shall be applied to the surface by a fine, light fog mist and the amount of water added shall be held to a minimum.

When required by the Engineer, the Contractor shall perform sufficient checks with a long handled three (3) meter straightedge on the plastic concrete to insure that the final surface will be within the tolerances specified below. The check shall be made with the straightedge parallel to the centerline. Each pass thereof shall lap half of the preceding pass. All high spots shall be removed and all depressions over two (2) millimeters in depth shall be filled with fresh concrete and floated. The checking and floating shall be continued until the surface is true to grade and free of depressions, high spots, voids and rough spots.

For one-lane pavement placement and uniform widening, the equipment for machine-finishing of concrete pavement shall be as approved by the Engineer.

Final finish shall consist of a combination of a carpet drag and metal tine finish, unless otherwise shown on the plans. Final finish shall be completed before the concrete has attained its initial set.

The final finish shall be accomplished by first drawing the specified carpet drag longitudinally along the pavement. The actual contact surface shall be regulated so that a coarse texture satisfactory to the Engineer is obtained.

Immediately following the carpet drag, the pavement surface shall be given a transverse metal-tine finish. The metal-tine device shall be operated so as to obtain randomly spaced grooves approximately five (5) millimeters deep, with minimum depth of three (3) millimeters and approximately two (2) millimeters wide. Successive passes of the tines shall not overlap a previous pass. Manual methods for achieving similar results may be used on ramps and other irregular sections of pavement.

After completion of texturing, the edge of the slab and joints shall be carefully finished as directed by the Engineer.

Pavement which is to be overlaid under this contract will not require tine texturing, unless otherwise shown on the plans.

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(2) Hand Finishing. Hand finishing will be permitted on the transition from a crowned section to a superelevated section without crown on curves, and on straight line superelevation sections less than 90 meters in length. Hand finishing will also be permitted on that portion of a widened pavement outside the normal pavement width, on sections where the pavement width is not uniform, or on required monolithic widths greater than that of available finishing machines. Hand finishing will be allowed only in those conditions provided for above and upon other specific areas authorized by the Engineer.

When hand finishing is permitted, the concrete shall be struck off with an approved strike-off screed to such elevation that, when consolidated and finished, the surface of the pavement shall conform to the required section and grade.

The pavement shall be straightedged prior to final finishing. Other operations and surface tests shall be as required for machine finishing.

(3) Emergency Procedures. The Contractor shall have available at all times hand operated tining equipment and hand operated carpet drags for the purpose of providing texture in the event of equipment breakdown.

When required by the Engineer, the Contractor shall also have available a conventional garden spray-type can containing a commercially available monomolecular film compound to be applied in the case of equipment breakdown or other emergencies in order to prevent the pavement from drying too rapidly.

360.11. Curing.

(1) General. All concrete pavement shall be cured for a period of not less than 72 hours from the beginning of curing operations. All exposed surfaces, including vertical surfaces of the placed concrete, shall be cured immediately after finishing operations have been completed, in accordance with the requirements specified herein.

Asphalt curing shall be used only when the concrete pavement is to be overlaid with asphaltic concrete. Membrane curing shall not be used when the concrete pavement is to be overlaid with asphaltic concrete. Unless otherwise shown on the plans, membrane curing shall be used when the concrete is placed with a slipform paver.

Failure to maintain adequate curing shall be cause for immediate suspension of concreting operations.

The applied curing material may be removed as necessary to saw joints or to comply with the requirements for any surface test. The hardened concrete surface shall be maintained wet with a water spray, if required, and the curing material replaced immediately after completion of sawing, testing and any required surface correction.

(2) Polyethylene Film Curing. After the final finish and the concrete surface has attained initial set, the concrete surface shall be wetted with water, applied in the form of a fine spray and covered with the polyethylene film so placed and weighted as to remain in direct contact with the surface. The polyethylene film blanket shall be maintained in place continuously for not less than the specified curing period.

All joints shall be sealed in a manner acceptable to the Engineer to provide a moisture-proof lap.

The polyethylene film blankets shall be adequately weighted to prevent displacement or billowing due to wind and the film folded down over the side of the pavement shall be secured by a continuous bank of earth or other approved material. Plowing of this windrow into place will not be permitted.

All tears or holes appearing in the polyethylene film during the curing period shall be immediately repaired by placing acceptable moisture proof patches over such defects or by replacing the blankets. It shall be the Contractor's responsibility to prevent damage to the film blankets which would affect their serviceability and effectiveness as a concrete curing method. Blankets may be rejected at any time when, in the opinion of the Engineer, they do not provide an airtight covering.

Polyethylene film blankets rejected because of pinholes or minor tears may be continued in service when repaired to an airtight condition.

(3) Membrane Curing. After final finish and immediately after the free surface moisture has disappeared, the concrete surface shall be sprayed uniformly with a curing compound in accordance with Article 526.5. Should the membrane be damaged from any cause before the expiration of 72 hours after original application, the damaged portions shall be repaired immediately with additional compound.

Special care shall be taken to insure that the sides of the tining grooves are coated with the curing compound.

(4) Asphalt Curing. The equipment and method of application shall be the same as described in Subarticle 360.11.(3), except that the rate of application may vary between the limits of 0.25 liter per square meter and 0.5 liter per square meter. The rate of application will be determined by the Engineer after observation of sections where amounts varying between the above limits have been applied. If it is found necessary to add water to the emulsion for the proper distribution through the spray, the addition of water may be done upon approval of the Engineer. When the emulsion is diluted with water the amount of the applied mixture shall be increased to give a coverage of the original emulsion between the limits as set out herein. Care must be taken to properly mix the emulsion and water and to keep the mixture well agitated during application.

360.12. Protection of Pavement and Opening to Traffic.

(1) Protection of Pavement. The Contractor shall erect and maintain the barricades, shown on the plans, and such other standard and approved devices that will exclude all vehicles and/or equipment from the newly placed pavement for the periods of time specified herein. During the period prior to opening to traffic as herein specified, crossings of the pavement required by the plans, or by construction sequence shall be accomplished through the use of an adequate and substantial bridge or other protection, as approved by the Engineer.

(2) Opening Pavement to Traffic. The pavement shall be closed to all traffic, including vehicles of the Contractor, until the concrete is at least four (4) days old. This period of closure to all traffic may be extended if, in the opinion of the Engineer, weather or other conditions may require an extension of the time of protection. When Type II cement is used one (1) additional day shall be required for a total of five (5) days.

At the end of this period the pavement may be opened for use by vehicles of the Contractor provided the gross mass (vehicle plus load) of such vehicles and/or equipment does not exceed 6350 kilograms. Such opening, however, shall in no manner relieve the Contractor from his responsibility for the work in accordance with Item 7, "Legal Relations and

Responsibilities to the Public". On those sections of the pavement to be opened to traffic, all joints shall first be sealed and the pavement cleaned. Unless otherwise shown on the plans, stable material shall be placed against the pavement edges before permitting vehicles thereon.

After the concrete in any section of pavement is seven (7) days old, such section of pavement may be opened to all traffic as shown on the plans or as directed by the Engineer. When Type II cement is used one (1) additional day shall be required for a total of eight (8) days. For those sections of the pavement to be opened to traffic, all joints shall first be sealed, the pavement cleaned, stable material placed against the pavement edges unless otherwise shown on the plans and all other work performed as required for the safety of traffic. Such opening, however, shall in no manner relieve the Contractor from his responsibility for the work in accordance with Item 7, "Legal Relations and Responsibilities to the Public".

Where a detour is not readily available or economically feasible to use, an occasional crossing of the roadway with overweight equipment may be permitted for relocating equipment only, but not for hauling material.

When an occasional crossing of overweight equipment is permitted, temporary matting or other methods may be required by the Engineer.

(3) Emergency Opening to Traffic. The Engineer may require the opening of pavement to traffic prior to the minimum time specified above under conditions of emergency which in his opinion require such action in the interest of the public. In no case will the Engineer order opening of the pavement to traffic within 72 hours after the last concrete in the section is placed. The Contractor shall remove all obstructing materials, place stable material against the pavement edges and perform other work involved in providing for the safety of traffic as required by the Engineer in ordering emergency opening. Orders for emergency opening of the pavement to traffic will be issued in writing by the Engineer.

360.13. Deficient Pavement Thickness. The adjustment in unit prices provided for in this subarticle will apply only when measurement for payment is by the square meter. The adjustment may be waived by a note on the plans where concrete pavement work is narrow widening or small placements.

(a) Coring. The pavement will be cored by the Department after all required profile corrective work and prior to final acceptance. Locations of core tests will be selected by the Engineer; however, the spacing interval for core tests, as specified herein, is to be maintained. The thickness of the pavement will be determined by measurement of the cores in accordance with Test Method Tex-424-A.

For the purpose of establishing an adjusted unit price for pavement, units to be considered separately are defined as 300 meters of pavement in each traffic lane starting at the end of the pavement bearing the smaller kilometer station number. The last unit in each lane shall be 300 meters plus the fractional part of 300 meters remaining. Traffic lane width will be as shown on typical sections and pavement design standards.

For the purpose of establishing an adjusted unit price for ramps, widening, acceleration and deceleration lanes that are machine-placed, isolated pavements of traffic lane width less than 300 meters in length, and other areas designated by the Engineer, units to be considered separately are defined as 850 square meters of pavement or fraction thereof.

One (1) core will be taken by the Department at the location selected by the Engineer or at random in each unit. When the measurement of the core from any unit is not deficient by more than five (5) millimeters from the plan thickness, full payment will be made. When the measurement of the core from any unit is deficient by more than five (5) millimeters but not by more than 20 millimeters from the plan thickness two (2) additional cores will be taken from the unit and the average of the three (3) cores determined. The two (2) additional cores from any 300-meter unit will be taken at intervals of not less than 90 meters. The two (2) additional cores from any 850-square meter unit will be taken at locations such that the pavement in the unit will be well represented. If the average measurement of these three (3) cores is not deficient more than five (5) millimeters from the plan thickness, full payment will be made. If the average thickness of the three (3) cores is deficient more than five (5) millimeters but not more than 20 millimeters from the plan thickness, an adjusted unit price as provided in Subarticle 360.13.(2)(b), will be paid for the unit represented by these cores.

In calculating the average thickness of the pavement, measurements which are in excess of the specified thickness by more than five (5) millimeters will be considered as the specified thickness plus five (5) millimeters, and measurements which are less than the specified thickness

by more than 20 millimeters will be considered as the specified thickness less 20 millimeters.

When the measurement of any core is less than the specified thickness by more than 20 millimeters, the actual thickness of the pavement in this area will be determined by taking additional cores at 3-meter intervals parallel to the centerline in each direction from the deficient core until, in each direction, a core is taken which is not deficient by more than 20 millimeters. Exploratory cores for deficient thickness will not be used in averages for adjusted unit price. Exploratory cores are to be used only to determine the length of pavement in a unit that is to be left in place without pay and/or removed and replaced as provided in this subarticle.

Any area of pavement found deficient in thickness by more than 20 millimeters but not more than 25 millimeters or 1/8 of the plan thickness, whichever is greater, shall be evaluated by the Engineer. If, in the judgment of the Engineer, the area of such deficiency should not be removed and replaced, there will be no payment for the area retained. If, in the judgment of the Engineer, the area of such deficiency warrants removal, the area shall be removed and replaced, at the Contractor's entire expense, with concrete of the thickness shown on the plans.

Any area of pavement found deficient in thickness by more than 25 millimeters or more than 1/8 of the plan thickness, whichever is greater, shall be removed and replaced, at the Contractor's entire expense, with concrete of the thickness shown on the plans.

(b) Price Adjustments. Where the average thickness of pavement is deficient in thickness by more than five (5) millimeters, but not more than 20 millimeters, payment will be made at an adjusted price as specified in the following table.

Deficient Thickness Price Adjustment

Deficiency in Thickness Determined by Cores Millimeters	Proportional Part of Contract Price Allowed Price Adjustment Factor
Over 0.0 through 5.0	1.00
Over 5.0 through 7.5	.80
Over 7.5 through 10.0	.72
Over 10.0 through 12.5	.68
Over 12.5 through 20.0	.57

(c) Additional Thickness. No adjustment to the contract unit price will be made for any pavement of a thickness exceeding that required by the plans.

360.14. Ride Quality. Unless otherwise shown on the plans, ride quality will be required in accordance with Item 585, "Ride Quality for Pavement Surfaces".

360.15. Measurement. This Item will be measured by one (1) of the following methods:

(1) Measurement by the Square Meter. When provided by the plans, concrete pavement will be measured by the square meter of surface area of completed and accepted work. The surface area will include that portion of the pavement slab extending beneath the curb. When concrete pavement is to be measured by the square meter and monolithic curb is required, measurements for "Monolithic Curb" will be by the meter complete in place.

(2) Measurement by the Cubic Meter. When provided by the plans, concrete pavement, including monolithic curb when required, will be measured by the cubic meter of absolute volume of all materials entering the mixture as prescribed in Construction Bulletin C-11.

(3) Ride Quality. Ride quality will be measured as described in Item 585, "Ride Quality for Pavement Surfaces".

360.16. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the adjusted unit price bid as provided under Article 360.13, for "Concrete Pavement" of the type, reinforcement and depth specified, and for "Monolithic Curb" of the type specified. This price shall be full compensation for furnishing, loading, unloading, storing, hauling and handling of all concrete ingredients, including all freight and royalty involved; for placing and adjusting forms, including supporting material or preparing track grade; for furnishing and installing all reinforcing steel; for furnishing all materials for sealing joints and placing longitudinal, expansion and weakened-plane joints, including all steel dowel caps and load transmission devices required; for mixing, placing, finishing, curing and sawing concrete; for cleaning and sealing concrete joints; and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work.

When surface Test Type-B, as specified in Item 585, "Ride Quality for Pavement Surfaces", is used, a bonus or deduction for each 0.1609 kilometer section of each travel lane will be calculated in dollars and cents.

ITEM 361

FULL-DEPTH REPAIR OF EXISTING CONCRETE PAVEMENT

361.1. Description. This Item shall govern for full-depth repair of existing sections of portland cement concrete pavement in accordance with the existing roadway section and the details shown on the plans, and to the lines and grades established by the Engineer.

361.2. Materials.

(1) Concrete. Concrete shall be Class "K" unless Class "K(Modified)" is indicated on the plans.

All materials shall conform to the pertinent requirements of Item 421, "Portland Cement Concrete", together with the following:

The coarse aggregate shall be either Grade 2 or 3. When specified on the plans, air entrainment will be required. An air entrained content of three (3) to six (6) percent, as directed by the Engineer, shall be provided. The fine aggregate shall be Grade 1 with a fineness modulus of 2.60 to 2.80. For Class "K (Modified)" concrete, the fineness modulus range may

be increased to between 2.30 and 3.10 when noted on the plans. All admixtures used shall conform to the requirements of Item 437, "Concrete Admixtures", except that the addition of an ASTM Type C nonchloride set-accelerating admixture may be required at the job site when the temperature of the concrete is above 10 °C. Either transit-mix or central-mix concrete will be permitted. If the concrete fails to reach the required 24-hour strength, the Engineer may direct that the concrete be redesigned to meet these requirements.

(a) Class "K" concrete shall be designed to include 390 kilograms per cubic meter of Type III cement. The maximum water cement ratio (W/C) shall not exceed 0.49. An ASTM Type A water-reducing admixture and an ASTM Type C nonchloride set-accelerating admixture shall be used to achieve the earliest possible concrete-setting times. The use of a set-retarding admixture will not be permitted with Class "K" concrete. The concrete will be designed to achieve a minimum flexural strength of 2930 kilopascal in 24 hours. Additional minimum flexural strength requirements for intermediate time intervals may be shown on the plans.

(b) Class "K (Modified)" concrete shall be designed to include 390 kilograms per cubic meter of cement when Type I cement is used and 335 kilograms per cubic meter of cement when Type III cement is used. The maximum water cement ratio shall not exceed 0.53. An ASTM Type D water-reducing, set-retarding admixture or an ASTM Type A water-reducing admixture will be used if directed by the Engineer. The concrete will be designed to achieve a minimum flexural strength of 2070 kilopascals in 24 hours.

(2) Reinforcing steel. Reinforcing steel and dowels shall be of the size and grade indicated on the plans and shall conform to the requirements of Item 440, "Reinforcing Steel".

(3) Stabilized base material. Stabilized base material shall conform to the material requirements of Item 276, 334, 340, 345, 350 or 421. The materials and material sources shall be approved by the Engineer. The quality-control tests required for these items may be waived by the Engineer and the material may be accepted by visual inspection.

(4) Epoxy. Epoxy shall conform to the requirements of Item 575, "Epoxy".

(5) Miscellaneous materials. All other materials shall conform to the pertinent requirements of Item 360, "Concrete Pavement".

361.3. Construction Methods. The areas to be repaired will be outlined on the slab by the Engineer. The area shown on the plans to be repaired is for bidding purposes only. Actual dimensions of areas to be

repaired will be determined during construction by the Engineer. Patches shall be a minimum of two (2) meters in length and the full lane in width. If the area to be repaired is covered with asphaltic concrete, the asphaltic concrete shall be removed over an area sufficient to allow for proper repair of the concrete pavement. The asphaltic concrete removed shall remain the property of the Department and shall be stockpiled as directed by the Engineer.

A pressure relief groove approximately 50 millimeters deep shall be sawed transversely 150 millimeters (to the inside) from the patch ends. Full-depth saw cuts shall be made transversely along the patch ends. Unless otherwise shown on the plans, longitudinal saw cuts shall be full depth along the patch sides. If in the opinion of the Engineer, spalling occurs along the full-depth longitudinal saw cut, the longitudinal saw cutting shall then include a longitudinal 50 millimeter deep pressure relief groove and be performed in the same manner as the transverse saw cutting. Additional full-depth saw cuts may be made as needed to facilitate removal of the concrete within the limits of the required full-depth cuts. Concrete adjacent to the patch shall not be spalled or fractured by the removal procedure.

The concrete shall be removed, taking care not to disturb the underlying pavement support. The total lift-out method shall be used within the limits of the full-depth saw cuts.

All loose subbase material shall be removed and replaced with stabilized base material as specified in Article 361.2., and approved by the Engineer. If concrete is used to replace loose subbase material, a bond breaker such as a polyethylene sheet shall be used at the interface between the replaced subbase material and the new concrete pavement, or as directed by the Engineer.

For a given patch, the Contractor shall schedule his work so that the concrete placement will follow the full-depth saw cut by no more than seven (7) days unless otherwise shown on the plans or permitted by the Engineer.

Unless otherwise shown on the plans, dowel bars and reinforcing bars shall be replaced with new bars of the same size, grade and spacing. Dowel bars will be required as shown on the plans.

New reinforcing bars shall be placed and firmly supported by approved bar chairs.

For all concrete pavement, the following procedure of reinforcement shall apply:

The longitudinal tiebars shall be reinforcing steel as detailed on the plans. The depth of reinforcing steel into the patch area shall be 30 bar diameters. The depth of reinforcing steel into the existing concrete shall be based on the pull-out test for bond strength but no less than 300 millimeters. The longitudinal tiebars shall be epoxy grouted into the existing concrete.

Transverse tiebars shall be 15M (unless otherwise shown on the plans) X 600 millimeter reinforcing steel and shall be epoxy grouted, with the same grout as used for the longitudinal tiebars, into the existing concrete pavement to a depth of 300 millimeters. Tiebar spacing shall be as shown on the plans. Other reinforcing steel for the repair shall match the existing reinforcing steel unless otherwise shown on the plans.

The Contractor must demonstrate, through simulated job conditions, that the bond strength of the longitudinal and transverse tiebars (for continuity of the reinforcing steel) shall withstand a tensile load in the field of 3/4 of the yield strength of the tiebar by using a tension test required by ASTM E 488. This test shall be conducted within 18 hours after grouting of the tiebar into existing concrete. The Contractor shall demonstrate this test before patching work can begin.

Concrete placement shall not begin in a given patch until the tiebar and dowel-bar grout has attained sufficient strength to preclude displacement of the tiebars by the concrete, as determined by the Engineer. Grout retention disks shall be used when required on the plans.

The edge of any patch that abuts a shoulder shall conform with the edge and to the alignment and grade of the existing pavement. The Contractor will be permitted to remove enough shoulder base and surfacing to provide room for the forms. All shoulder material removed shall be replaced with asphaltic concrete material conforming to the material requirements of Items 330, 334 or 340. Testing of asphaltic concrete is waived, unless otherwise directed by the Engineer.

The requirements of Item 420, "Concrete Structures", shall govern the mixing and placing of the concrete. Immediately prior to placing the concrete, the subbase and each face of existing concrete shall be wetted. 361.4 to 361.5

Approved hand manipulated mechanical vibrators shall be used to insure the proper consolidation of the concrete. The concrete shall be screeded to the elevation of the adjacent concrete pavement and checked with a straightedge to insure that the riding surface will be satisfactory. The concrete shall be given a broom finish as directed by the Engineer, unless otherwise shown on the plans.

If the repaired area had been covered with asphaltic concrete, the repaired area shall be overlaid with asphaltic concrete material conforming to the material requirements of Item 330, 332, 334 or 340, unless otherwise shown on the plans. The asphaltic concrete overlay shall not be placed until the repaired area has attained the required flexural strength for opening to traffic. Testing asphaltic concrete is waived, unless otherwise directed by the Engineer.

The concrete shall be cured in accordance with Article 360.11.(1), (3) and (4). Membrane or asphalt curing shall be used for the curing of the repaired area. The curing period shall extend only until the repaired area is opened to traffic.

The repaired area may be opened to traffic when the concrete has attained a flexural strength of 1760 kilopascals. All test specimens representing tests for opening to traffic shall be cured using the same methods and under the same conditions as the repaired area.

Modifications to the specified construction methods which are requested by the Contractor, must be submitted to the Engineer in writing for his approval.

361.4. Measurement. This Item will be measured by the square meter of surface area, except for areas that require repair which were damaged by the negligence of the Contractor.

361.5. Payment. The work performed and the materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Repairing Existing Concrete Pavement", of the nominal depth specified. This price shall be full compensation for sawing and breaking the existing pavement structure; for the removal, loading, hauling and disposal of the broken concrete or loose subbase; for furnishing all materials; for all reinforcing steel; for all curing; for all asphaltic concrete for restoring shoulders and overlaying the repaired area; for subbase patching material; and for all manipulations, labor, equipment, tools and incidentals necessary to complete the work.

368.1 to 368.3

Monolithic curbing will not be measured and paid for separately, but will be considered as part of the area measured and paid for under this Item.

The asphaltic concrete necessary for the completion of this work will not be paid for directly, but will be considered subsidiary to this Item.

ITEM 368

TERMINAL ANCHORAGE LUGS
(Concrete Pavement)

368.1. Description. This Item shall govern for the construction of terminal anchor lugs on the prepared subgrade or other base courses in conformance with the typical cross sections shown on the plans and to the lines, depths and grades established by the Engineer.

368.2. Materials. All material shall conform to the pertinent requirements of the following items:

Item 421, "Portland Cement Concrete"
Item 440, "Reinforcing Steel"

Unless otherwise shown on the plans, the concrete used shall be either Class "A" or Class "P".

368.3. Construction Methods. Excavation for the construction of terminal anchor lugs shall conform to the requirements of Item 400, "Excavation and Backfill for Structures".

Over-excavation shall be avoided and any excavation for the terminal anchor lugs beyond the lines required by the plan dimensions shall be filled with portland cement concrete of the type used in the terminal anchor lugs at the Contractor's expense.

The reinforcing steel shall be placed as shown on the plans and in accordance with Item 440, "Reinforcing Steel".

The specified class of concrete shall be mixed, placed, consolidated, finished and cured as specified in Item 420, "Concrete Structures" and Item 421, "Portland Cement Concrete", except membrane curing shall not be used for curing.

368.4 to 368.5

Equipment and construction methods shall be approved by the Engineer.

368.4. Measurement. This Item will be measured by the cubic meter of concrete. Measurement of concrete quantities will be based on the

dimensions shown on the plans or those established in writing by the Engineer.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required. If the quantity for one or more of the terminal anchor lugs has been erroneously included or omitted from the plans, the quantity for those terminal anchor lugs will be deducted from or added to the plan quantity and included for payment.

368.5. **Payment.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement", will be paid for at the unit price bid for "Terminal Anchorage Lugs". This price shall be full compensation for excavation and disposal of excavated material; for furnishing and placing all reinforcing steel; for furnishing, hauling, and mixing all concrete materials; for placing, consolidating, curing and finishing all concrete; and for all labor, tools, equipment and incidentals necessary to complete the work.

PART II, CONSTRUCTION DETAILS

DIVISION IV
STRUCTURES

ITEM 400

EXCAVATION AND BACKFILL FOR STRUCTURES

400.1. Description. This Item shall govern for the excavation, bedding, backfill and/or portland cement stabilized backfill required for the construction of all structures, except drilled shafts. This Item shall also govern for any necessary sloping, pumping or bailing, for drainage, and for all sheeting and bracing of excavation walls up to 1.5 meters in depth. Excavation greater than 1.5 meters in depth shall be protected as specified in Item 402, "Trench Excavation Protection" or Item 403, "Temporary Special Shoring". Unless otherwise provided, the work included herein shall provide for the removal of old structures or portions thereof (abutments, wingwalls, piers, house foundations, old sewers, sewer appurtenances, etc.), trees and all other obstructions to the proposed construction, the blocking of the ends of abandoned sewers cut and left in place, and the protection of existing utilities. Also governed by this Item are the cutting and restoration of pavement and base courses, the construction and removal of any required cofferdams, the hauling and disposition of surplus materials and the bridging of trenches and other provisions for maintenance of traffic or access.

400.2. Excavation.

(1) General. Excavation shall conform to the lines and grades shown on the plans or as directed by the Engineer.

When trench and/or negative projecting conditions for concrete pipe culverts are required by design, an excavation diagram will be shown on the plans. These limits of excavation shall not be exceeded.

(a) Disposal of Excavation. All materials from excavation operations not required for backfilling and that are considered satisfactory, may be placed in embankment in accordance with Item 132, "Embankment". All excess material or material not satisfactory for use in

embankment will become the property of the Contractor. All surplus material shall be removed from the work site promptly following the completion of the portion of the structure involved and disposed of in a manner satisfactory to the Engineer.

Whenever excavation is made for installing structures across private property or beyond the limits of the embankment, the top soil removed in the excavation shall be kept separate and replaced, as nearly as feasible, in its original position, and the entire area involved in the construction operations shall be restored to a condition acceptable to the Engineer.

(b) Excavation in Streets. Where structures are installed in streets, highways or other paved areas, the work shall include the cutting of pavement and base to neat lines and the restoration of pavement structure after structural excavation and backfill are completed. The type and thickness of replacement materials shall be as shown on the plans. Any work done or any damage to base and/or pavement incurred outside the limits shown on the plans or authorized by the Engineer, will not be measured for payment, but shall be restored at the Contractor's expense. Maintenance and control of traffic shall be in accordance with the approved traffic control plan and Manual on Uniform Traffic Control Devices.

(c) Protection of Utilities. The Contractor shall conduct his work with a minimum disturbance of existing utilities and it shall be his responsibility to coordinate all work in or near the utilities with the utility owners. The Contractor shall inform utility owners sufficiently in advance of his operations to enable them to identify and locate, reroute, provide temporary detours, or to make other adjustments to utility lines in order that work may proceed with a minimum of delay. The Contractor shall cooperate with all utility owners concerned for any utility adjustments necessary.

Particular care shall be exercised to avoid the cutting or damaging of underground utility lines that are to remain in place. Such lines, if damaged shall be restored promptly and shall be handled in accordance with Article 7.11. When active sanitary sewer lines are cut during excavation operations, temporary flumes shall be provided across the excavation, while open, and the lines shall be restored when the backfilling has progressed to the original bedding lines of the cut sewer.

(d) Removing Old Or Abandoned Structures. When old or abandoned structures or foundations are encountered in the excavation, such obstructions shall be removed for the full width of the excavation and to a depth of 0.3 meter below the bottom of the excavation. When old inlets or manholes are encountered and no plan provision is made for adjustment or connection to the new structures, such manholes and inlets shall be removed completely to a depth 0.3 meter below the bottom of the excavation. In each instance, the bottom of the excavation shall be restored to grade by backfilling and compacting by the methods provided hereinafter for backfill. Where the excavation cuts through abandoned sewers, these sewers shall be removed as required to clear the new structure and plugged in a manner approved by the Engineer.

(e) Dewatering Of Excavation Area. Structures shall not be constructed or laid in the presence of water unless approved by the Engineer. Setting of precast members, placement of concrete, or pipe placing operations shall be performed on a dry firm bed. This shall be accomplished by removal of water from the surface of the bed by bailing, pumping, wellpoint installation, deep wells, french drains, or any other method approved by the Engineer.

For foundations placed in the presence of water, when approved by the Engineer, pumping or bailing from the interior of any foundation enclosure shall be done in a manner which precludes the possibility of movement of water through or alongside any concrete being placed. No pumping or bailing will be permitted during the placing of structural concrete, or for a period of at least 36 hours thereafter, unless from a suitable sump separated from the concrete work. Pumping or bailing during placement of seal concrete shall be only to the extent necessary to maintain a static head of water within the cofferdam. Pumping or bailing to dewater a sealed cofferdam shall not be started until the seal has aged at least 36 hours.

In the event that the excavation cannot be dewatered to the point where the subgrade is free of mud, or it is difficult to keep the reinforcing steel clean in cast-in-place structures, a special material shall be used in the bottom of the excavation. Such special material shall be a minimum depth of 75 millimeters and shall consist of a lean concrete mixture (not less than 165 kilograms of cement per cubic meter), or other material approved by the Engineer.

(2) Bridge Foundations and Retaining Walls. To determine the adequacy of a proposed foundation, the Engineer may require the Contractor to make soundings or take cores to determine the character of the subgrade materials. The maximum depth of soundings or cores will not exceed 1.5 meters below the proposed footing grade.

Care shall be taken not to disturb the material below the bottom of footing grade. Backfilling in a foundation to compensate for excavation which has extended below grade will not be permitted. Such areas below grade shall be filled with concrete at the time the footing is placed. The additional concrete involved shall be at the Contractor's expense.

Unless otherwise required herein or on the plans, rock or other hard foundation material shall be free from all loose material, clean, and cut to a firm surface which may be level, stepped, or serrated, as directed by the Engineer. All seams shall be cleaned out and filled with concrete at the time the footing is placed.

When the material encountered at footing grade of a retaining wall, bridge bent or pier is found to be partially of rock or incompressible material and partially of a compressible material, the foundation shall not be placed until the Engineer has inspected the footing and authorized necessary changes to provide a uniform bearing condition.

(3) Culverts. For all single and multiple box culverts, pipe culverts, pipe arch culverts, long span structural plate structures, box sewers, and pipe sewers where the soil encountered at established footing grade is an unstable or incompressible material, the following procedure shall be used unless other methods are called for on the plans:

Unstable material shall be removed to a depth not to exceed 0.6 meters below the footing of the structure unless additional depth is authorized by the Engineer. All soil removed shall be replaced with stable material in uniform layers not to exceed 200 millimeters in depth (loose measurement). Each layer shall have sufficient moisture to be compacted by rolling or tamping as required to provide a stable foundation for the structure.

When it is not feasible to construct a stable footing as outlined above, the Contractor shall use special materials, such as flexible base, cement stabilized base, cement stabilized backfill or other material, as directed by the Engineer. This work will be paid for as provided in Article 400.8. Special material used, or additional excavation made, for the Contractor's convenience to expedite the work, will be at the Contractor's expense.

When the material encountered at the footing grade of a structure is found to be rock, partially rock or other incompressible material, the incompressible material shall be removed to a depth of 150 millimeters below the footing grade and backfilled with a compressible material approved by the Engineer and compacted in accordance with Article 400.5.

(4) Trench. Unless otherwise shown on the plans, all sewer pipe structures shall be constructed in an open cut with vertical sides to a point 0.3 meter above the pipe. When site conditions or the plans do not prohibit the sloping of the cut, the excavation 0.3 meter above the pipe may be stepped and/or the sides laid back to a stable slope. Required vertical sides shall be sheeted and braced when necessary to maintain the required vertical excavation throughout the construction period.

For all pipe sewers to be constructed in fill above natural ground, the embankment shall first be constructed to an elevation not less than 0.3 meter above the top of the pipe, after which excavation for the pipe shall be made as noted above.

Unstable or incompressible material shall be removed in accordance with Subarticle 400.2.(3). For unstable trench conditions requiring outside forms, seals, sheeting and bracing, or where ground water is encountered, any additional excavation and backfill required shall be done at the Contractor's expense for trenches up to 1.5 meters in depth.

400.3. Cofferdams. The term cofferdam designates any temporary or removable structure constructed to hold the surrounding earth, water, or both out of the excavation, whether the structure is formed of soil, timber, steel, concrete, or a combination of these. The "cofferdam" shall also include the use of pumping wells or well points used for the same purpose. The cost of cofferdams shall be included in the price bid for excavation except where temporary special shoring is shown on the plans to provide excavation protection.

For sheet pile or other types of cofferdams which require internal bracing, the Contractor shall submit details and design calculations bearing the seal of a Registered Professional Engineer for review. The maximum stresses shall not exceed 125 percent of the working allowable stresses used by the Department for the design of structures. The interior dimensions of cofferdams shall provide sufficient clearance for the construction, inspection (inside and outside), and removal of any required forms and to permit pumping outside the forms. In general, sheet pile cofferdams shall extend well below the bottom of the footings and any concrete seal and shall be well braced and as watertight as practicable.

Concrete for foundation seals, unless otherwise specified shall be Class E concrete in accordance with Item 421, "Portland Cement Concrete". The concrete seal shall be placed in accordance with Item 420, "Concrete Structures". Seal concrete when authorized by the Engineer will be paid for as provided in the various bid items. If no direct method of payment is provided in the contract for seal concrete, the work will be measured and paid for in accordance with Article 4.3. Seal placed for the convenience of the Contractor will be at the Contractor's expense.

When the Engineer judges it to be impractical to dewater a cofferdam and a concrete seal is to be placed around piling driven therein, the excavation shall be deep enough to allow for swell of the material during pile driving operations. After driving the piling, all swelling material shall be removed to the bottom of the seal grade. Where it is possible to dewater the cofferdam without placing a seal, the foundation material shall be removed to exact footing grades after piling are driven. Backfilling a foundation to compensate for excavation which has been extended below grade will not be permitted. Such areas below grade shall be filled with concrete at the time the seals or footings are placed. The additional concrete quantities necessary to compensate for excavation below grade shall be at the Contractor's expense.

Unless otherwise provided, cofferdams shall be removed by the Contractor after the completion of the substructure without disturbing or damaging the structure.

400.4. Shaping and Bedding. For precast pipe and box sections, the excavation shall be undercut a minimum depth sufficient to accommodate the class of bedding indicated on the plans and conforming to the bedding requirements of this Item. Where cement stabilized backfill is

indicated on the plans, the excavation shall be undercut a minimum of 100 millimeters and backfilled with stabilized material to support the pipe at the required grade.

400.4

400.4

Three classes of bedding for trench or embankment conditions are shown in Figures 1, 2, and 3. Bedding shall be in accordance with Class C bedding unless otherwise shown on the plans. The Engineer may require the use of a template to secure reasonably accurate shaping of the foundation material.

400.5. Backfill.

(1) General. As soon as practical, all portions of the excavation not occupied by the permanent structure shall be backfilled. Backfill material may be obtained from excavation or from other sources. Backfill material shall be free from stones of such size as to interfere with compaction; free from large lumps which will not break down readily under compaction; and free from frozen lumps, wood, or other extraneous material.

Backfill which will not support any portion of the completed roadbed or embankment shall be placed in layers not more than 250 millimeters in depth (loose measurement). Backfill which will support any portion of the roadbed or embankment shall be placed in uniform layers not to exceed 200 millimeters in depth (loose measurement). Each layer of backfill shall be compacted to a density comparable with the adjacent undisturbed soil or as shown on the plans.

Each layer of backfill material, if dry, shall be wetted uniformly to the moisture content required to obtain a density comparable with the adjacent undisturbed soil or as shown on the plans and shall be compacted to that density by means of mechanical tamps or rammers. The use of rolling equipment of the type generally used in compacting embankments will be permitted on portions which are accessible to such equipment.

When tamping equipment is furnished which, when proven to the satisfaction of the Engineer, will adequately compact the backfill material to the density required, the 200 and 250 millimeter lifts (loose measurement) specified above may be increased to lifts not to exceed 300 millimeters.

Cohesionless materials, such as sand, may be used for general backfilling purposes. Compaction of cohesionless materials shall be done with vibratory equipment, water ponding or a combination thereof.

(2) Bridge Foundations, Retaining Walls, And Culverts. No backfill shall be placed against any structure until the concrete has reached the minimum flexural strength required in Item 421, "Portland Cement Concrete".

The material used for backfilling shall be free of any appreciable amount of gravel or stone particles more than 100 millimeters in greatest dimension and shall be of a gradation that permits thorough compaction. The use of rock or gravel mixed with soil will be permitted, provided the percentage of fines is sufficient to fill all voids and insure a uniform and thoroughly compacted mass of proper density.

When the excavation has been made through a hard material resistant to erosion, the Engineer may require the backfill around piers and in front of abutments and wings to be of stone or lean concrete. Unless otherwise provided, such backfill will be measured and paid for as extra work in accordance with Article 4.3.

Embankment which is too close to a structure to permit compaction by the use of the blading and rolling equipment used on adjoining sections of embankment, shall be placed and compacted in accordance with Subarticle 400.5(1). Mechanical tamps or rammers shall be required when the structure being backfilled could sustain damage from other compacting operations.

Care shall be taken to prevent any wedging action of backfill against the structure, and the slopes bounding the excavation shall be stepped or serrated to prevent such action. Backfill placed around piers shall be deposited uniformly.

(3) Pipe. After the bedding and pipes have been installed as required, the selected backfill materials shall be brought to proper moisture condition, placed along both sides of the pipe equally, in uniform layers not exceeding 200 millimeters in depth (loose measurement), and each lift thoroughly compacted mechanically. Special care shall be taken to secure thorough compaction of the materials placed under the haunches of the pipe and to prevent damage or displacement of the pipe. Filling and/or backfilling shall be continued in this manner to the elevation of the top of the pipe. Backfill above the top of the pipe shall be placed and compacted in accordance with Subarticle 400.5(1). During construction, protection of the pipe shall be in accordance with the pertinent pipe item. Pipe damaged

by the Contractor during construction shall be replaced at the Contractor's expense or repaired to the satisfaction of the Engineer.

The Engineer may reject any material containing more than 20 percent by mass of material retained on a 75 millimeter sieve, or material excavated in such a manner as to produce large lumps not easily broken down or which cannot be spread in loose layers. In general, material excavated by means of a trenching machine will meet the requirements above, provided large stones are not present.

Where sewers extend beyond the toe of slope of the embankment and the depth of cover provided by backfill to the original ground level is less than the minimum required by the specifications for the type of pipe involved, additional material shall be placed and compacted, as herein specified for backfill outside the limits of the roadbed, until this minimum cover has been provided.

400.6. Cement Stabilized Backfill. When shown on the plans, the excavation shall be backfilled to the elevations shown with cement stabilized backfill. Unless otherwise shown on the plans, cement stabilized backfill shall contain aggregate, water and a minimum of seven (7) percent portland cement based on the dry mass of the aggregate, in accordance with Test Method Tex-120-E. Aggregate shall be as shown on the plans or as approved by the Engineer.

Cement stabilized backfill below the top of sewers, manholes, inlets, or other structures shall be placed equally along all sides of the structure so as to prevent strain on or displacement of the structure. Cement stabilized backfill shall be placed in a manner that will completely fill all voids in the trench. Should compaction be required to fill all voids, hand operated tampers may be used.

400.7. Measurement. Excavation and backfill will be measured by the cubic meter. Cutting and restoring of pavement will be measured by the square meter.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

Unless otherwise shown on the plans, structural excavation for pipe headwalls, inlets, manholes, culvert widening (extensions) five (5) meters or less in length, bridge abutments, retaining walls and side road and private entrance pipe culverts will not be measured but shall be considered subsidiary to the various bid items.

For culvert widening (extensions) greater than five (5) meters, quantities for structural excavation will be shown on the plans.

Structural excavation will be measured by the cubic meter computed by the method of average end areas using the following limits to establish templates for measurement:

(1) For all excavation requiring measurement, except that required for the barrels of pipe culverts; for structural plate structures no material outside of vertical planes 0.3 meter beyond the edges of the footings and parallel thereto will be included, unless otherwise shown on the plans. When the plans provide the Contractor the option of cast-in-place or precast boxes, measurement will be based on the cast-in-place option.

(2) For pipes 1050 millimeters or less in nominal or equivalent diameter, no material outside of vertical planes 0.3 meter beyond the horizontal projection of the outside surfaces of the pipe and parallel thereto will be included. For pipes more than 1050 millimeters in nominal or equivalent diameter, no material outside of vertical planes located 0.6 meter beyond the horizontal projection of the outside surfaces of the pipe and parallel thereto will be included. Excavation for pipes shall be measured between the extreme ends of the completed structure, including any end appurtenances, as shown on the plans and from centerline to centerline of inlets, manholes, etc., therein. When excavation for appurtenances is measured for payment, the limits of excavation for the pipes shall not overlap those of the appurtenances.

(3) For structural plate structures no material outside of vertical planes one (1) meter beyond the horizontal projection of the outside surfaces of the structure(s) and parallel thereto will be included. When the quality of the existing soil or embankment is less than that of the proposed backfill material, the excavation shall be extended for measurement to vertical planes located at one-half of the span beyond the horizontal projection of the outside surfaces of the structure(s) and parallel thereto.

(4) If a cofferdam is used, the limitations of Subarticle 400.7.(1) shall apply just as if no cofferdam were used. Excavation quantities for foundations shown on the plans and in the proposal where cofferdams are required shall be considered as final quantities and no further measurement will be made.

(5) Where excavation, in addition to that allowed for the footings, is required for other portions of the structure, such as for the cap, cross strut, or tie beam of a pier or bent or for the superstructure, measurement for such additional excavation will be limited laterally by vertical planes 0.3 meter beyond the face of the member and parallel thereto and vertically to a depth of 0.3 meter below the bottom of such member.

(6) No measurement will be made of any excavation necessary for placing forms or falsework except as allowed by the above conditions.

(7) At all structure sites except at culverts and trench excavations, the measurement of structural excavation will include only material below or outside the limits of the completed road or channel excavation.

Trench excavation in fill above natural ground, as specified in Subarticle 400.2.(4), will be measured for payment. Quantities will include that area as specified in Subarticle 400.7.(2) plus 0.3 meter above the top of the pipe, regardless of the height of fill previously made.

(8) Excavation required for shaping the slopes of header banks which were built by prior contract and upon which riprap is to be placed will be measured as "Structural Excavation, (Riprap)".

(9) For all culverts, except for side road and private entrance culverts, all excavation within the limits of the structure and below or outside the limits of the completed roadway excavation, will be measured as culvert excavation. Where the overall normal width of the culvert is four (4) meters or less, measurement will be as "Structural Excavation, Culvert, Small". Where the overall normal width of the culvert exceeds four (4) meters, measurement will be as "Structural Excavation, Culvert, Large".

(10) Where excavation diagrams are shown on the plans, they shall take precedence over these provisions.

(11) Measurement will not include materials removed below footing grades to compensate for anticipated swelling due to pile driving, nor will it include material required to be removed due to swelling beyond the specified limits during pile driving operations.

(12) Measurement will not include additional volume caused by slips, slides, cave-ins, silting, or fill material resulting from the action of the elements or the Contractor's operation.

(13) Where rock, or other incompressible or unstable material is undercut to provide a suitable foundation for pipe or box sections, such material below grade, which is directed by the Engineer to be removed, will be measured for payment.

(14) No allowance will be made for any variance from plan quantity incurred by an alternate bid.

(15) Additional measurement will be made of the volume of excavation involved in the lowering or raising of the elevation of a footing, foundation, or structure unit, when such grade change is authorized by the Engineer.

(16) Cement stabilized backfill will be measured in accordance with the backfill diagram shown on the plans. The quantity of "Cement Stabilized Backfill" shown on the plans shall be considered as final quantities and no further measurement will be required. Changes in alignment or grade as authorized by the Engineer will be measured for payment.

(17) The work to be done in the cutting and restoring of pavement will be measured in accordance with the dimensions shown on the plans. The excavation below the pavement and/or base shall be measured as structural excavation of the pertinent type.

400.8. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Structural Excavation", "Structural Excavation (Bridge)", "Structural Excavation (Culvert, Small)", "Structural Excavation (Culvert, Large)", "Structural Excavation (Trench)", "Structural Excavation (Riprap)", "Cement Stabilized Backfill" and "Cutting and Restoring Pavement".

Payment for removal and replacement of unstable or incompressible material below the footing grades of culverts as provided for in Subarticle 400.2.(3) will be made as follows:

When the plans specify or when the Engineer directs the use of special materials such as flexible base, cement stabilized base, cement stabilized backfill or other special material, payment for excavation below the footing grades shall be made at the unit price bid for "Structural Excavation" of the pertinent type. Payment for furnishing, hauling, placing and compacting the flexible base, cement stabilized base, cement stabilized backfill or other special materials will be made at the unit price bid for these items in the contract or in accordance with Article 4.3. in cases where the required material is not a bid item.

Where special materials are not required or specified, payment for the removal and replacement of unstable and/or incompressible material will be made at a price equal to 200 percent of the unit price bid per cubic meter for "Structural Excavation" of the pertinent type. This price shall be full compensation for removing the unstable or incompressible material, furnishing, hauling, placing and compacting suitable replacement material and for all labor, equipment, tools, and incidentals necessary to complete the work.

If no direct method of payment is provided in the contract for culvert excavation and no special materials are required or specified, the removal and replacement of unstable or incompressible material, when such work is authorized by the Engineer, will be measured and paid for at twenty dollars ($20.00) per cubic meter.

Should the Engineer deem it necessary to lower a bridge foundation to an elevation below the grade shown on the plans, such over excavation below plan will be paid for as "Structural Excavation" at an adjusted unit price as defined herein. Payment will be made at a unit price equal to 115 percent of the contract unit price bid for all over excavation where the revised footing grade does not vary from plan grade by more than 1.5 meters.

Payment will be made at a unit price of 125 percent of the contract unit price bid for all over excavation where the revised grade varies from plan grade by more than 1.5 meters but not in excess of three (3) meters.

In cases where the revised footing grade varies from plan grade by more than three (3) meters, a supplemental agreement shall be prepared to establish a unit price with which to make payment for the over excavation.

No direct payment will be made for backfilling around structures. Payment for the backfilling and compacting of areas which were removed as structural excavation shall be included in the unit price bid for "Structural Excavation".

Unless otherwise shown on the plans, structural excavation which has been completed to the satisfaction of the Engineer, but not backfilled, a partial payment of 50 percent of the price bid will be made. The remaining amount will be paid upon the satisfactory completion of the backfilling.

This price shall be full compensation for all excavation, bedding, and backfill including placing, sprinkling and compaction of material; all soundings; cleaning and filling seams; constructing all cofferdams; all dewatering; and for furnishing all materials, hauling, labor, equipment, tools, sheeting and/or bracing of excavations up to and including 1.5 meters in depth, pumps, drills, explosives, disposition of surplus material, cutting pavement and base to neat lines; and for incidentals necessary to complete the work, except that protection methods for excavations greater than 1.5 meters in depth shall be measured and paid for as required under Item 402, "Trench Excavation Protection" or Item 403, "Temporary Special Shoring".

ITEM 402

TRENCH EXCAVATION PROTECTION

402.1. Description. This Item shall govern for the excavation protection required for the trenches in excess of 1.5 meters deep, including all additional excavation, backfill, pavement reconstruction and repair made necessary by the protection system, in accordance with this Item.

A trench shall be defined as a narrow excavation made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench is not greater than 4.5 meters. If forms or other structures are installed or constructed in an excavation so as to reduce the

dimension measured from the forms or structure to the side of the excavation to 4.5 meters or less (measured at the bottom of the excavation), the excavation is also considered to be a trench. In addition, "Trench Excavation Protection" will not be limited to these applications, but may be used wherever deemed expedient and proper to the ensuing work.

402.2. Construction Methods. Trench Excavation Protection shall be as required by the provisions of Part 1926, Subpart P-Excavations, Trenching, and Shoring of the Occupational Safety and Health Administration's Standards and Interpretations.

402.3. Measurement. This Item will be measured by the meter along the centerline of trench where the depth of trench exceeds 1.5 meters.

402.4. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Trench Excavation Protection". This price shall be full compensation for all excavation and backfill; for furnishing, placing and removing all shoring, sheeting, or bracing; for dewatering or diversion of water; for all jacking and jack removal; and for all other labor, materials, tools, equipment and incidentals necessary to complete the work.

No payment will be made for excavation protection made necessary due to the selection of an optional design or sequence of work that creates the need for the protection system.

ITEM 403

TEMPORARY SPECIAL SHORING

403.1. Description. This Item shall govern for furnishing and constructing temporary shoring to hold the surrounding earth, water or both out of the work area and to the lines and grades shown on the plans and in accordance with this Item.

403.2. Design. Unless otherwise shown on the plans, the Contractor shall be responsible for the adequacy of the temporary special shoring design. The Contractor shall submit, to the Engineer, details and design calculations bearing the seal of a Registered Professional Engineer for review and approval. All loads and allowable stresses shall comply with

the latest AASHTO Standard Specifications for Bridges, except that the maximum allowable service load stress may be increased by 25 percent.

403.3. Materials. The Contractor shall furnish shoring that meets or exceeds the design requirements. Materials may be new or used. Materials shall not present a hazard to the public, shall be structurally adequate and shall fulfill the intended shoring purpose.

403.4. Construction Methods. The construction methods used for temporary shoring shall be in accordance with the applicable Specifications and the design requirements.

403.5. Measurement. This Item will be measured by the square meter of surface area of a vertical plane between the top of the shoring and the minimum protection grade line shown on the plans.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

403.6. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Temporary Special Shoring". This price shall be full compensation for furnishing and placing all temporary shoring materials; for design of the shoring; for all necessary excavation; for the removal of the shoring or portions thereof; and for all labor, tools, equipment and incidentals necessary to complete the work.

No payment will be made for special shoring made necessary due to the selection of an optional design or sequence of work that creates the need for shoring.

ITEM 404

DRIVING PILING

404.1. Description. This Item shall govern for the equipment required and the methods to be utilized for driving piling.

404.2. General. Unless otherwise shown on the plans or approved by the Engineer, the embankment at bridge ends shall be completed prior to the driving of abutment piling. Piling passing through the structural volume of retaining walls shall be subject to the provisions of Item 423, "Retaining Wall".

Foundation piling are defined as piling placed under interior bent footings or retaining wall abutment footings. Trestle piling are defined as piling which are embedded directly into the abutment cap or interior bent cap. Sheet piling are defined as retaining piling and not considered to be either foundation or trestle piling.

Foundation piling shall not be driven until the footing excavation is approximately complete.

Driving of prestressed piling, including buildups, will not be permitted until the piling concrete including buildups has aged a minimum of 14 days. Piling to be driven in a saltwater environment shall not be driven until the piling concrete including buildups has aged a minimum of 21 days after concrete placement.

Any piling raised when driving adjacent piling shall be redriven. Broken, split, or displaced piling shall be withdrawn and properly replaced, or corrected as directed by the Engineer based on a design analysis.

404.3. Tolerance for Driving. Trestle piling shall be driven to the required vertical or batter alignment. Allowable variations from plan alignment shall not exceed the following:

1. Transverse to the centerline of bent, the top of the piling shall not be more than 50 millimeters from the position shown on the plans.

2. Parallel to the centerline of the bent, the top of the piling shall not be more than 100 millimeters from the position shown on the plans.

Foundation piling shall be driven to the required vertical or batter alignment. The top of any pile shall not be more than 100 millimeters in any direction from the position shown on the plans. If the center of gravity of the piling group varies by more than 75 millimeters from the center of gravity determined from plan location, a structural analysis will be required and modifications shall be made as directed by the Engineer.

The minimum edge distance for piling in a footing shall be 125 millimeters. Additional concrete required to obtain this edge distance and the specified reinforcing steel cover shall be at the Contractor's expense.

Piling shall be cut off reasonably square at the elevation shown on the plans. A tolerance of not more than 50 millimeters above or below established cut off grade will be permitted.

Piling shall be driven in alignment holes and/or with templates when necessary to comply with the above tolerances. The depth of alignment holes normally shall not exceed 1.5 meters.

404.4. Protection of Pile Heads. A structural steel driving head (helmet) suitable for the type and size of piling being driven shall be used. Steel H and sheet piling shall be driven with a helmet compatible with the specific pile shape driven.

For concrete piling, a cushion block shall be provided between the driving head and the top of the pile. Unless otherwise shown on the plans, the cushion block shall be a minimum of 100 millimeters thick for short piling (15 meters or less) and at least 150 millimeters thick for longer piling. The cushion block shall be multiple layers of one of the following:

1. Nineteen (19) millimeters or 25 millimeters structural grade southern pine or fir plywood

2. Green oak or gum, with the grain of the wood horizontal

3. Other material specifically produced for this application and approved by the Engineer

Careful attention shall be given to the condition of the cushioning material. Generally, one cushion block shall not be used to drive more than three (3) piling; cushioning shall be changed more frequently if necessary to prevent damage. Cushion blocks which have ignited shall be replaced immediately. For concrete piling, a tight fitting driving helmet will not be permitted. Some room for slight movement must be provided, however, the driving helmet shall not be large enough for the pile head to rotate freely.

Table 1
SIZE OF DRIVING EQUIPMENT

Type	Type Hammer		Mass of Ram Min. kilogram	Mass of Ram Max. kilogram	Maximum Ram Stroke meter	Minimum[1] Hammer Energy joules (J)
Timber	Gravity		900	1600	4.5	50 R
	Power	Steam, Air, Hydraulic	900		1.5	
		Diesel	900		3.0	
Steel H	Gravity		900	2300	3.0	38 R or 7.5 Wp whichever is larger
	Power	Steam, Air, Hydraulic	1350		1.5	
		Diesel	900		3.0	
Concrete	Power	Steam, Air, Hydraulic	1350 but not less than 1/4 Wp		1.5	38 R but not less than three (3) newton meter per kilogram of pile mass
		Diesel[2]	1200 but not less than 1/4 Wp		2.5 See Note [2]	

R = Design load in kilonewtons
Wp= Mass of pile in kilograms based on plan length.

[1] See Subarticle 404.9(2).
[2] Diesel hammers with less ram mass and/or greater ram stroke may be permitted if a wave equation analysis indicates that the combination of ram mass, stroke, and cushioning will not overstress the piling.

404.5. Driving Equipment. Driving equipment shall comply with Table 1. Pile driving shall be done with power hammers, except gravity hammers may be used for sheet piling and timber piling when no bearing resistance is shown on the plans.

Steam or air hammers shall be operated at not less than 80 percent of the manufacturer's rated capacity.

The boiler or air compressor shall be sufficient to supply to the hammer adequate volume and pressure at least equal to that specified by the manufacturer of the hammer used. The boiler or compressor shall be equipped with an accurate pressure gauge at all times.

The valve mechanism and other parts of all power hammers shall be maintained in first class condition so the hammers will operate at the speed and stroke length specified by the manufacturer.

For initial rating of diesel hammers to determine compliance with the requirements of Table 1, the height of fall of the ram of the single-acting (open end) hammer will be two (2) meters. For a double-acting (enclosed ram) hammer, the energy rating shall be 85 percent of the rated output by the manufacturer. Enclosed ram diesel hammers shall be equipped with a gauge and charts to evaluate the equivalent energy being produced. Calibration of the gauge will be required prior to beginning work and at such other times when in the opinion of the Engineer there is a question as to the gauge accuracy, and at least once each six (6) months.

Cap block cushioning material, when used between the ram and anvil or follow block, shall consist of layers of micarta plastic and aluminum or other material specifically produced for this application and approved by the Engineer.

When gravity hammers are used, the height of fall shall be regulated to avoid injury to the piling. The Contractor shall furnish the Engineer a certified public scale mass of the hammer to be used.

To control excessive stresses resulting in damage to the piling during driving, the Engineer may require:

1. Increase in cushion thickness

2. Reduction of ram stroke

3. Reduced ram stroke for driving through very soft soil and longer ram stroke as soil resistance increases

404.6

4. Combination of increased cushion thickness and reduced ram stroke

5. Heavier ram with a shorter stroke

6. Combination of increased cushion thickness and heavier ram with shorter stroke

7. Use of pilot holes or jetting when driving through hard or alternating hard and soft strata

All test piling in a structure, or in any approved segment thereof shall be driven with the same hammer. The same type and size hammer shall be used to drive the remainder of the piling in the structure, or in the approved segment thereof, that was used to drive the test piling.

Pile drivers shall be equipped with leads which are constructed to afford freedom of movement of the hammer and provide adequate support to the pile during driving. The longitudinal axis of the leads, hammers and pile shall coincide.

Except where piling are driven through water, the leads shall be long enough so that a follower will not be necessary. Where a follower is required when driving piling underwater, one (1) pile in each 10 shall be long enough to permit driving without a follower. It shall be driven as a test pile for proper correlation of the follower-driven piling. Payment will be made as regular piling.

Hammers which are designed to operate underwater may be used for underwater driving without a follower, and without the correlation required above for other hammers.

404.6. Penetration. Except as noted herein, the piling lengths shown on the plans are the lengths estimated to give required bearing and are for estimating purposes only.

Piling shall be driven to within 1.5 meters of plan length and to such greater depths necessary to obtain the required bearing resistance shown on the plans unless other penetration requirements or bearing evaluation methods as stated herein govern.

When test piling or test loads are used, subsequent pile lengths will be established by the Engineer on the basis of these test data. In these cases, piling shall be driven to this approximate elevation and to greater depths as required to obtain the required bearing resistance.

When unusually hard driving conditions are encountered, typically less than 2.5 millimeters penetration per blow, and plan penetration is not obtained, the Contractor shall provide either pilot holes or jetting or a combination of both. With the approval of the Engineer, the penetration may be reduced providing stability requirements are met.

404.7. Pilot Holes. Except as specified herein, pilot holes shall not be deeper than 1.5 meters below bottom of footings for foundation piling or three (3) meters below finished ground line for trestle piling unless the specified penetration cannot be obtained by using the depth of holes indicated. When deeper pilot holes are required, their size and depth shall be determined from the results of trial operations on the first few piling driven and/or available test pile data. Any excess depth and/or size of pilot holes shall require approval by the Engineer. Generally, the maximum diameter of hole permitted will be approximately 100 millimeters less than the diagonal of square or steel-H piling, and 25 millimeters less than the diameter of round piling. Hole size and depth may be varied by the Engineer to obtain penetration and/or bearing resistance.

Pilot holes shall extend through all embankment to natural ground when driving prestressed concrete piling.

Where a pilot hole is required in granular material that cannot be sealed off by ordinary drilling methods, a casing may be required around the boring device deep enough to prevent loose material from falling into the pilot hole.

The piling shall be driven below the depth of the pilot hole a minimum of 0.3 meter or 100 blows, but not less than the required bearing resistance shown on the plans. In any case, piling shall not be driven beyond the point where the penetration per blow is less than 2.5 millimeters as determined by an average of 10 blows. If damage to the pile is apparent, driving shall cease.

404.8. Jetting. Jetting will be required when the specified penetration cannot be obtained by driving and other methods are not feasible. Prior to jetting, the Contractor shall submit details of the proposed methods to the Engineer for approval. The Engineer may authorize varying depths of jetting to achieve the desired results.

Jetting may be done as required in conjunction with driving but only to the depth approved by the Engineer.

For jetting operations, sufficient power shall be provided to simultaneously operate a minimum of two 65 millimeter diameter pipes equipped with 20 millimeter nozzles at a pressure of 1000 kilopascal.

The jetting may be performed with one (1) or two (2) jets as determined by the Contractor and approved by the Engineer from the results of trial operations.

The piling shall be driven below the depth of the jetting a minimum of 0.3 meter or 100 blows, but not less than the required bearing resistance shown on the plans. In any case, piling shall not be driven beyond the point where the penetration per blow is less than 2.5 millimeters as determined by an average of 10 blows. If damage to the pile is apparent, driving shall cease.

404.9. Bearing Evaluation.

(1) Hammer Formula Method. Unless otherwise shown on the plans, the dynamic bearing resistance of piling will be determined by one of the following formulas.

For gravity hammers:

$$P = \frac{1.63WH}{S + 25}$$

When the energy delivered (WxH) by the gravity hammer is 32,000 joules or greater, and the penetration does not exceed 12 millimeters per blow for the last 40 blows delivered (without increasing), the bearing resistance will be determined by:

$$P = \frac{1.63WH}{3S}$$

For single-acting power hammers:

$$P = \frac{1.63WH}{S + 2.5}$$

For double-acting power hammers:

$$P = \frac{E}{6(S+2.5)}$$

P = dynamic resistance in kilonewtons.

S =average penetration in millimeters per blow for the last 20 blows.

W = mass of ram in kilograms.

H =height of fall of ram in meters. (For the single-acting diesel hammer, H may be determined either by visual observation of the ram against a calibrated rod mounted on the hammer or by an approved stroke indicator and blow count logging device.)

E =manufacturer's rated energy in joules (for double-acting power hammers).

E =the equivalent energy in joules, determined by a calibrated gauge attached to the hammer and taken when the average penetration in millimeters per blow is determined (for enclosed ram diesel hammer).

(2) Wave Equation Method. When it is specified on the plans that the bearing capacity of the piling will be determined by the Wave Equation Method, the Contractor shall submit to the Engineer the following data:

1. Manufacturer's specification data of the hammer proposed for use, including any and all modifications.

2. Complete description and dimensions of all cushioning material used between the pile and helmet, and in the cap block, including total thickness of each, and the direction of grain if wood is used.

The above data will be used to determine the required number of blows per unit of penetration the hammer must deliver to obtain the required bearing resistance. This will be determined and furnished by the Division of Bridges and Structures in the form of bearing graphs.

After evaluation by the Wave Equation Method, any change in the driving equipment may require reevaluation, but in all cases such changes shall be approved by the Engineer prior to further driving.

A hammer which produces less energy than required by Table 1 may be approved if a wave equation analysis indicates the hammer can drive the specified pile against a bearing resistance of three (3) times the required design load before reaching practical refusal. Practical refusal is defined as 2.5 millimeter penetration per blow as determined by an average of 10 blows. The bearing resistance of the piling driven with this particular equipment will be determined in accordance with the Wave Equation Method.

404.10. Test Piling. Test piling shall be driven at locations shown on the plans, or as directed by the Engineer. In general, they shall be made a part of the completed work and shall be cut off or built up to grade as necessary. The required bearing evaluation method will be used to determine bearing resistance.

Test piling shall be driven to one (1) meter above plan tip elevation of the other piling for the structure with the blow count recorded for each 0.3 meter of driving. (Typically four (4) meters above plan tip elevation of the test piling when test piling are three (3) meters longer than other piling.)

After a minimum of seven (7) days have elapsed since the original driving, the test piling shall be redriven the additional length required by the plans with the same hammer and the same type and amount of all cushioning material as originally used. The blow count will be recorded for each 25 millimeters of driving for the first 0.3 meter, for every 75 millimeters for the next 0.6 meter, and for each 0.3 meter thereafter.

The required evaluation method will be used to determine the initial and redrive bearing resistance of the test piling. These data will be used to

determine pile lengths and to develop a redrive "K" factor to modify the evaluation method.

Upon completion of the test piling redrive, driving shall be to the penetration as approved, or to greater depth as necessary to obtain the required dynamic penetration resistance determined by the evaluation method modified by the redrive "K" factor, where:

$$K = \frac{P_R}{P}$$

K =a static correction factor applied to the evaluation method.

P_R =redrive bearing (kilonewtons) of the test pile determined by the evaluation method.

P =original bearing (kilonewtons) of test pile determined by the evaluation method.

The driving resistance shall be multiplied by the appropriate K factor to determine the final driving resistance. The final in-place lengths of piling shall be in accordance with Article 404.6.

404.11. Test Load. The required evaluation method will be used to determine the bearing resistance of the test load pile and any anchor piling. The test load data will be used to determine pile lengths, and to develop a "K" factor to modify the method of bearing evaluation.

Piling to be test loaded and anchor piling shall be driven at the location shown on the plans or as directed by the Engineer. In general, they shall be made a part of the completed work and shall be cut off or built up to grade as necessary.

Upon completion of the test load, driving shall be to the penetration, as approved, or to greater depth as necessary to obtain the required dynamic penetration resistance determined by the evaluation method modified by the test load "K" factor, where:

$$K = \frac{L}{P}$$

K =a static correction factor applied to the evaluation method.

L = maximum safe static load proven by test load.

P =bearing resistance of the test loaded pile determined by the evaluation method.

The driving resistance shall be multiplied by the appropriate K factor to determine the final driving resistance. The final in-place lengths of piling shall be in accordance with Article 404.6.

404.12. Length Determination. Piling lengths shall be determined by one of the following methods:

1. Plan Lengths. The plan lengths for piling are determined based on soil tests. Where test piling or test loads are not required, the approved lengths of piling shall be those shown on the plans. The final in-place lengths of piling shall be in accordance with Article 404.6.

2. Test Piling. When required by the plans, test piling shall be driven and the data used to determine approved lengths in accordance with Article 404.10.

3. Test Load. When required by the plans, designated piling shall be driven and test loaded in accordance with Item 405, "Foundation Test Load". The test load data shall be used to determine approved lengths in accordance with Article 404.11.

404.13. Measurement and Payment. The work performed, materials furnished and all labor, tools, equipment and incidentals necessary to complete the work under this Item will not be measured or paid for directly, but will be considered subsidiary to the various bid items of the contract.

ITEM 405

FOUNDATION TEST LOAD

405.1. Description. This Item shall govern for the test loading of piling or drilled shafts.

405.2. General. The piling or drilled shafts to be test loaded shall be specified on the plans. A complete record of the pile driving data or

shaft drilling data for all foundations used in the test load will be made under the supervision of the Engineer.

The test load shall be applied no earlier than the seventh day after driving the test piling or after placing concrete in the test shaft providing the concrete design strength has been attained.

Unless otherwise specified, the Department will furnish the jacking equipment, suitable jacking beams and displacement indicators.

The Contractor shall furnish and drive the piling or construct the shaft to be test loaded and such appropriate anchors that may be necessary, and shall furnish all necessary material, labor, work, tools, equipment in addition to that furnished by the State, shelter to protect the test load equipment from sun and rain, and incidentals necessary for the handling, transportation and installation of the complete test load set-up. After the test has been completed, the test set-up shall be dismantled by the Contractor in a manner satisfactory to the Engineer.

405.3. Construction Methods. The test piling shall be of the same type and cross section as the piling to be used in the structure.

Anchor shafts shall be constructed first so that a satisfactory procedure can be developed for drilling the test shaft. The same procedure used for the test shaft shall be used for drilling the shafts required in the structure.

A permanent piling or shaft may be used as an anchor or for test loading when shown on the plans or when approved by the Engineer. Piling or shafts, not a part of the structure, shall be removed or cut off at least 0.3 meter below the bottom of the footing or finished elevation of the ground upon completion of the test load. Permanent piling used as anchor piling which are raised during the test load shall be redriven to the original grade and bearing.

The driving of anchor and test piling shall be in accordance with Item 404, "Driving Piling".

The construction of anchor and test shafts shall be in accordance with Item 416, "Drilled Shaft Foundations".

405.4. Method of Loading and Evaluation of Tests. Test loading shall consist of the application of incremental static loads to a pile or shaft

and measuring the resultant settlement. The loads shall be applied by a hydraulic jack acting against suitable anchorage, transmitting the load directly to the pile or shaft, in accordance with details shown on the plans or as approved by the Engineer.

All test loads shall be carried to failure of the test pile or test shaft or to such load as directed by the Engineer.

The loading procedure, recording of data and evaluation of test load data shall be in accordance with "Test Loading Piling", Construction Bulletin C-8, Pile Driving Manual or "Test Loading Drilled Shafts", Construction Bulletin C-9, Drilled Shaft Manual, whichever is pertinent.

405.5. Measurement. Measurement will be made for each complete test load, satisfactorily performed and accepted.

Anchor and test piling or anchor and test shafts, which are a part of the permanent structure, will be measured by the meter before cutting them to final plan grade.

Anchor and test piling or anchor and test shafts, which are not a part of the permanent structure, will not be measured for payment but will be included in the price bid for this Item.

If subsequent test loads are required on a previously loaded test piling or test shaft after the Engineer has directed the Contractor to dismantle the test equipment, any additional build up and driving of the test pile and/or reinstallation of the test equipment shall be considered as a separate test load.

405.6. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for each "Foundation Test Load". This price shall be considered full compensation for furnishing all material, labor, work, tools, equipment and incidentals necessary for the proper installation and completion of the test load. Anchor and test piling or anchor and test shafts, which are not a part of the permanent structure, will be included in the unit price bid for each "Foundation Test Load". Anchor and test piling or anchor and test shafts, which are a part of the permanent structure, will be paid for under the appropriate item.

If a subsequent test load is required, as described above under Article 405.5, such test will be paid for at the rate of one-half the price bid for each "Foundation Test Load".

ITEM 406

TIMBER PILING

406.1. Description. This Item shall govern for the furnishing of treated or untreated timber piling, in place, in accordance with the size, type and details shown on the plans.

406.2. Material. Unless otherwise required, timber piling shall meet the requirements of ASTM D 25.

Untreated piling may be of any species of durable timber which will satisfactorily stand driving. Treated piling shall consist of Southern Pine or Douglas Fir, impregnated with a preservative of such quantity and process as shown on the plans and/or as specified in Item 492, "Timber Preservative and Treatment".

The minimum circumference of round piling at a section one (1) meter from the butt, measured under the bark, shall be as follows:

Length of Piling	Minimum Circumference One (1) meter from Butt
12 meters and under	965 millimeters
Over 12 meters	1040 millimeters

All piling shall be subject to inspection by the Engineer or his authorized representative before and after treatment. The Engineer shall be allowed free access to all points from which materials are being produced or processed. The producer shall render whatever assistance is necessary for the proper inspection of materials. When unsuitable material is rejected, the judgment of the Engineer shall be final. The butt and tip of each acceptable pile will be branded with a marking hammer showing the identity of the Engineer or inspection agency who performed the work.

Inspection at all points will be made to insure compliance with these specifications. In the event any material is found which does not comply, the Engineer will require corrections or replacement of defective material.

406.3. General. Driving of piling shall be in accordance with Item 404, "Driving Piling".

The length of piling furnished shall be as indicated on the plans or as authorized by the Engineer.

406.4. Storing and Handling. At all points, suitable precautions shall be taken to prevent excessive splitting, checking, warping, distortion or any other damage which may cause the piling to be rejected. Treated timber piling shall be carefully handled without dropping, breaking of outer fibers, bruising or penetrating the surface with tools. The piling shall be handled with rope slings. Cant dogs, hooks or pike poles shall not be used where such tools will penetrate untreated wood.

406.5. Cut-Offs and Build-Ups. The tops of all piling shall be sawed to a true plane as shown on the plans and at the elevation established by the Engineer. Piling which support timber caps or grillage work shall be sawed to the exact plane of the superimposed structure.

Piling which must be driven below established grade in order to attain the required bearing capacity shall be built up to the required grade by splicing on an additional length of piling of the same diameter and quality as the pile to be built up. Splices shall be made in accordance with the details shown on the plans after the pile head and the lower end of the build-up section have been squared up and treated in accordance with Article 406.6. The build-up shall be of such length as to preclude the use of more than one (1) splice in any one (1) pile, and no splices or build-ups will be permitted except under the conditions outlined herein.

406.6. Treatment of Cuts, etc. After the necessary cutting has been done, the heads of treated timber piling shall be given three (3) coats of hot creosote oil and one (1) coat of hot tar pitch. When indicated on the plans, the pile heads shall then be covered with a sheet of 912 micrometer thick galvanized metal. The cover shall measure at least 150 millimeters more in each dimension than the diameter of the piling and it shall be bent or folded down over the piling and the edges fastened with large-headed galvanized nails or secured by binding with galvanized wire as indicated on the plans.

The heads of untreated timber piling, unless otherwise provided, shall be coated thoroughly with a thick protective coat of hot tar, hot asphaltum, or hot tar creosote and, when indicated on the plans, covered with galvanized metal as provided above.

All places where the surface of treated piling is broken by cutting, boring, or otherwise damaged, shall be coated thoroughly with hot creosote oil and then with a coating of hot tar pitch. Hot creosote oil shall be injected under pressure into the bolt holes, before the insertion of the bolts, in such a manner that the entire surface of the holes shall receive a coating of the oil.

Creosote oil used for treatment of cuts, bolt holes, etc., shall conform to the requirements of Item 492, "Timber Preservative and Treatment".

406.7. Measurement. Timber piling, treated or untreated, driven in accordance with the specifications will be measured by the meter of acceptable piling complete in place after all cut-offs and build-ups have been made.

No cut-off will be measured on any pile which is built-up.

Each authorized build-up splice other than those made necessary by careless or improper handling or driving, shall be measured as "One Build-Up".

Cut-offs will be measured by the meter of piling cut-off above grade. No measurement will be made for cut-offs necessitated by damage resulting from improper driving.

When the Contractor elects to drive piling deeper than required to meet the specified penetration and bearing requirements, no measurement will be made on that portion below the elevation at which penetration and bearing requirements were first obtained.

406.8. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid per meter for "Treated Timber Piling" or "Untreated Timber Piling".

Each completed authorized build-up splice will be paid for at four (4) times the unit price bid for "Treated Timber Piling" or "Untreated Timber Piling". This shall not include any allowance for the length of piling used in the build-ups as this is measured and paid for as timber piling as provided elsewhere in this specification.

Cut-offs will be paid for by the meter at one-half the unit price bid for "Treated Timber Piling" or "Untreated Timber Piling".

The unit price bid shall be full compensation for furnishing all materials, tools, labor, equipment, jetting, pilot holes, alignment holes, and incidentals necessary to complete the work.

ITEM 407

STEEL PILING

407.1. Description. This Item shall govern for the furnishing of steel piling of H-section and sheet piling, in place, of the type and mass, and at the locations shown on the plans.

407.2. Material. Steel H-piling and steel sheet piling shall be furnished in accordance with Item 441, "Steel Structures", and Item 442, "Metal for Structures". Steel sheet piling with a section modulus and minimum thickness of material equal to or greater than that of the section specified may be substituted therefor.

Prefabricated pile points manufactured from material conforming to Item 442, "Metal for Structures", ASTM A 27 or ASTM A 148, grade 65/35 minimum may be provided. The Contractor shall furnish certification that materials conform to this requirement.

407.3. General. Driving of piling shall be in accordance with Item 404, "Driving Piling". Test loading, when required, shall be in accordance with Item 405, "Foundation Test Load".

The length of piling to be furnished shall be as indicated on the plans or authorized by the Engineer. Where test piling are required, approved lengths will be determined by the Engineer from either test driving data or test load data.

Reinforcement of steel H-pile tips in accordance with the following detail shall be furnished when the piling are driven into rock, shale or other material of similar hardness when directed by the Engineer.

In lieu of the pile tip reinforcement detail shown herein, prefabricated pile tips may be used.

407.4. Storing and Handling. Sufficient blocking shall be used to prevent deflection of the piling and to prevent contact with the ground. When stored, they shall be kept clean and fully drained at all times. The methods of handling shall prevent damage to the piling.

407.5. Cut-Offs, Splices and Build-Ups. All splices for steel H-piling shall be made in accordance with the details shown herein. If the required penetration or bearing resistance has not been obtained, spliced piling may be driven the additional depth required as soon as the splice is completed.

The Contractor may, at his expense, fabricate piling by welding together not more than three (3) sections of piling, provided the distance between welds is not less than 1.5 meters.

After the pile has been driven to the approximate penetration and to the bearing resistance required, it shall be cut off square at plan grade, or to the grade established by the Engineer.

If the head of the pile is appreciably distorted or otherwise damaged below cut-off level, the damaged portion shall be cut off and an undamaged section shall be spliced in its place at the Contractor's expense.

Sheet pile splices shall be prepared similar to the details shown for H-piling with care taken not to interfere with the interlocks.

Welding shall be in accordance with Item 448, "Structural Field Welding".

407.6. Painting. Steel piling shall not be painted before driving. After driving, all exposed portions of the piling shall be cleaned and painted in accordance with Item 446, "Cleaning, Paint and Painting". Unless otherwise shown on the plans, the paint shall consist of Protection System II, followed by 50 micrometers of dry Protection System I prime coat, with Aluminum appearance coat. Painting shall extend to a point 300 millimeters below finished ground line, unless the pile is standing in water, in which case, painting shall extend to low water line. Earth removed for this painting shall be replaced after the paint has dried.

407.7 to 407.9

407.7. Test Piling. Test piling shall meet the requirements herein specified for steel H-piling. The Engineer may adjust the number of test piling to secure the desired information.

407.8. Measurement. Steel H-piling will be measured by the meter of acceptable piling in place after all cut-offs and build-ups have been made. A splice made necessary by driving beyond the authorized pile length to obtain the required bearing resistance will be measured as "One Splice". Each additional splice required for build-up will be measured as "One Splice", provided the distance between splice points is not less than three (3) meters. Cut-offs will not be measured for payment.

Where a reinforced tip is required it will be measured as "One Pile Tip".

When the Contractor elects to drive piling, other than required test piling, deeper than required to meet the specified penetration and bearing requirements, no measurement will be made on that portion below the elevation at which penetration and bearing requirements were first obtained. Portions of test piling, directed by the Engineer to be driven below the level at which penetration and bearing requirements were first obtained, will be measured for payment.

Anchor piling and piling to be test loaded shall be measured as provided in Item 405, "Foundation Test Load". Measurement of all other test piling will be made by the meter of acceptable test pile in place after all cut-offs and build-ups have been made.

Steel sheet piling shall be measured by the square meter of acceptable piling in place. Sheet piling driven below the elevation required by the plans or the elevation authorized by the Engineer will not be measured for payment. No measurement will be made for cut-offs or splices.

407.9. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid per meter for "Steel H-Piling", or "Steel H-Test Piling", of the specified size and mass.

Steel sheet piling will be paid for at the unit price bid per square meter for "Sheet Piling" of the type shown on the plans.

No direct payment will be made for cut-offs, painting, or for excavation and backfill required for the painting of portions of piling below ground line. Payment for all work and materials required by these items shall be included in the unit price bid per meter for "Steel H-Piling", "Steel H-Test Piling", or in the unit price bid per square meter for "Sheet Piling".

Test piling, driven at the option of the Contractor, will be paid for at the unit price bid per meter for "Steel H-Piling" provided they are located to form a portion of the completed structure as shown on plans, and are structurally acceptable and driven to required penetration and bearing resistance.

Payment for each completed authorized build-up splice for both regular and test piling, measured as provided above, will be made at a price equal to three (3) times the unit price bid for "Steel H-Piling". This shall not include any allowance for the length of piling in the build-ups as this is measured and paid for as steel H-piling as provided elsewhere in this specification.

Payment for the work and materials required for each reinforced tip will be made at a price equal to two (2) times the unit price bid per meter for "Steel H-Piling" of the size and mass on which the tip is added.

No payment will be made for cut-offs or splices of sheet piling.

Anchor piling and piling to be test loaded will be paid for as provided in Item 405, "Foundation Test Load".

The unit price bid shall be full compensation for furnishing all materials, tools, labor, equipment, jetting, pilot holes, alignment holes, cleaning, painting, and incidentals necessary to complete the work.

ITEM 409

PRESTRESSED CONCRETE PILING

409.1. Description. This Item shall govern for the furnishing of prestressed concrete piling in place, of the size and at the locations shown on the plans.

409.2. Materials. All materials shall conform to the pertinent requirements of the following items:

Item 420, "Concrete Structures"
Item 421, "Portland Cement Concrete"
Item 425, "Prestressed Concrete Structural Members"
Item 426, "Prestressing"
Item 440, "Reinforcing Steel"

409.3. General. Driving of piling shall be in accordance with Item 404, "Driving Piling". Test loading, when required, shall be in accordance with Item 405, "Foundation Test Load".

Prestressed piling fabrication shall conform to Item 425, "Prestressed Concrete Structural Members", Item 426, "Prestressing", and Item 424, "Precast Concrete Structures (Fabrication)".

The lengths of piling to be furnished shall be as indicated on the plans or authorized by the Engineer. Where test piling are required, approved lengths will be determined by the Engineer from either test driving data, or test load data.

409.4. Handling and Storing. The method of handling and storing piling shall minimize the danger of damage by impact or undue bending stresses. The piling shall be stored above ground on adequate blocking. Any damaged piling shall be cause for immediate review and correction of the conditions causing the damage. The use of chain slings will not be permitted.

409.5. Defects and Breakage. Piling cracked in the process of fabrication, handling, hauling or driving will be subject to the following provisions:

(1) Piling which have one or more cracks transverse to the main reinforcement or strand, which are 1.5 millimeters or greater in width, shall be rejected if the crack(s) occurs in a portion which will be below ground or water level after driving. If the crack(s) herein described will be located above ground or water level when driving is completed, the piling may be used provided it is cut back to the crack and rebuilt to grade. No additional payment will be made for this build-up.

(2) Piling which have one or more cracks as described above, that are less than 1.5 millimeters in width, may be used if the crack(s) is sealed with a Type VII epoxy, meeting the requirements of Item 575, "Epoxy".

The cracks shall be grooved a minimum of six (6) millimeters in width and depth and the epoxy shall be applied in the groove and extend over an area not less than 25 millimeters on each side of the crack. The area to which the epoxy is to be applied shall be clean and dry. If, during driving, cracks develop in the portion which will be below ground, driving operations shall be stopped and the required epoxy material applied before driving continues.

(3) Piling with one or more cracks parallel or diagonal to the main reinforcing steel or strand, which extend to the plane of reinforcement as determined by the Engineer, may be cause for rejection. If these piling are found to be acceptable, proper repair shall be made, in accordance with the above requirements.

(4) Fine hairline cracks or surface checks, which do not extend to the plane of the nearest reinforcing steel, as determined by the Engineer, will not generally require repair and will not be cause for rejection.

(5) Replacements or repairs specified herein, and other replacements due to faulty materials or construction methods, will not be paid for.

409.6. Build-ups and Cut-offs. Build-ups shall be made in accordance with the details shown on the plans and constructed in accordance with Item 420, "Concrete Structures".

Form removal and concrete curing shall conform to requirements for concrete piling in Item 420, "Concrete Structures".

For cut-offs, the final cut of the concrete shall be normal to the longitudinal axis and any damage shall be remedied by further cut back.

409.7. Test Piling. Test piling shall meet the requirements herein specified for prestressed concrete piling. The Engineer may adjust the number of test piling to secure the desired information.

409.8. Measurement. Prestressed concrete piling will be measured by the meter of acceptable piling in place after all cut-offs and build-ups have been made. A build-up made necessary by driving beyond the authorized pile length to obtain the required bearing resistance, other than those made necessary by improper casting, handling or driving, will be measured as "One Build-up".

Cut-offs for both regular and test piling will be measured by the meter of cut-off above required grade. Test loaded piling which are cut off after making the tests will be measured in accordance with Item 405, "Foundation Test Load".

Anchor piling and piling to be test loaded will be measured as provided in Item 405, "Foundation Test Load". Measurement of all test piling not test loaded, will be made by the meter of acceptable piling in place after all cut-offs and build-ups have been made.

When the Contractor elects to drive piling, other than required test piling, deeper than required to meet the specified penetration and bearing requirements, no measurement will be made on that portion below the elevation at which penetration and bearing requirements were first obtained. Portions of test piling, directed by the Engineer to be driven below the level at which penetration and bearing requirements were first obtained, will be measured for payment.

409.9. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid per meter for the specified size of "Prestressed Concrete Piling", or "Prestressed Concrete Test Piling".

Test piling, driven at the option of the Contractor, will be paid for at the unit price bid per meter for "Prestressed Concrete Piling", provided they are located to form a portion of the completed structure as shown on the plans and are structurally acceptable and driven to the required penetration and bearing resistance.

Payment for each completed authorized build-up splice for both regular and test piling, measured as provided above will be made at a price equal to four (4) times the unit price bid for "Prestressed Concrete Piling". This price shall not include any allowance for the length of piling in the

build-ups as this is measured and paid for as prestressed concrete piling as provided elsewhere in this specification.

Payment for cut-offs for both regular piling and test piling will be made at a price equal to one-half the unit price bid per meter for "Prestressed Concrete Piling". Where cut-backs are made below grade for the purpose of making build-ups, payment will be included in the allowance for build-ups.

Anchor piling and piling to be test loaded will be paid for as provided in Item 405, "Foundation Test Load".

The unit price bid shall be full compensation for furnishing all materials, tools, labor, equipment, jetting, pilot holes, alignment holes and incidentals necessary to complete the work, except that any test load ordered by the Engineer that is not provided for in the contract shall be paid for in accordance with Article 9.3.

ITEM 416

DRILLED SHAFT FOUNDATIONS

416.1. Description. This Item shall govern for the construction of foundations consisting of reinforced concrete drilled shafts and/or nonreinforced concrete drilled shafts, with or without bell footings of the size and at the location shown on the plans.

416.2. Materials. All materials shall conform to the requirements of the pertinent items as follows:

Item 421, "Portland Cement Concrete"
Item 440, "Reinforcing Steel"
Item 448, "Structural Field Welding"

Unless otherwise shown on the plans, concrete for drilled shafts shall conform to the following:

Drilled Shaft Type	Concrete
Nonreinforced	Class "A"
Reinforced	Class "C"
Slurry & Underwater Concrete Placement	Class "SS"

A Type D water-reducing, retarding admixture will be required in all concrete when casing is used or when shafts are placed underwater or under slurry.

416.3. Construction Methods.

(1) Excavation.

(a) General.

The plans indicate the expected depths and elevations where satisfactory bearing material will be encountered.

The Contractor shall perform the excavation required for the shafts and bell footings, through whatever materials encountered, to the dimensions and elevations shown on the plans or required by the site conditions. If satisfactory founding material is not encountered at plan elevation, the bottom of the shaft will be adjusted, or the foundation altered, as determined by the Engineer, to satisfactorily comply with design requirements.

Shaft alignment shall be within a tolerance of 25 millimeters per three (3) meters of depth.

The center of the shaft shall not be more than 25 millimeters from the horizontal position shown on the plans. Any shafts in violation of this tolerance will be subject to a structural review by the Engineer.

Where caving conditions and/or excessive ground water is encountered, no further drilling will be allowed until a construction method is employed which will prevent excessive caving that will cause the excavation to be appreciably larger than the size of casing to be used. Predrilling in disturbed soil as necessary to control ground water and caving until a casing is set or setting casing with a vibratory hammer, will be permitted.

Casing will be required when necessary to prevent caving of the material or when necessary to exclude ground water. Casing shall be of sufficient strength to withstand handling stresses, the pressure of concrete and of the surrounding earth or backfill materials, and shall be watertight, smooth, clean and free of accumulations of hardened concrete.

When casing is used, the outside diameter of the casing shall not be less than the specified diameter of the shaft. That portion of the shaft below the casing may be slightly smaller than the nominal diameter of the shaft, i.e., shall be the largest size possible when drilled through a casing with the outside diameter as specified herein.

The hole shall be drilled in such a manner that when the casing is inserted into the hole, a minimal amount of disturbed soil will be trapped outside the casing. This provision does not apply to temporary undersized casings used to protect workers inside shafts or for drilled shafts designed for point bearing only.

If the elevation of the top of the shaft is below ground level or a problem exists with material caving into the excavation, a surface casing will be required from ground elevation to a point below the top of the shaft. Any surface casing used shall not remain in place unless otherwise indicated on the plans or permitted by the Engineer. It shall not be extracted until after the concrete placement has been completed.

Under normal operations, a sufficient head of concrete shall be maintained at all times above the bottom of the casing to overcome hydrostatic pressure. Movement of the casing for short pulls of 75 to 100 millimeters, rotating, exerting downward pressure and tapping it to facilitate extraction will be permitted. The total removal of the casing shall not be started until all concrete placement is completed in the shaft. When unusual conditions warrant, the casing may be pulled in partial stages. Casing extraction shall be at a slow, uniform rate with the pull in line with the axis of the shaft.

Casing shall not be left in place unless otherwise shown on the plans or permitted by the Engineer.

Bells shall be excavated to form a bearing area of the size and shape shown on the plans. Blasting will not be permitted. Bell shapes varying slightly from those shown on the plans are permissible provided the bearing area equals that specified.

Material excavated from shafts and bells, including slurry, and not used in the backfill around the completed bents or piers shall be disposed of as directed by the Engineer.

At the time concrete is placed, the excavation shall be free from accumulated seep water. All loose material shall be removed from the bottom of the excavation prior to placing concrete.

The Contractor shall provide suitable access and lighting for proper inspection of the completed excavation, and to check the dimensions and alignment of shafts and bell excavation.

Any required lighting shall be electric. Any mechanical equipment used within the excavation shall be operated by air or electricity. The use of gasoline driven engines within the excavation for pumping or drilling will not be permitted.

In order that the Engineer may judge the adequacy of a proposed foundation, the Contractor, if requested, shall take cores to determine the character of the supporting materials. The minimum depth of such soundings or cores shall be 1.5 meters below the proposed founding grade, or a depth equal to the diameter of the shaft, whichever is greater. It is the intent of this provision that cores shall be taken at the time the excavation is approximately complete. Unless otherwise shown on the plans, the Contractor may be required to provide one (1) core at his expense at each bent or abutment. Only cores in excess of the first core taken at each bent or abutment or in excess of those called for in the plans, will be measured for payment.

When the plans require shafts in abutment bents, the embankment at the bridge ends shall be completed to grade and thoroughly compacted prior to drilling, unless otherwise shown on the plans or as permitted by the Engineer.

(b) Additional Requirements for Slurry Displacement Method.

Unless otherwise shown on the plans, drilled shafts may be constructed by the "Slurry Displacement Method" which is defined as a construction procedure whereby the sides of the excavation are supported

by a processed bentonite slurry, which is then displaced by concrete to form a continuous concrete shaft. Casing, other than surface casing, will not be permitted.

Slurry shall consist of a commercial bentonite compatible with fresh water, and shall be mixed with water conforming to the requirements in Item 421, "Portland Cement Concrete" to produce a slurry. Nonsite mixed commercially supplied slurry shall conform to all the requirements herein. Slurry mixed at the project site shall be premixed in a reservoir adjacent to the excavation. Mixing of the slurry in the shaft excavation or other hole will not be permitted. The reservoir shall be of sufficient capacity to fill the excavation and for recovery of the slurry during concrete placement.

Slurry shall conform to the following requirements:

Bentonite Content (Percent by mass)	2% to 8%
Specific Gravity	1.02 to 1.15
Viscosity (500 ml Marsh funnel)	40 second maximum
Sand Content (Percent by volume)	10% maximum

At the discretion of the Engineer, the specific gravity or sand content limits may be exceeded if it appears that the slurry consistency will not hinder concrete placement.

Slurry shall be sampled from the bottom of the excavation and tested in accordance with Test Method Tex-130-E.

A head of slurry shall be maintained in the shaft excavation during and after drilling operations, at or near ground level, or higher as necessary to counteract ground water pressure.

When a surface casing is used, the slurry shall fill the excavation to at least one (1) meter above the bottom of the surface casing. The surface casing shall be smooth and shall extend approximately to the top of the shaft. The surface casing shall not be extracted until the concrete placing operation has been completed.

Just prior to placement of reinforcing steel, a clean-out bucket of the proper size and/or other acceptable tool shall be passed down and up the excavation to remove loose cuttings or any material that may have fallen from its sides after the completion of drilling operations.

If concrete placement is not started within four (4) hours of the completion of the shaft excavation, the hole shall be reprocessed with the auger as directed by the Engineer. The bottom shall then be recleaned with a cleanout bucket. The slurry at the bottom of the hole shall be rechecked for compliance with the above requirements.

If the slurry "sets up" or forms a gel prior to concrete placement, the gelled slurry shall be agitated to liquefaction just prior to concrete placement and at other times when directed by the Engineer.

(2) Reinforcing Steel. The cage of reinforcing steel, consisting of longitudinal bars and lateral reinforcement (spiral reinforcement, lateral ties or horizontal bands) shall be completely assembled and placed as a unit immediately prior to concrete placement, unless otherwise shown on the plans.

If the shaft is lengthened, the longitudinal bars and lateral reinforcement required in the upper portion of the shaft shall be extended to the bottom unless otherwise shown on the plans. These bars may be lap spliced or spliced by welding. Any splices required shall be in the lower portion of the shaft.

Where spiral reinforcement is used, it shall be tied to the longitudinal bars at a spacing not to exceed 300 millimeters. Welding of lateral reinforcement to longitudinal bars will not be permitted unless otherwise shown on the plans.

In uncased shafts, concrete spacer blocks or steel chairs shall be used at sufficient intervals to insure concentric spacing for the entire length of the cage. In cased shafts, concrete spacer blocks shall not be used. Steel chair spacers or bent pieces of steel bars shall be placed at sufficient intervals around the steel cage to insure concentric spacing inside the casing.

It shall be the Contractor's responsibility to support or hold down the cage to control vertical displacement during concrete placement and/or extraction of the casing. The support shall be concentric with the cage to prevent racking and distortion of the steel. An adequate number of the vertical bars shall be supported.

The elevation of the top of the steel cage shall be checked before and after concrete placement or after casing extraction when casing is used. Generally, downward movement of the steel not exceeding 150 millimeters per six (6) meters of shaft length will be acceptable. Upward movement of the steel not exceeding 150 millimeters will be acceptable. Displacement of the steel beyond the above limits shall be cause for a structural review.

The minimum length of steel required for lap with column steel shall be maintained. Dowel bars may be used if the proper lap length is provided both into the shaft and into the column. All dowel bars shall be adequately supported and may be inserted after concrete placement.

(3) Concrete.

(a) General.

All work shall be performed in accordance with the provisions of Item 420, "Concrete Structures", and with the requirements herein.

Concrete shall be placed as soon as possible after all excavation is complete and reinforcing steel placed, and shall be of such workability that vibrating or rodding will not be required. Portions of drilled shafts which are formed shall be vibrated.

Concrete placing shall be continuous for the entire length of the shaft. Concrete shall be placed through a suitable tube or tremie to prevent segregation of materials. The tube or tremie may be made in sections to provide proper discharge and permit raising it as the placement progresses. A nonjointed pipe may be used if concrete is not allowed to discharge from the side openings. Free fall of concrete a maximum of 4.5 meters will be allowed provided the Contractor can demonstrate that the concrete may be directed such that it does not strike the reinforcing cage or sides of the hole during placement.

The elapsed time from the beginning of concrete placement in the cased portion of the shaft, until extraction of the casing is begun, shall not exceed one (1) hour.

A riser block of equal diameter as the column and of a maximum height of 150 millimeters may be cast at the top of the completed shaft.

The top surface shall be cured and any construction joint area shall be treated in accordance with Item 420, "Concrete Structures".

(b) Additional Requirements for Slurry Displacement or Underwater Placement Methods.

Provisions shall be made for a sump, or other approved method, to channel displaced fluid away from the shaft excavation. Slurry shall be recovered and disposed of as approved of by the Engineer. Displaced fluids shall not be discharged into streams or other bodies of water.

Concrete shall be placed as soon as possible after all excavation is completed and reinforcing steel is placed, and within the same day's operation as the shaft excavation.

The concrete shall be placed through a closed tremie or pumped to the bottom of the excavation. Placement of the concrete shall be continuous from the beginning of placing until the shaft is completed. If a tremie is used, it shall be kept full of concrete and well submerged in the previously placed concrete at all times. If a pump is used, the discharge tube shall be submerged in the previously placed concrete at all times. Additional concrete shall be placed to assure the removal of any contaminated concrete at the top of the shaft.

If concrete placement is interrupted due to withdrawal of the submerged end of the tremie or pump discharge tube prior to completion, the tube shall be removed, resealed at the bottom, forced well into the concrete already placed and recharged prior to progressing further.

416.4. Test Load. Any required test loading of shafts shall be in accordance with Item 405, "Foundation Test Load".

416.5. Measurement. Drilled shaft foundations will be measured by the meter to the bottom of the shaft. Shafts for interior bents and piers will be measured from a point approximately 150 millimeters below the finished earthwork elevation at the center of each shaft unless specific elevations or dimensions are indicated on the plans or unless the Engineer directs otherwise to meet unusual conditions. (The bent height shown on the plans is for estimating purposes only and does not control the top of shaft measurement.) For abutment bents and retaining walls, the length of each shaft shall be measured from the bottom of footing or cap elevation.

For sign structures and illumination poles, the length of each shaft shall be measured from the top of shaft elevation shown on the plans.

The quantity of concrete for bell footings as shown on the plans and in the proposal shall consist of the volume outside of the plan dimensions of the shaft and shall be considered as final quantities and no further measurement will be required, unless revised by the Engineer during construction.

Core holes to determine the adequacy of a founding strata will be measured by each core hole drilled. Only core holes in excess of one (1) per bent or abutment or in excess of those called for in the plans will be measured for payment.

416.6. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid per meter of "Drilled Shaft", or "Drilled Shaft (Nonreinforced)", of the specified diameter, subject to the following limitations for overruns authorized by the Engineer:

(1) Payment for individual completed shaft lengths up to and including 1.5 meters in excess of the maximum plan length shaft, as defined herein, will be made at the unit price bid per meter of the specified diameter of "Drilled Shaft".

(2) Payment for that portion of individual completed shaft length in excess of 1.5 meters and up to, and including, 4.5 meters more than the maximum plan length shaft, as defined herein, will be made at a unit price equal to 115 percent of the unit price bid per meter of the specified diameter of "Drilled Shaft".

(3) Payment for that portion of individual completed shaft length in excess of 4.5 meters more than the maximum plan length shaft, as defined herein will be made at a unit price equal to 125 percent of the unit price bid per meter of the specified diameter of "Drilled Shaft".

Payment as described above shall be subject to the following provisions:

(1) For extra depth drilling at interior bents and piers, the maximum plan length shaft shall be the maximum length shaft, regardless of diameter, for any interior pier or bent of any bridge included in the contract.

(2) For extra depth drilling for abutment bents and retaining walls, the maximum plan length shaft shall be the maximum length shaft, regardless of diameter, for any abutment bent of any bridge or of any retaining wall included in the contract.

(3) For extra depth drilling for overhead sign structures, the maximum plan length shaft shall be the maximum length shaft, regardless of diameter, for any overhead sign structures included in the contract.

(4) For extra depth drilling for high mast illumination poles, the maximum plan length shaft shall be the maximum length shaft, regardless of diameter, for any high mast illumination pole included in the contract.

Bell footings constructed to the specified dimensions will be paid for at the unit price bid per cubic meter for "Bell Footings". The quantity to be paid for will be the quantity shown on the plans unless revised by the Engineer in accordance with "Measurement".

Core holes will be paid for based on a price to be determined as follows: the price bid for the drilled shaft size of greatest quantity in the contract shall be divided by two times the shaft diameter in meters and then multiplied by five (5).

The unit prices bid for the various classifications of drilled shafts and bell footings shall be full compensation for making all excavations and soundings; for any necessary pumping; for furnishing, predrilling, placing and removing any required casing; for furnishing and placing all concrete including additional concrete required to fill an oversize casing or oversize excavation; for furnishing and placing reinforcing steel; for furnishing and processing any slurry; for all backfilling; for disposing of cuttings and slurry; and for furnishing all tools, labor, equipment and incidentals necessary to complete the work. When the bottom of any drilled shaft is ordered to be placed at an elevation below plan grade and a splice of reinforcement is required, no direct payment will be made for the extra reinforcement required, but it will be considered subsidiary to the price bid per meter of shaft. No extra payment will be made for casings left in place.

No payment will be allowed for "Bell Footing" or for "Drilled Shaft" until the concrete has been placed.

ITEM 420

CONCRETE STRUCTURES

420.1. Description. This Item shall govern for the construction of all types of structures involving the use of cast-in-place concrete. All structures shall be constructed in accordance with the details shown on the plans and this Item.

420.2. Materials.

(1) Concrete. All concrete shall conform to the provisions of Item 421, "Portland Cement Concrete".

The class of concrete for each type of structure or unit shall be as shown on the plans, or by pertinent governing specifications.

(2) Reinforcing Steel. All reinforcing steel shall conform to the provisions of Item 440, "Reinforcing Steel".

(3) Expansion Joint Material. The following materials shall conform to the requirements of Item 433, "Joint Sealants and Fillers".

(a) Preformed Fiber Material. Preformed fiber expansion joint material shall conform to the dimensions shown on the plans. Unless otherwise specified, "Preformed Bituminous Fiber Material" shall be used.

(b) Joint Sealing Material. Unless shown otherwise, the sealer shall be a "Low Modulus Silicone Sealant".

(c) Asphalt Board. Asphalt board shall conform to the dimensions shown on the plans.

(d) Rebonded Neoprene Filler. Rebonded neoprene filler shall conform to the dimensions shown on the plans.

(4) Waterstop.

(a) Rubber waterstop or polyvinyl chloride (PVC) waterstop shall be in conformance with Item 435, "Elastomeric Materials".

(b) Other types shall be as shown on the plans.

(5) Curing Materials.

(a) Membrane curing shall conform to Item 526, "Membrane Curing".

(b) Cotton mats shall consist of a filling material of cotton "bat" or "bats" (min. 400 grams per square meter); covered with unsized cloth (min. 200 grams per square meter); tufted or stitched to maintain stability; shall be free from tears; and shall be in good general condition.

(c) Polyethylene sheeting shall be 100 micrometers minimum thickness and free from visible defects. It shall be clear or opaque white except when the temperature during the curing period does not exceed 15 °C or when applicable to control temperature during mass pours.

(d) Burlap-polyethylene mats shall be made from burlap impregnated on one side with a film of opaque white pigmented polyethylene and free from visible defects.

(e) Laminated mats shall have not less than one (1) layer of an impervious material such as polyethylene, vinyl plastic or other acceptable material (either as a solid sheet or impregnated into another fabric) and shall be free of visible defects.

(6) Admixtures. Concrete admixtures shall comply with the requirements of Item 437, "Concrete Admixtures".

(7) Epoxy. Unless otherwise specified, epoxy materials shall conform to Item 575, "Epoxy".

(8) Latex Emulsions. Latex emulsion used for latex based grout/mortar, latex adhesive grout/mortar or other purposes shall conform to Departmental Materials Specification D9-8110.

420.3. General Requirements. Before starting work, the Contractor shall inform the Engineer fully of the construction methods he proposes to use, the adequacy of which shall be subject to the approval of the Engineer.

Concurrence on the part of the Engineer of any proposed construction methods, approval of equipment, or of form and falsework plans does not relieve the Contractor of the responsibility for the safety or correctness of the methods, the adequacy of his equipment or from carrying out the work in full accordance with the contract.

Plans for forms and falsework for piers, superstructure spans over six (6) meters long and for all bridge widening details shall be submitted to the Engineer for review. Similar plans shall be submitted for other units of the structure, if requested by the Engineer. The plans shall be prepared on ISO A1 sheets (metric units of 841 millimeters x 594 millimeters) or on sheets having English units of 34 inches x 22 inches. The drawing area is to be 787 millimeters x 533 millimeters. The right margin is fixed at seven (7) millimeters with equal top and bottom margins. The drawings shall show all essential details of the proposed forms, falsework and bracing to permit a structural analysis. Four (4) sets of such plans will be required. One (1) set of design calculations shall accompany the submission of such plans. Plans, forms and falsework shall be designed, sealed, and signed by a professional engineer.

Forms or screed supports may be attached to I-beams or girders by welding, subject to the following requirements:

(1) Welds will not be permitted on tension flanges and in those areas shown on the plans or as directed by the Engineer.

(2) Welds shall be made in accordance with Item 448, "Structural Field Welding".

Unless otherwise shown on the plans, the time sequence in which construction operations may be carried on and in which completed structures may be opened to traffic shall be governed by the following:

(1) Superstructure members, forms, falsework, or erection equipment shall not be placed on the substructure before the concrete therein has attained a flexural strength of 2930 kilopascal.

(2) Storage of materials on completed portions of a structure will not be permitted until all curing requirements for those particular portions have been met.

(3) A minimum flexural strength of 2344 kilopascal will be required for the following:

(a) Forms erected on concrete footings supported by piling or drilled shafts.

(b) Forms on individual drilled shafts.

Such work may begin on spread footings and culvert footings, after the concrete therein has aged at least two (2) curing days. Concrete may be placed as soon as the forms and reinforcing steel are approved.

(4) The support of tie beam and/or cap forms by falsework placed on previously placed tie beams will be permissible provided such beams have attained 2930 kilopascal flexural strength, curing requirements are completed, and the member is properly supported to eliminate stresses not provided for in the design.

(5) Bridges and direct traffic culverts shall not be opened to construction traffic or to the traveling public until authorized by the Engineer in accordance with the following:

After the last slab concrete has been in place at least 14 days, authorization may be given for construction traffic on structures not to exceed 0.7 megagram vehicles.

After the last slab concrete has been in place at least 21 days, authorization may be given for other construction traffic, or for the traveling public when necessary. Vehicles exceeding the legal load limit will be allowed in accordance with Item 6, "Control of Materials".

(6) Box culverts in fills may be opened to backfilling and compaction equipment when the concrete in the top slab has attained 2930 kilopascal flexural strength, and may be opened to other traffic as soon as sufficient backfill and/or embankment has been placed over the top to protect the culverts against damage from heavy construction equipment. The Contractor shall repair, at his expense, any damage inflicted on the culvert by construction traffic.

420.4 to 420.6

420.4. Drains. Weep holes and roadway drains shall be installed and constructed as shown on the plans.

420.5. Expansion Joints. Joints and devices to provide for expansion and contraction shall be constructed in accordance with plan details and the requirements of this Item.

The bearing area under the expansion ends of concrete slabs and slab and girder spans shall be given a steel trowel finish, and finished to the exact grades required.

Bridging of concrete or mortar around expansion joint material in bearings and expansion joints shall be prevented.

All open joints and joints to be filled with expansion joint material shall be constructed using forms adaptable to loosening or early removal. To avoid expansion or contraction damage to the adjacent concrete, these forms shall be loosened as soon as possible after final concrete set to permit free movement of the span without requiring full form removal.

When a "Type A" joint is shown on the plans, preformed fiber joint material shall be used in the vertical joints of the roadway slab, curb, median or sidewalk and the top 25 millimeters thereof shall be filled with the joint sealing material shown herein or shown on the plans.

The sealer shall be installed in accordance with Item 438, "Cleaning and/or Sealing Joints and Cracks (Portland Cement Concrete)", and the manufacturer's recommendations.

Where preformed fiber joint material is used, it shall be anchored to the concrete on one (1) side of the joint by light wire or nails.

Finished joints shall conform to the plan details with the concrete sections completely separated by the specified opening or joint material.

Soon after form removal and again where necessary after surface finishing, all concrete shall be removed from within the joint opening to insure full effectiveness of the expansion joint.

420.6. Construction Joints. The joint formed by placing plastic concrete in direct contact with concrete that has attained its initial set shall be deemed a construction joint. The term monolithic placement shall be

interpreted to mean that the manner and sequence of concrete placing shall not create a construction joint.

Construction joints shall be of the type and at the locations shown on the plans. Construction joints other than those shown on the plans will not be permitted in bridge slabs. Additional joints in other members will not be permitted without written authorization from the Engineer. When additional joints are authorized, they shall have details equivalent to those shown on the plans for joints in similar locations.

Unless otherwise provided, construction joints shall be square and normal to the forms. Bulkheads shall be provided in the forms for all vertical joints.

Construction joints requiring the use of joint sealing material shall be as shown on the plans.

A concrete placement terminating at a horizontal construction joint shall have the top surface roughened thoroughly as soon as practicable after initial set is attained.

The hardened concrete surface shall be thoroughly cleaned of all loose material, laitance, dirt or foreign matter and saturated with water. All freewater shall be removed and the surface shall be in a moist condition when concrete and/or bonding grout is placed against it.

Forms shall be drawn tight against the existing concrete to avoid mortar loss and offsets at joints.

When shown on the plans or in other specifications, the joint surface shall be coated with bonding mortar, grout, or other specified material.

When shown on the plans, Type V epoxy material shall be used for bonding fresh concrete to hardened concrete. The bonding epoxy shall be placed on a clean, dry surface and shall be tacky when the fresh concrete is placed.

420.7. Seal for Foundations. Concrete for foundation seals, unless otherwise specified, shall be in accordance with Item 400, "Excavation and Backfill for Structures".

420.8. Falsework. Falsework shall be designed and constructed to safely carry the maximum anticipated loads, including wind loads, and to provide the necessary rigidity. Details of falsework construction shall be subject to review and approval by the Engineer in accordance with the provisions of Article 420.3.

For evaluating the adequacy of job fabricated falsework, a force of 23.6 kilonewtons per cubic meter shall be assumed for concrete, and a live load allowance of 2400 pascal of horizontal surface of the form work shall be included. The maximum stresses shall not exceed 125 percent of the allowable stresses used by the Department for the design of structures.

Commercially produced structural units used in falsework shall not exceed the manufacturer's maximum allowable working load for moment, and shear or end reaction. The maximum allowable working load shall include an allowance of 1680 pascal of horizontal form surface and sufficient details and data shall be submitted to the Engineer for approval.

All timber used in falsework shall be sound, in good condition, and free from defects which would impair its strength.

When wedges are used to adjust falsework to desired elevations, the wedges shall be used in pairs to insure even bearing. The use of wedges to compensate for incorrectly cut bearing surfaces will not be permitted. Wedges shall be hardwood or metal.

Sills or grillages shall be large enough to support the superimposed load without settlement, and unless founded on solid rock, shale or other hard materials, precautions shall be taken to prevent yielding of the supporting material.

Falsework which cannot be founded on a satisfactory spread footing shall be placed on piling or drilled shafts having a bearing capacity sufficient to support the superimposed load without settlement. Falsework piling shall be driven to the required resistance determined by the applicable formula given in Item 404, "Driving Piling". Drilled shafts for falsework shall be designed to carry the superimposed load using both skin friction and point bearing.

Welding, when used, shall conform to the requirements of Item 448, "Structural Field Welding". Each falsework bent shall be securely braced

to provide the stiffness required with the bracing securely fastened to each pile or column it crosses.

The falsework shall be removed when no longer required. False- work piling shall be pulled or cut off not less than 150 millimeters below finished ground level. Falsework, piling or drilled shafts in a stream, lake, or bay shall be completely removed to a point specified by the Engineer to prevent any obstruction to the waterway.

420.9. Forms. All forms shall be constructed in accordance with the following:

(1) General. Except where otherwise specified, forms may be of either timber or metal.

Forms for round columns exposed to view shall be of steel, except that other materials will be allowed with written permission of the Engineer.

Studs, joists, wales or other devices used for form supports shall be of sufficient section and rigidity to withstand undue bulging or settling of the forms. Any device or method used for form support shall be subject to the approval of the Engineer.

Forms shall be designed for a fluid pressure of 23.6 kilonewtons per cubic meter. The rate of placing the concrete shall be taken into consideration in determining the depth of the equivalent liquid. Job fabricated forms shall be designed for an additional live load of 2400 pascal of horizontal surface. The maximum unit stresses shall not exceed 125 percent of the allowable stresses used by the Department for the design of structures.

Commercially produced structural units used in form work shall not exceed the manufacturer's maximum allowable working load for moment, shear or end reaction. The maximum working load shall include a live load of 1680 pascal of horizontal form surface and sufficient details and data shall be submitted to the Engineer for review.

Forms shall be practically mortar-tight, rigidly braced and strong enough to prevent bulging between supports and shall be maintained to the proper line and grade during concrete placement. Forms shall be maintained in a manner to prevent warping and shrinkage.

Offsets at form joints shall not exceed two (2) millimeters. Form supports for slabs shall not be welded to the top flange of I-beams or girders except in accordance with the provisions of Article 420.3.

Deflections due to cast-in-place slab concrete and railing shown in the dead load deflection diagram shall be taken into account in the setting of slab forms.

All forms and footing areas shall be cleaned of any extraneous matter before placing concrete.

Permission to place concrete will not be given until all preparatory work is complete to the satisfaction of the Engineer.

If, at any stage of placement, the forms show signs of bulging or sagging, the portion of the concrete causing such condition shall be removed immediately, if necessary, and the forms shall be reset and securely braced against further movement.

(2) Timber Forms. Lumber for forms shall be properly seasoned, of good quality, and free from imperfections which would affect its strength or impair the finished surface of the concrete.

Forms or form lumber to be reused shall be maintained clean and in good condition. Any lumber which is split, warped, bulged, marred or has defects that will produce inferior work shall not be used and shall be promptly removed from the work.

Form lining will be required for all formed surfaces, except for the inside of culvert barrels, inlets, manholes and box girders; the bottom of bridge decks between beams or girders; surfaces that are subsequently covered by backfill material or are completely enclosed; and, any surface formed by a single finished board. Lining will not be required when plywood forms are used.

Form lining shall be of an approved type such as masonite or plywood. Thin membrane sheeting such as polyethylene sheets shall not be used for form lining.

Commercial form liners used to imprint a pattern or texture on the surface of the concrete shall be as shown on the plans and/or as approved by the Engineer.

Forms may be constructed of plywood not less than 13 millimeters in thickness. The grain of the face plies on plywood forms shall be placed parallel to the span between the supporting studs or joists.

Plywood used for forming surfaces which remain exposed shall be equal to that specified as B-B Plyform Class I or Class II Exterior of the U.S. Department of Commerce, National Institute of Standards and Technology, U.S. Product Standard, latest edition.

Studs and joists shall be spaced so that the facing form material remains in true alignment under the imposed loads.

Wales shall be spaced close enough to hold forms securely to the designated lines and scabbed at least 1.2 meters on each side of joints to provide continuity. A row of wales shall be placed near the bottom of each placement.

Facing material shall be placed with parallel and square joints and securely fastened to supporting studs.

Forms for surfaces receiving only an ordinary finish and exposed to view shall be placed with the form panels symmetrical, i.e., long dimensions set in the same direction. Horizontal joints shall be continuous.

Molding for chamfer strips or other uses shall be made of materials of a grade that will not split when nailed and which can be maintained to a true line without warping. Wood molding shall be mill cut and dressed on all faces. Unless otherwise provided herein or shown on the plans, forms shall be filleted at all sharp corners and edges with triangular chamfer strips measuring 20 millimeters on the sides.

Except at structures where railing is to be attached, culvert headwall heights shall be adjusted as necessary to provide a maximum projection of 75 millimeters above the roadway slope unless otherwise directed by the Engineer. At the entrance of all box culverts, a 75 millimeter chamfer shall be provided along the bottom edge of the top slab. Reinforcing steel shall be adjusted as necessary to provide a minimum 30 millimeter clear cover.

No changes will be made in quantities and no additional compensation will be allowed for this work.

All forms shall be constructed to permit their removal without marring or damaging the concrete. The forms may be given a slight draft to permit ease of removal.

Metal form ties of an approved type or a satisfactory substitute shall be used to hold forms in place and shall be of a type that permits ease of removal of the metal as hereinafter specified.

All metal appliances used inside of forms for alignment purposes shall be removed to a depth of at least 13 millimeters from the concrete surface. The appliances shall be made so the metal may be removed without undue chipping or spalling of the concrete, and when removed, shall leave a smooth opening in the concrete surface. Burning off of rods, bolts or ties will not be permitted.

Any wire ties used shall be cut back at least 13 millimeters from the face of the concrete.

Devices holding metal ties in place shall be capable of developing the strength of the tie and adjustable to allow for proper alignment.

Metal and wooden spreaders which are separate from the forms shall be removed entirely as the concrete is being placed.

Adequate clean-out openings shall be provided for narrow walls and other locations where access to the bottom of the forms is not readily attainable.

The facing of all forms shall be treated with bond breaking coating of such composition that would not discolor or otherwise injuriously affect the concrete surface. Care shall be exercised to prevent coating of the reinforcing steel.

(3) Metal Forms. The foregoing requirements for timber forms regarding design, mortar-tightness, filleted corners, beveled projections, bracing, alignment, removal, reuse and wetting shall also apply to metal forms, except that these will not require lining, unless specifically noted on the plans.

The thickness of form metal shall be as required to maintain the true shape without warping or bulging. All bolt and rivet heads on the facing sides shall be countersunk. Clamps, pins or other connecting devices shall be designed to hold the forms rigidly together and to allow removal without injury to the concrete. Metal forms which do not present a smooth surface or which line up improperly shall not be used. Metal shall be kept free from rust, grease or other foreign materials.

(4) Form Supports for Overhang Slabs. Form supports which transmit a horizontal force to a steel girder or beam, or to a prestressed concrete beam will be permitted, providing a satisfactory structural analysis has been made of the effect on the girder or beam and approval is granted by the Engineer.

When overhang brackets are used on prestressed concrete beam spans with slab overhangs not exceeding one (1) meter, bracing requirements shall conform to the details shown on the plans.

For spans in which the overhang exceeds one (1) meter, additional support will be required for the outside beams regardless of the type beam used. Details of the proposed support system shall be submitted by the Contractor for approval.

Holes in steel members for support of overhang brackets may be punched or drilled full size or may be torch cut to six (6) millimeters under size and reamed full size. In no case shall the holes be burned full size. The hole shall be left open unless otherwise shown on the plans. The holes shall never be filled by welding.

420.10. Placing Reinforcement. Reinforcement shall be placed as provided in Item 440, "Reinforcing Steel". Reinforcing steel supports shall not be welded to I-beams or girders or to reinforcing steel except where shown on the plans to be permissible.

Post tensioning ducts shall be placed in accordance with the approved prestressing details, and in accordance with Item 426, "Prestressing". The Contractor shall maintain all ducts free of obstructions until all post tensioning operations are complete.

420.11. Placing Concrete-General. The Contractor shall give the Engineer sufficient advance notice before placing concrete in any unit of the

structure to permit the inspection of forms, reinforcing steel placement and other preparations.

The sequence of placing concrete shall be as shown on the plans or as required herein.

Concrete placement will not be permitted when impending weather conditions would impair the quality of the finished work. If conditions of wind, humidity, and temperature are such that concrete cannot be placed without cracking, concrete placement shall be done in the early morning or at night. When concrete mixing, placing, and finishing is done in other than daylight hours, provisions shall be made to adequately light the entire placement site. The Engineer will approve the adequacy of such lighting before operations are begun.

Where work has been started and changes in weather conditions require protective measures, the Contractor shall furnish adequate shelter to protect the concrete against damage from rainfall, or from freezing temperatures as outlined in Article 420.12. If necessary to continue operations during rainfall, the Contractor shall also provide protective coverings for the material stockpiles. Aggregate stockpiles need to be covered only to the extent necessary to control the moisture conditions in the aggregates.

After concrete has achieved initial set, at least one (1) curing day shall elapse before placing strain on projecting reinforcement in order to prevent damage to the concrete.

(1) Placing Temperature. The temperature of all concrete at the time of placement shall be not less than 10 °C.

The temperature of cast-in-place concrete in bridge slabs and top slabs of direct traffic structures shall not exceed 29 °C when placed. Concrete diaframs, parapets, concrete portions of railing, curbs, and sidewalks, unless monolithically placed with the slab, will not be subject to the above maximum. Other portions of structures, when shown on the plans, shall require the temperature control specified.

For mass concrete placements, as defined in Subarticle 420.11 (10), the concrete temperature at the time of placement shall not exceed 24 °C.

(2) Transporting Time. The maximum time interval between the addition of cement to the batch and the placing of concrete in the forms shall conform to the requirements in Table 1.

Table 1
Temperature-Time Requirements

Concrete Temp (at point of placement)	Max Time (No Retarding Agent) Minutes	Max Time(1) (With Retarding Agent) Minutes
	Non-Agitated Concrete	
Above 27 °C	15	30
27 °C and Below	30	45
	Agitated Concrete	
Above 32 °C	45	75
Above 24 °C thru 32 °C	60	90
24 °C and Below	90	120

(1) Normal dosage of retarder

(3) Transporting Equipment. The method and equipment used to transport concrete to the forms shall be capable of maintaining the rate of placement shown on the plans or required by the Engineer. Concrete may be transported by buckets, chutes, buggies, belt conveyors, pumps or other methods.

When belt conveyors or pumps are used, sampling for testing should be done at the discharge end. When in the opinion of the Engineer, it is deemed impractical to sample at the discharge end, sampling may be done at the mixer provided that correlation testing is performed and documented to ensure specification requirements are met at the discharge end.

Concrete transported by conveyors shall be protected from sun and wind, if necessary, to prevent loss of slump and workability. Pipes through which concrete is pumped shall be shaded and/or wrapped with wet burlap, if necessary, to prevent loss of slump and workability. Concrete shall not

be transported through aluminum pipes, tubes, or other aluminum equipment.

Pump lines shall conform to the following:

For Grade 2 coarse aggregate and smaller, the minimum size pump line shall be 125 millimeters ID.

For Grade 1 coarse aggregate, the minimum size pump line shall be 200 millimeters ID.

Chutes, troughs, conveyors or pipes shall be arranged and used so that the concrete ingredients will not be separated. When necessary to prevent segregation, such equipment shall terminate in vertical down-spouts. Open troughs and chutes shall extend, if necessary, down inside the forms or through holes left in the forms.

All transporting equipment shall be kept clean and free from hardened concrete coatings. Water used for cleaning shall be discharged clear of the concrete.

(4) Forms. Openings in forms shall be provided, if needed, for the removal of laitance or foreign matter.

All forms, prestressed concrete panels, T-beams, and concrete box beams on which concrete is to be placed shall be wetted thoroughly prior to placing concrete thereon. Any remaining puddles of excess water shall be removed. The top of such members shall be in a moist surface dry condition when concrete is placed on them.

(5) Handling, Placing, and Consolidation. The method of handling, placing, and consolidation of concrete shall minimize segregation of the concrete and displacement of the reinforcement. A uniform dense compact mass shall be produced.

(a) Handling and Placing. Concrete shall not have a free fall of more than 1.5 meters, except in the case of thin walls such as in culverts or as specified in other items. Any hardened concrete splatter ahead of the plastic concrete shall be removed.

Each part of the forms shall be filled by depositing concrete as near its final position as possible. Depositing large quantities at one point and running or working the concrete along the forms will not be allowed.

Concrete shall be deposited in the forms in layers of suitable depth but not more than 900 millimeters in thickness, unless otherwise directed by the Engineer.

Cold joints in a monolithic placement shall be avoided. The sequence of successive layers or adjacent portions of concrete shall be such that they can be vibrated into a homogeneous mass with the previously placed concrete. Not more than one (1) hour shall elapse between adjacent or successive placements of concrete, except as otherwise required by an approved placing procedure when revibration of the concrete is shown on the plans or specifications. This time requirement may be extended by 1/2 hour when the concrete contains not less than a normal dosage of retarding admixture.

An approved retarding agent shall be used to control stress cracks and/or cold joints in placements where differential settlement and/or setting time may induce stress cracking.

(b) Consolidation. All concrete shall be well consolidated and the mortar flushed to the form surfaces with immersion type vibrators. Vibrators which operate by attachment to forms or reinforcement will not be permitted, except on steel forms. At least one (1) stand-by vibrator shall be provided for emergency use in addition to those required for placement.

The concrete shall be vibrated immediately after deposit. A systematic spacing of the points of vibration shall be established to insure complete consolidation and thorough working of the concrete around the reinforcement, embedded fixtures, and into the corners and angles of the forms. The vibrator may be inserted in a sloping or horizontal position in shallow slabs. The entire depth of each lift shall be vibrated, allowing the vibrator to penetrate approximately 100 millimeters into the preceding lift. Concrete along construction joints shall be thoroughly consolidated by operating the vibrator along and close to but not against the joint surface. The vibration shall continue until thorough consolidation and complete embedment of reinforcement and fixtures is produced, but not long enough to cause segregation. Vibration may be supplemented by hand spading or rodding, if necessary, to insure the flushing of mortar to the surface of all forms.

(6) Slabs. Unless otherwise shown on the plans or other specifications, slab concrete shall be mixed in a plant located off the structure. Carting or wheeling concrete batches over completed slabs will not be permitted until the slabs have aged at least four (4) full curing days. For the remainder of the curing period, timber planking will be required for carting of the concrete. Carts shall be equipped with pneumatic tires. Curing operations shall not be interrupted for the purpose of wheeling concrete over finished slabs.

The storing of reinforcing or structural steel on completed roadway slabs generally shall be avoided and, when permitted, shall be limited to quantities and distribution that will not induce excessive stresses.

A longitudinal screed may be placed directly on previously placed concrete slabs for the purpose of checking and grading of an adjacent slab after the previously placed slab has aged not less than 24 hours. Actual screeding may be done after the previously placed slabs have aged at least 48 hours.

(7) Continuous Placements. For continuous placement of the deck on steel units, the initial set of the concrete shall be retarded sufficiently to insure that the concrete remains plastic in not less than three (3) spans immediately preceding the slab being placed. For simple spans, retardation shall be required only if necessary to complete finishing operations or as required by Article 420.13.

(8) Fogging and Interim Curing. From the time of initial strike off of the concrete until finishing is completed and required interim curing is in place, the unformed surfaces of slab concrete in bridge decks and top slabs of direct traffic culverts shall be fogged when necessary to replace water loss due to evaporation.

Fogging equipment shall be capable of applying water in a fine mist, not a spray. The fog shall be produced using equipment which pumps water or water and air under high pressure through a suitable atomizing nozzle. The equipment shall be hand operated and sufficiently portable for use in the direction of any prevailing wind. It shall be adaptable for intermittent use as directed by the Engineer to prevent excessive wetting of the concrete.

Interim curing will be required for slab concrete in bridge decks and top slabs of the direct traffic culverts immediately upon completion of final finish. Type 1-D membrane curing compound (Resin Base Only) will be required. Water curing will be required in accordance with Article 420.20 and shall be commenced as soon as possible without damaging the surface finish.

(9) Installation of Dowels and Anchor Bolts. Dowels and anchor bolts may be cast-in-place or installed by grouting with grout, epoxy or epoxy mortar. Holes for grouting may be formed or drilled.

(a) General. Holes for anchor bolts shall accommodate the bolt embedment required by the plans. Holes for dowels shall be a minimum of 300 millimeters deep unless otherwise shown on the plans. When grout or epoxy mortar is used, the diameter of the hole shall be not less than twice the dowel or bolt diameter nor more than the diameter plus 38 millimeters. When using epoxy, the hole diameter shall be two (2) millimeters to six (6) millimeters greater than the dowel or bolt diameter.

Holes shall be thoroughly cleaned of all loose material, oil, grease, or other bond breaking substance and blown clean with filtered compressed air. Holes shall be in a surface dry condition when epoxy type material is used. Holes shall be in a surface moist condition when portland cement grout is used. The Contractor shall develop and demonstrate a procedure for cleaning and preparing the holes for installation of the dowels and anchor bolts that is satisfactory to the Engineer. The void between the hole and dowel or bolt shall be completely filled with grouting material.

(b) Cast-in-Place or Grouted Systems. Portland cement grout, epoxy, epoxy mortar, or other prepackaged grouts as approved by the Engineer may be used.

Portland cement grout shall conform to the pertinent provisions of Item 421, "Portland Cement Concrete". Epoxy (Type V) and Epoxy Mortar (Type VIII) shall conform to Item 575, "Epoxy". Grout, epoxy or epoxy mortar may be used as the binding agent unless otherwise indicated on the plans.

(c) Other Anchor Systems. These systems shall be in accordance with the plans and approved by the Engineer.

(10) Mass Placements. Unless otherwise shown on the plans, for monolithic mass placements having a least dimension greater than 1.5 meters, the Contractor shall develop a plan to assure that during the heat dissipation period, the temperature differential between the central core of the placement and the exposed concrete surface does not exceed 20 °C.

A detailed plan, along with an analysis of the associated heat generation and dissipation (heat flow analysis) shall be submitted to the Engineer for approval. No concrete shall be placed until this plan is approved.

This plan may include a combination of the following:

1. Selection of concrete ingredients to minimize heat of hydration.
2. Using ice or cooling concrete ingredients.
3. Controlling rate of concrete placement.
4. Using insulation to control heat loss.
5. Using supplemental heat to control heat loss.
6. Use of fly ash.

The Contractor shall furnish and install two (2) sets of strip chart temperature recording devices or approved equivalent at locations designated by the Engineer. These devices shall be accurate to within +/- 1 °C within the range of 0 °C to 100 °C and shall be used to simultaneously measure the temperature of the concrete at the core and the surface.

420.12. Placing Concrete in Cold Weather. The Contractor is responsible for the protection of concrete placed under any and all weather conditions. Permission given by the Engineer for placing during cold weather will not relieve the Contractor of the responsibility for producing concrete equal in quality to that placed under normal conditions. Should concrete placed under such conditions prove unsatisfactory, it shall be removed and replaced.

Concrete may be placed only when the atmospheric temperature is greater than 2 °C. Concrete shall not be placed in contact with any material coated with frost or having a temperature less than 0 °C.

Aggregates shall be free from ice, frost and frozen lumps. When required, in order to produce the minimum specified concrete temperature,

the aggregate and/or the water shall be heated uniformly, in accordance with the following:

The water temperature shall not exceed 82 °C, nor shall the aggregate temperature exceed 66 °C. The heating apparatus shall heat the mass of aggregate uniformly. The temperature of the mixture of aggregates and water shall be between 10 °C and 29 °C before introduction of the cement.

The Contractor shall provide and install recording thermometer(s) or other suitable temperature measuring device(s) to verify that all concrete is effectively protected as follows:

(a) The temperature of all unformed surfaces of bridge decks and top slabs of direct traffic culverts shall be maintained at 10 °C or above for a period of 72 hours from time of placement and above 4 °C for an additional 72 hours.

(b) The temperature at the surface of all concrete in bents, piers, culvert walls, retaining walls, parapets, wingwalls, bottom of slabs, and other similar formed concrete shall be maintained at 4 °C or above for a period of 72 hours from time of placement.

(c) The temperature of all concrete, including the bottom slabs (footings) of culverts placed on or in the ground, shall be maintained above 0 °C for a period of 72 hours from time of placement.

Protection shall consist of providing additional covering, insulated forms or other means, and if necessary, supplementing such covering with artificial heating. Curing as specified under Article 420.20 shall be provided during this period until all requirements for curing have been satisfied.

When impending weather conditions indicate the possibility of the need for such temperature protection, all necessary heating and covering material shall be on hand and ready for use before permission is granted to begin placement.

Sufficient extra test specimens will be made and cured with the placement to ascertain the condition of the concrete as placed prior to form removal and acceptance.

420.13. Placing Concrete in Hot Weather. Unless otherwise directed by the Engineer, when the temperature of the air is above 29 °C, an approved retarding agent will be required in all concrete used in superstructures and top slabs of direct traffic culverts.

420.14. Placing Concrete in Water. Concrete shall be deposited in water only when shown on the plans or with the written permission of the Engineer. The forms or cofferdams shall be sufficiently tight to prevent any water current passing through the space in which the concrete is being deposited. Pumping of water will not be permitted during the concrete placing, nor until it has set for at least 36 hours.

The concrete shall be placed with a tremie, or other approved method, and shall not be permitted to fall freely through the water nor shall the concrete be disturbed after being placed. The concrete surface shall be kept approximately level during placement.

The tremie shall consist of a water-tight tube of a diameter which will permit adequate placement of the concrete, but not greater than 355 millimeters. The tremie shall be constructed so that the bottom can be sealed and opened after the tremie is in place and fully charged with concrete. The tremie shall be supported so that it can be easily moved horizontally to cover all the work area and vertically to control the concrete flow. The lower end of the tremie shall be submerged in the concrete at all times.

The placing operations shall be continuous until the work is complete.

Unless otherwise specified, all classes of concrete placed under water, except Class E and Class SS, shall be redesigned to contain an additional 60 kilograms of cement per cubic meter more than the mix design being used. Pilot beam tests may be waived by the Engineer for this redesign.

420.15. Placing Concrete in Superstructure. Unless otherwise shown on the plans, simple span bridge slabs shall be placed without transverse construction joints by using either a mechanical longitudinal screed or a self propelled transverse finishing machine. For small placements or for unusual conditions, the Engineer may waive the mechanical screed requirement and permit the use of manually operated screeding equipment. The screed shall be adequately supported on a header

or rail system sufficiently stable to withstand the longitudinal or lateral thrust of the equipment. Unless otherwise shown on the plans, temporary intermediate

headers will be permitted for placements exceeding 15 meters in length for the longitudinal screed, provided the rate of placement is rapid enough to prevent a cold joint and that these headers are designed for early removal to permit satisfactory consolidation and finish of the concrete at their locations.

Unless otherwise shown on the plans, slabs on continuous units shall be placed in one continuous operation without transverse construction joints using a mechanical longitudinal screed or a self propelled transverse finishing machine. For unusual conditions, such as widening, variable cross slopes or transitions, the Engineer may waive the mechanical screed requirement and permit the use of manually operated screeding equipment. Rails for transverse finishing machines which are supported from the beams or girders shall be installed so that the supports may be removed without damage to the slab. Bond between removable supports and the concrete shall be prevented in a manner acceptable to the Engineer. Rail support parts which remain embedded in the slab shall not project above the upper mat of reinforcing steel. Rail or screed supports attached to I-beams or girders shall be subject to the requirements of Article 420.3.

Unless otherwise shown on the plans, for transverse screeding, the minimum rate of concrete placement shall be nine (9) meters of bridge deck per hour. The Contractor shall furnish personnel and equipment capable of placing, finishing and curing the slab at an acceptable rate to insure compliance with the specifications.

The profile gradeline may require adjustment, due to variation in beam camber and other factors, to obtain the required cover over the slab reinforcement. Beams shall be set in a sufficient number of spans so that when adjustment is necessary, the profile gradeline can be adjusted over suitable increments and the revised gradeline will produce a smooth riding surface.

One (1) or more passes shall be made with the screed over the bridge deck segment prior to the placement of concrete thereon to insure proper operation and maintenance of grades and clearances.

Slab concrete shall be deposited between the exterior beam and the adjacent beam prior to placing concrete in the overhang portion of the slab.

For transverse screeding, concrete shall be placed in transverse strips. Additionally, on profile grades greater than 1 1/2 percent, placement shall begin at the lowest end.

For longitudinal screeding, concrete shall be placed in longitudinal strips starting at a point in the center of the segment adjacent to one side, except as provided herein, and the strip completed by placing uniformly in both directions toward the ends, except that for spans on a grade of 1 1/2 percent or more placing shall start at the lowest end.

The width of strips shall be such that the concrete therein will remain plastic until the adjacent strip is placed. Where monolithic curb construction is specified, the concrete shall be placed therein in proper sequence to be monolithic with the adjacent longitudinal strips of the slabs.

An approved system of checking shall be used to detect any vertical movement of the forms or falsework. Forms for the bottom surface of concrete slabs, girders and overhangs shall be maintained to the required vertical alignment during concrete placing.

Unless otherwise shown on the plans, girders, slab and curbs of slab and girder spans shall be placed monolithically. Concrete girder stems shall be filled first and the slab concrete placed within the time limits specified in Article 420.11.

Construction joints, when permitted for slab placements on steel and prestressed concrete beams, shall be as shown on the plans. Where plans permit segmental placing without specifying a particular order of placement, any logical placing sequence which will not result in the overstressing of any of the supporting members will be permitted subject to the approval of the Engineer.

Any falsework under steel girder or truss spans shall be released and the spans swung free on their permanent supports before placing any slab concrete thereon.

When the curb forms are filled, the top of curb and sidewalk section shall be brought to the correct camber and alignment and finished as described in Articles 420.18 and 420.23.

420.16. Placing Concrete in Box Culverts. Where the top slab and walls are placed monolithically in culverts more than 1.2 meters in clear height, an interval of not less than one (1) nor more than two (2) hours shall elapse before placing the top slab to allow for settlement and shrinkage in the wall concrete.

The footing slab shall be accurately finished at the proper time to provide a smooth uniform surface. Top slabs which carry direct traffic shall be finished as specified in Article 420.19. Top slabs of fill type culverts shall be given a float finish.

420.17. Placing Concrete in Foundation and Substructure. Concrete shall not be placed in footings until the depth and character of the foundation has been inspected by the Engineer and permission has been given to proceed.

Placing of concrete footings upon seal concrete will be permitted after the cofferdams are free from water and the seal concrete cleaned. Any necessary pumping or bailing during the concreting operation shall be done from a suitable sump located outside the forms.

All temporary wales or braces inside cofferdams shall be constructed or adjusted as the work proceeds to prevent unauthorized construction joints.

When footings can be placed in a dry excavation without the use of cofferdams, forms may be omitted, if approved by the Engineer, and the entire excavation filled with concrete to the elevation of the top of footing. In this case, measurement for payment will be based on the footing dimensions shown on the plans.

Concrete in columns shall be placed monolithically between construction joints unless otherwise provided. Columns and caps and/or tie beams supported thereon may be placed in the same operation. To allow for settlement and shrinkage of the column concrete, it shall be placed to the lower level of the cap or tie beam and placement delayed for not less than one (1) hour nor more than two (2) before proceeding.

420.18. Treatment and Finishing of Horizontal Surfaces Except Roadway Slabs. All unformed upper surfaces shall be struck off to grade

and finished. The use of mortar topping for surfaces under this classification will not be permitted.

After the concrete has been struck off, the surface shall be floated with a suitable float. Bridge sidewalks shall be given a wood float or broom finish or may be striped with a brush, as specified by the Engineer.

The tops of caps and piers between bearing areas shall be sloped slightly from the center toward the edge, and the tops of abutments and transition bents sloped from the backwall to the edge, as directed by the Engineer, so that the water drains from the surface. The concrete shall be given a smooth trowel finish. When shown on the plans, the top of caps and piers shall be coated with Type X epoxy material except for areas under shoes and bearing pads. Unless otherwise shown on the plans, the color shall be concrete gray. The color of the epoxy may be adjusted to concrete gray by the use of a black universal type tinting paste. Bearing areas for steel units shall be constructed in accordance with Item 441, "Steel Structures".

Bearing seat build-ups or pedestals for concrete units may be cast integrally with the cap or with a construction joint as follows:

The bearing seat build-ups shall be constructed of a latex based mortar or an epoxy mortar, mixed in accordance with the manufacturer's recommendation. Pedestals shall be constructed of Class "C" concrete, reinforced as shown on the plans.

Bearing areas under elastomeric pads or non-reinforced bearing seat build-ups shall be given a textured, wood float finish.

420.19. Finish of Roadway Slabs. In all roadway slab finishing operations, camber for specified vertical curvature and transverse slopes shall be provided.

For concrete slab or concrete slab girder spans cast in place on falsework, an additional amount of camber shall be provided to offset the initial and final deflections of the span. The additional amount of camber shall be determined from the dead load deflection diagram shown on the plans. When dead load deflection is not shown on the plans, the additional amount of camber shall be one (1) millimeter per one (1) meter of span length but not to exceed 13 millimeters. For pan girder spans the additional camber for initial and final deflections shall be approximately 13 millimeters for 9.1 meter spans and 16 millimeters for 12.2 meter spans unless otherwise directed by the Engineer.

Roadway slabs supported on prestressed concrete, steel beams or girders shall receive no additional camber, except that for slabs without vertical curvature, the longitudinal camber shall be approximately six (6) millimeters.

Dead load deflection shall be taken into account in setting the grades of headers and rail systems.

Work bridges or other suitable facilities shall be provided by the Contractor from which to perform all finishing operations and check measurements for slab thickness and reinforcement cover.

As soon as the concrete has been placed and vibrated in a section of sufficient width to permit working, the surface shall be approximately leveled, struck off and screeded, carrying a slight excess of concrete ahead of the screed to insure filling of all low spots. The screed shall be rigid enough to hold true to shape and shall have sufficient adjustments to provide for the required camber or section. A vibrating screed may be used if heavy enough to prevent undue distortion. The screeds, except those of the roller drum type, shall be provided with metal cutting edges.

Longitudinal screeds shall be moved across the concrete with a saw-like motion while their ends rest on headers or templates set true to the roadway grade or on the adjacent finished slab.

The surface of the concrete shall be screeded a sufficient number of times and at such intervals to produce a uniform surface, true to grade and free of voids.

If necessary, the screeded surface shall be worked to a smooth finish with

a long handled wood or metal float, or hand floated from bridges over the slab.

When required by the Engineer, the Contractor shall perform sufficient checks with a long handled 3-meter straightedge on the plastic concrete to insure that the final surface will be within the tolerances specified below. The check shall be made with the straightedge parallel to the centerline. Each pass thereof shall lap half of the preceding pass. All high spots shall be removed and all depressions over two (2) millimeters in depth shall be filled with fresh concrete and floated. The checking and floating shall be continued until the surface is true to grade and free of depressions, high spots, voids or rough spots.

Rail support holes shall be filled with concrete and finished to match the top of the slab.

Unless otherwise shown on the plans, when no additional wearing course is to be placed, the bridge deck surface shall be given a grooved steel tine finish. The grooves shall be approximately three (3) millimeters to five (5) millimeters deep, approximately three (3) millimeters wide. The tines shall be randomly spaced approximately 20 to 25 millimeters apart. The grooves shall run perpendicular to the structure center line when a transverse screed is used and parallel to the structure centerline when a longitudinal screed is used. Areas which receive insufficient texture depth shall receive additional texturing, when directed by the Engineer, by saw grooving in accordance with the procedure given below.

At the option of the Contractor, or when shown on the plans, the surface shall be given its final texture by saw grooving to meet the above requirements. Saw grooving may be done a minimum of four (4) days after the slab concrete has been placed. If saw grooving is done prior to the completion of curing, the curing shall be continued after sawing to provide the minimum curing time required.

When shown on the plans that a concrete overlay is to be placed on the slab (new construction) or on prestressed concrete box beams or other precast elements, the slab or the top surface of shear key and diafram concrete shall be given a broom finish. The finish shall have an average texture depth of approximately 0.9 millimeter with any individual test, not falling below 0.5 millimeter unless otherwise shown on the plans, when tested in accordance with Test Method Tex-436-A. Should the texture depth

fall below that intended, the finishing procedures shall be revised to produce the desired texture.

When the plans require that an asphaltic seal, with or without overlay, on the slab (new construction), on prestressed concrete box beams or other precast

elements, the slab or top surface of shear key and diafram concrete shall be given a lightly textured broom finish having an average texture depth of approximately 0.6 millimeter when tested in accordance with Test Method Tex-436-A.

Straightedge requirements will be required on slabs (new construction) to be overlaid.

After the concrete slab has attained final set, the Engineer may require that the finished surface be tested with a standard 3-meter straightedge. The straightedge shall be used parallel to the centerline of the structure to bridge any depressions and touch high spots. Ordinates of the irregularities, measured from the face of the straightedge to the surface of the slab, should normally not exceed three (3) millimeters, making proper allowances for camber, vertical curve and surface texture; however, occasional variations exceeding this will be acceptable if, in the opinion of the Engineer, the variations will not produce unacceptable riding qualities.

When directed by the Engineer, irregularities exceeding the above shall be corrected. Areas which are corrected to produce satisfactory riding qualities shall be provided with an acceptable surface texture in a manner approved by the Engineer.

420.20. Curing Concrete. The Contractor shall inform the Engineer of the methods proposed for curing; shall provide the proper equipment and material in adequate amounts; and shall have the proposed methods, equipment and material approved prior to placing concrete.

Unless otherwise noted herein or shown on the plans, the choice of curing methods shall be at the option of the Contractor, except that the Engineer may require the same curing methods for like portions of a single structure.

Inadequate curing and/or facilities shall be cause for the Engineer to delay all concrete placement on the job until remedial action is taken.

All concrete shall be cured for a period of four (4) curing days except as noted herein.
420.20

Table 2
EXCEPTIONS TO 4-DAY CURING

Description	Type of Cement	Required Curing Days
Upper surfaces of bridge slabs, top slab of direct traffic	I or III	8

culverts, and concrete overlays		
	II or I/II*	10
	All types with fly ash	10
Concrete Piling Build-ups	All	6

*Meets the requirements of both Type I and Type II.

When the air temperature is expected to drop below 4 °C, the concrete shall be covered with polyethylene sheeting, burlap-polyethylene blankets, mats or other acceptable materials to provide the protection required by Article 420.12.

A curing day is defined as a calendar day when the temperature, taken in the shade away from artificial heat, is above 10 °C for at least 19 hours, or on colder days if satisfactory provisions are made to maintain the temperature of all surfaces of the concrete above 4 °C for the entire 24 hours. The required curing period shall begin when all concrete therein has attained its initial set.

The following methods are permitted for curing concrete subject to the requirements of Table 3 and the following additional requirements for each method of curing:

(1) Form Curing. When forms are left in contact with the concrete, other curing methods will not be required except for exposed surfaces and for cold weather protection.

(2) Water Curing. All exposed surfaces of the concrete shall be kept wet continuously for the required curing time. The water used for curing shall meet the requirements for concrete mixing water as specified

in Item 421, "Portland Cement Concrete". Sea water will not be permitted. Water which stains or leaves an unsightly residue shall not be used.

(a) Wet Mat Curing. This curing method shall consist of keeping the concrete continuously wet by maintaining wet cotton mats in direct contact with the concrete for the required curing time. Damp burlap blankets made from 250 grams stock may be placed on the damp concrete surface for temporary protection prior to the application of cotton mats. The cotton mats may then be placed dry and wetted down immediately after they are placed. The mats shall be weighted down adequately to provide continuous contact with all concrete where possible.

Surfaces which cannot be cured by direct contact shall be covered with mats forming an enclosure well anchored to the forms or ground so that outside air cannot enter the enclosure. Sufficient moisture shall be provided inside the enclosure to keep all surfaces of the concrete wet. Wet mat curing will be required for Part A in Table 3 when the anticipated ambient temperature is expected to remain above 4 °C for the first 72 hours of the curing period.

Polyethylene sheeting, burlap-polyethylene blankets, laminated mats or insulating curing mats placed in direct contact with the slab will be required when the air temperature is expected to drop below 4 °C during the first 72 hours of the curing period. These curing materials shall be weighted down with dry mats to maintain direct contact with the concrete and to provide insulation against cold weather. Supplemental heating or insulation may be required in cold and/or wet weather if the insulating cotton mats become wet or if the concrete drops below the specified curing temperature.

(b) Water Spray. This curing method shall consist of overlapping sprays or sprinklers that keep all unformed surfaces continuously wet.

(c) Ponding. This curing method requires the covering of the surfaces with a minimum of 50 millimeters of clean granular material, kept wet at all times, or a minimum of 25 millimeters depth of water. Satisfactory provisions shall be made to provide a dam to retain the water or saturated granular material.

(3) Membrane Curing. Unless otherwise provided herein or shown on the plans, either Type 1-D or Type 2 membrane curing compound may

be used where membrane curing is permitted except that Type 1-D (Resin Base Only) will be required for bridge slabs and top slabs of direct traffic culverts and all other surfaces which may require a higher grade of surface finish.

Table 3
CURING REQUIREMENTS

STRUCTURE UNIT DESCRIPTION	REQUIRED		PERMITTED	
	Water for Complete Curing	Membrane for Interim Curing	Water for Complete Curing	Membrane for Complete Curing
A. Upper surfaces of Bridge Roadway, Median and Sidewalk slabs, Top Slabs of Direct Traffic Culverts.	X	X (Resin Base)		
B. Top Surface of any Concrete Unit upon which Concrete is to be placed and bonded at a later interval (Stub Walls, Risers, etc.). Other Super structure Concrete (Curbs Wingwalls, Parapet Walls, etc.).	X			
C. All Substructure Concrete, Culverts, Box Sewers, Inlets, Manholes, Retaining Walls, Riprap, Railing			*X	*X
All other concrete	As specified in other items.			

*Polyethylene Sheeting, Burlap-Polyethylene Mats or Laminated Mats in close intimate contact with the concrete surfaces will be considered equivalent to water or membrane curing.

420.21

For substructure concrete only one (1) type of curing compound will be permitted on any one (1) structure. Material requirements and construction methods shall be as required by Item 526, "Membrane Curing", except as changed herein.

Membrane curing shall not be applied to dry surfaces, but shall be

applied just after free moisture has disappeared. Formed surfaces and surfaces which have been given a first rub shall be dampened and shall be moist at the time of application of the membrane.

When membrane is used for complete curing, the film shall remain unbroken for the minimum curing period specified. Membrane which is damaged shall be corrected immediately by reapplication of membrane. Unless otherwise noted herein or shown on the plans, the choice of membrane type shall be at the option of the Contractor.

420.21. Removal of Forms and Falsework. Except as herein provided, forms for vertical surfaces may be removed when the concrete has aged not less than 12 hours, provided the removal can be done without damage to the concrete.

Forms for inside curb faces may be removed at such time the removal can be done without damage to the curb.

Mass supporting forms and falsework for all bridge components and culvert slabs, except as noted herein, shall remain in place a minimum of four (4) curing days. The forms then may be removed if the concrete has attained a flexural strength of 2930 kilopascal, as evidenced by strength tests using test beams made from the same concrete and cured under the same conditions as the portion of the structure involved. Forms for other structural components may be removed as specified by the Engineer.

Inside forms (walls and top slabs) for box culverts and sewers may be removed after concrete has aged not less than one (1) day (24 hrs.) and has acquired a flexural strength of not less than 1760 kilopascal, provided an overhead support system, approved by the Engineer, is used to transfer the mass of the top slab to the walls of the box culvert or sewer before the support provided by the forms is removed.

When all test beams made for the purpose of form removal have been broken without attaining the required strength, forms shall remain in place for a total of 14 curing days.

The above provisions relative to form removal shall apply only to forms or parts thereof which are constructed to permit removal without disturbing forms or falsework required to be left in place for a longer period on other portions of the structure.

All forms and falsework shall be removed unless otherwise approved by the Engineer.

420.22. Defective Work. Any defective work shall be repaired as soon as possible.

Any defect which in the opinion of the Engineer cannot be repaired satisfactorily to the extent required by the Engineer shall be removed and replaced at the expense of the Contractor.

420.23. Finishing Exposed Surfaces. A Surface Finish shall be applied to all concrete surfaces and shall be in accordance with Item 427, "Surface Finishes for Concrete".

420.24. Measurement. The quantities of concrete of the various classifications which will constitute the completed and accepted structure or structures in place will be measured by the cubic meter, each, square meter, or meter as shown on the plans. Measurement will be as follows:

(1) General.

(a) All concrete quantities will be based on the dimensions shown on the plans or those established in writing by the Engineer. Diafram concrete, when required, will be included in the slab measurement.

(b) In determining quantities, no deductions will be made for chamfers less than 50 millimeters, embedded portions of structural steel or prestressed concrete beams, piling, anchor bolts, reinforcing steel, drains, weep holes, junction boxes, electrical or telephone conduit, conduit and/or voids for prestressed tendons or for embedded portions of light fixtures.

(c) For pan girder spans, a quantity will be included for the screed setting required to provide proper camber in the roadway surface after form removal.

(d) For slabs on steel and prestressed beams, a quantity for the haunch between the slab and beams will be included when required. No measurement will be made during construction for variation in the amount of haunch concrete due to deviation from design camber in the beams.

(e) For slabs on panels, T-beams, or box beams, the combination of span length, theoretical camber in beams, computed deflections, and plan vertical curve will be taken into account in determining the quantity for the slab.

Additional concrete which may be required by an adjustment of the profile grade line during construction, to insure proper slab thickness, will not be measured for payment.

(f) Variation in concrete headwall quantity incurred when an alternate bid for pipe is permitted will not be measured for payment.

(g) Quantities revised by a change in design, measured as specified herein, will be increased or decreased, as the case may be, and included for payment.

(2) Plan Quantity. For structure elements designated in Table 4, and when measured by the cubic meter, this is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

When the quantity for a complete structure element has been erroneously included or omitted from the plans, the quantity shown on the plans for that element will be added to or deducted from the plan quantity and included for payment. A complete structure element will be the smallest portion of a total structure for which a quantity is included on the plans.

When the plan quantity for a complete structure element is in error by five (5) percent or more, a recalculation will be made and the corrected quantity included for payment.

(3) Measured in Place. For those Items not measured for plan quantity payment, measurement will be made in place.

Table 4
PLAN QUANTITY PAYMENT
(Cubic Meter Measurement Only)

Culverts and WingwallsSlabs on Steel Spans
Headwalls for pipeSlabs on Prestressed Spans
Retaining WallsPan Girder Spans
Inlets and ManholesPile Bent Caps
Slab SpansShear Key Concrete
Slab and Girder SpansAbutments

Note: Other structure elements may be paid for as "plan quantity", including pier and bent concrete, when shown on the plans.

For those portions of structures not listed in Table 4, the concrete quantities, measured as provided in Subarticle 420.24.(1) will be paid for at the unit price bid per "Cubic Meter", per "Each", per "Square Meter", or per "Meter", in place, for the various classifications of concrete shown.

420.25. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for the various structure elements specified of the various classes of concrete. This price shall be full compensation for furnishing, hauling and mixing all concrete materials; for furnishing, bending, fabricating, splicing, welding and placing the required reinforcement; for all clips, blocks, metal spacers, ties, wire or other materials used for fastening reinforcement in place; for placing, finishing and curing all concrete; for all grouting and pointing; for furnishing and placing drains; for furnishing and placing metal flashing strips; for furnishing and placing expansion-joint material required by this Item; and for all forms and falsework, labor, tools, equipment and incidentals necessary to complete the work.

Concrete which fails to meet minimum strength requirements may be rejected or a structural review may be made by the Engineer. Such concrete which is proven structurally adequate may be accepted at an adjusted price based on the following formula:

$A = 0.10Bp + 0.75(Sa/Ss)^2 Bp$
A = Amount to be paid per unit of measure
Sa = Actual strength from beams or cores.
Ss = Minimum required strength (specified)
Bp = Unit bid price

ITEM 421

PORTLAND CEMENT CONCRETE

421.1. Description. This Item shall govern for portland cement concrete to be used in concrete pavement, concrete structures and other concrete construction.

421.2. Materials. The concrete shall be composed of portland cement, (with or without) fly ash, fine and coarse aggregates and water.

(1) Cement. Portland cement shall conform to Item 524, "Hydraulic Cement".

Unless otherwise shown on the plans or in the specifications, the cement shall be either Type I, IP, II or III portland cement except as follows:

a. Type III cement shall not be used when the anticipated air temperature for the succeeding 12 hours will exceed 15 °C.

b. Type III cement may be used, regardless of air temperature, in all precast concrete.

All cement used in a monolithic placement shall be of the same type.

Type I/II cement may be considered as either Type I or Type II cement except as otherwise noted.

Type IP cement may be used in lieu of Type I or Type II cement except when otherwise required by the plans or specifications. When Type IP cement is used, additional fly ash will not be permitted.

(2) Fly Ash. Fly ash shall conform to the requirements of Departmental Materials Specification D-9-8900. Copies of Departmental Materials Specifications are available from the Texas Department of Transportation, Materials and Tests Division, 125 East 11th Street, Austin, Texas 78701-2483.

When fly ash is used, "cement" shall be defined as "cement plus fly ash". "Cement plus fly ash" shall be composed of Type I, II or III portland cement and 20 to 35 percent fly ash by absolute volume, except that for classes of concrete which are specified to have less than 280 kilograms of portland cement per cubic meter, the fly ash replacement of cement shall not exceed 25 percent by absolute volume of the specified cement content. The Contractor has the option of using "cement plus fly ash" as defined herein for all classes of concrete except that Type B fly ash shall not be used when Type II cement is required, and no fly ash is permitted when a white portland cement is required.

(3) Mixing Water. Water for use in concrete and for curing shall be free from oils, acids, organic matter or other deleterious substances and shall not contain more than 1000 parts per million of chlorides as Cl nor more than 1000 parts per million of sulfates as SO_4.

Water from municipal supplies approved by the State Health Department will not require testing, but water from other sources will be sampled and tested before use in concrete. Tests shall be made in accordance with AASHTO T26. A sample of approximately four (4) liters shall be submitted to the Texas Department of Transportation, Materials and Tests Division, 3800 Jackson Ave., Bldg. No. 5, Austin, Texas 78731-6033.

Water used in white portland cement concrete shall be free from iron and other impurities which may cause staining or discoloration.

(4) Coarse Aggregate. Coarse aggregate shall be washed and shall consist of durable particles of gravel, crushed blast furnace slag, crushed stone, or combinations thereof and shall be free from frozen material or injurious amounts of salt, alkali, vegetable matter, or other objectionable

material either free or as an adherent coating. When white portland cement is specified, the coarse aggregates used in the concrete shall be light colored. Quality shall be reasonably uniform throughout. Coarse aggregate shall not contain more than 0.25 percent by mass of clay lumps, nor more than one (1.0) percent by mass of shale, nor more than five (5.0) percent by mass of laminated and/or friable particles when tested in accordance with Test Method Tex-413-A. Coarse aggregate from each source shall have a wear of not more than 40 percent when tested in accordance with Test Method Tex-410-A.

Unless otherwise shown on the plans, coarse aggregate from each source will be subjected to five (5) cycles of both the sodium sulfate and the magnesium sulfate soundness test in accordance with Test Method Tex-411-A. When the loss is greater than 12 percent with sodium sulfate and/or 18 percent with magnesium sulfate, further testing will be required prior to acceptance or rejection of the material. A satisfactory record under similar conditions of service and exposure will be considered in the evaluation of material failing to meet these requirements.

When tested in accordance with Test Method Tex-401-A, the coarse aggregate, including combinations of aggregates when used, shall conform to the gradation requirements shown in Table 1, except as provided in Subarticle 427.8.(3) for exposed aggregate finishes.

TABLE 1

COARSE AGGREGATE GRADATION CHART

Aggregate Grade No.	Nominal Size mm	Percent Retained on Each Sieve								
		63.0 mm	50.0 mm	37.5 mm	25.0 mm	19.0 mm	12.5 mm	9.5 mm	4.75 mm	2.36 mm
1	50.0	0	0-20	15-50		60-80			95-100	
2 (467)*	37.5		0	0-5		30-65		70-90	95-100	
3	37.5		0	0-5		10-40	40-75		95-100	
4 (57)*	25.0			0	0-5		40-75		90-100	95-100
5 (67)*	19.0				0	0-10		45-80	90-100	95-100
6 (7)*	12.5					0	0-10	30-60	85-100	95-100
7	9.5						0	5-30	75-100	
8	9.5						0	0-5	35-80	90-100

*Numbers in parenthesis indicate that these gradations conform to corresponding ASTM gradation in ASTM C 33.

The loss by decantation in accordance with Test Method Tex-406-A plus the allowable mass of clay lumps, shall not exceed one (1) percent, or the value shown on the plans, whichever is smaller. In the case of aggregates made primarily from the crushing of stone, if the material finer than the 75 micrometer sieve is definitely established to be the dust of fracture, essentially free from clay or shale, as established by Part III of Test Method Tex-406-A, the percent may be increased to 1.5.

(5) Fine Aggregate. Fine aggregate shall be washed and consist of clean, hard, durable and uncoated particles of natural or manufactured sand or a combination thereof, with or without a mineral filler. When white portland cement is specified the fine aggregate used in the concrete shall be light colored. It shall be free from frozen material or injurious amounts of salt, alkali, vegetable matter or other objectionable material and it shall not contain more than 0.5 percent by mass of clay lumps. When the aggregate is subjected to the color test for organic impurities in accordance with Test Method Tex-408-A, the test result shall not show a color darker than standard.

Unless otherwise shown on the plans, the acid insoluble residue of fine aggregate used in concrete subject to direct traffic shall be not less than 60 percent by mass when tested in accordance with Test Method Tex-612-J.

When tested in accordance with Test Method Tex-401-A, the fine aggregate or combinations of aggregates, including mineral filler, shall conform to the gradation requirements shown in Table 2.

Table 2

FINE AGGREGATE GRADATION CHART

	Percent Retained on Each Sieve							
Aggregate Grade No.	9.5 mm	4.75 mm	2.36 mm	1.18 mm	600 µm	300 µm	150 µm	75 µm
1	0	0 to 5	0 to 20	15 to 50	35 to 75	65 to 90	90 to 100	97 to 100

Where manufactured sand is used in lieu of natural sand, the percent retained on the 75 micrometer sieve shall be 94 to 100.

Where the sand equivalent value is greater than 85, the retainage on the 300 micrometer sieve may be 65 to 94 percent.

Fine aggregate will be subjected to the Sand Equivalent Test (Test Method Tex-203-F). The sand equivalent shall not be less than 80 unless otherwise shown on the plans.

For all classes of concrete, except class K, the fineness modulus shall be between 2.30 and 3.10 as determined by Test Method Tex-402-A. The fineness modulus for class K shall be 2.6 to 2.8 unless otherwise shown on the plans.

(6) Mineral Filler. Mineral filler shall consist of stone dust, clean crushed sand, or other approved inert material. When tested in accordance with Test Method Tex-401-A, it shall conform to the following gradation:

Retained on 600 µm Sieve	0 percent
Retained on 75 µm Sieve	0-35 percent

(7) Admixtures. Admixtures and their use shall conform to the requirements of Item 437, "Concrete Admixtures". Calcium chloride will not be permitted.

(8) Mortar and Grout. Unless otherwise specified or approved by the Engineer, mortar and grout shall consist of one (1) part portland cement, two (2) parts finely graded sand and sufficient water to provide the desired consistency. Mortar may contain admixtures.

Post tensioning grout shall be in accordance with Item 426, "Prestressing".

Mortar shall have a consistency such that the mortar can be easily handled and spread by trowel. Grout shall have a consistency such that the grout will flow into and completely fill all voids.

When required to prevent color difference, white cement shall be added to produce the color required. When shown on the plans or in the specifications, or when required by the Engineer, latex adhesive conforming to the requirements of Departmental Material Specification D-9-8110 shall be added to the mortar.

421.3. Storage of Materials.

(1) Cement, Fly Ash and Mineral Filler. All cement, fly ash and mineral filler shall be stored in well ventilated weatherproof buildings or approved bins, which will protect them from dampness or absorption of moisture. Each shipment of packaged cement shall be kept separated to provide easy access for identification and inspection.

The Engineer may permit small quantities of sacked cement to be stored in the open on a raised platform and under waterproof covering for a maximum of 48 hours.

(2) Aggregates. The method of handling and storing concrete aggregates shall prevent contamination with foreign materials. If the aggregates are stored on the ground, the sites for the stockpiles shall be clear of all vegetation and shall be level. The bottom 150 millimeter layer of aggregate shall not be disturbed or used without recleaning.

When conditions require the use of two (2) or more sizes of aggregates, the aggregates shall be separated to prevent intermixing. Where space is limited, stockpiles shall be separated by physical barriers. Aggregates from different sources shall be stored in different stockpiles unless the aggregates are pre-blended as approved by the Engineer prior to stockpiling.

Methods of handling aggregates during stockpiling and their subsequent use shall be such that segregation will be minimized. The Engineer may require that stockpiles be remixed when segregation is apparent.

Unless otherwise authorized by the Engineer, all aggregate shall be stockpiled at least 24 hours to reduce the free moisture content. In order to control absorption, stockpiles shall be sprinkled when directed by the Engineer.

To assure uniform concrete, aggregate stockpiles shall be maintained at reasonably uniform moisture content.

(3) Admixtures. Admixtures shall be stored in accordance with Item 437, "Concrete Admixtures".

421.4. Measurement of Materials. Except as noted below, the measurement of materials used in batches of concrete shall be by mass.

Water may be measured by volume or by mass.

Cement and fly ash shall be weighed separately from other materials. Weighing of sacked cement will not be required. When sacked cement is used, the quantity of cement per batch shall be based upon using full bags of cement. Batches involving use of fractional bags will not be permitted

except for small hand mixed batches of approximately 0.15 cubic meter or less

and when an approved method of volumetric measurement is used.

Where two (2) or more sizes or types of aggregates are used, each type and/or size shall be measured separately.

When determining aggregate batch mass, proper allowance shall be made for the water content in the aggregate (free water and/or absorption).

Admixtures shall be measured and dispensed in accordance with Item 437, "Concrete Admixtures".

Measuring materials by volumetric methods may be used where permitted by the specifications. When a mixer using volumetric batching of materials is used, an accurate method of measuring by volume shall be provided. Continuous volumetric mixers shall be calibrated to assure correct measurement of materials.

The amount of each ingredient in the batch shall be measured to within plus or minus one (1) percent of the required amount except that water shall be measured to within plus or minus four (4) liters and admixture tolerances shall be in accordance with Item 437, "Concrete Admixtures".

421.5. Equipment.

(1) Weighing and Measuring Equipment. Weighing and measuring equipment shall conform to Item 520, "Weighing and Measuring Equipment".

(2) Mixing Equipment.

(a) General. All equipment, tools, and machinery used for hauling materials and performing any part of the work shall be maintained in such condition as to insure completion of the work under way without excessive delays for repairs or replacement.

The mixer shall be of an approved type and size that will produce uniform distribution of the material throughout the mass and shall be capable of producing concrete meeting the requirements of these specifications.

The mixing equipment shall be capable of producing the quantities of concrete necessary to comply with requirements shown on the plans or in these specifications.

For all mixers, an adequate water supply and an accurate method of measuring the water shall be provided.

Delivery of concrete to the worksite and the discharge from the hauling equipment, agitating, or nonagitating, shall be in accordance with the requirements shown on the plans or in the governing specifications.

Specific requirements for batch plants, mixers and other equipment shall be in accordance with Item 522, "Portland Cement Concrete Plants", Item 360, "Concrete Pavement", or other specifications, except that continuous volumetric mixers shall conform to Subarticle 421.5(2)(b) of this Item.

(b) Continuous Volumetric Mixers. For all miscellaneous con- crete placements, a mobile, continuous, volumetric mixer may be used.

When approved in writing by the Engineer or when specified for use in other Items, these mixers may be used for other types of concrete construction, including structural concrete, if the number of mixers furnished will supply the amount of concrete required for the particular operation in question.

These mixers shall be designed to receive all the concrete ingredients, including admixtures, required by the mix design in a continuous uniform rate and mix them to the required consistency before discharging.

(c) Portland Cement Concrete Plants. The use of ready-mixed concrete from a commercial source will be permitted for all structural concrete provided that the plant, truck mixers, and mixing equipment conform to the requirements of Item 522, "Portland Cement Concrete Plants". The use of ready-mix plants and ready-mix concrete for concrete pavement shall be in accordance with Item 360, "Concrete Pavement". The

class of plant furnished shall conform to the requirements of Item 522, "Portland Cement Concrete Plants".

421.6. Mixing.

(1) General. Mixed concrete which does not conform to specification requirements shall not be placed. Mixing shall be in accordance with Item 522, "Portland Cement Concrete Plants", except that mixing with continuous volumetric mixers will be in accordance with Subarticle 421.6.(2) and except as set out in Subarticle 421.6.(3).

(2) Continuous Volumetric Mixers. Mixing shall be in accordance with mixer manufacturer's recommendations unless otherwise revised by the Engineer.

(3) Mixing of concrete by hand methods or by the use of a small motor driven mixer will be permitted for small placements of approximately 1.5 cubic meters or less when authorized by the Engineer. Hand mixed batches shall not exceed a 85 kilogram batch of cement in volume. For such placements the mix may be proportioned by approved volumetric methods.

421.7. Placing, Curing and Finishing. The placing of concrete, including construction of forms and falsework, curing and finishing, shall be in accordance with Item 420, "Concrete Structures", Item 360, "Concrete Pavement", and Item 427, "Surface Finishes for Concrete".

421.8. Classification and Mix Design. The Contractor shall furnish the mix design, using a coarse aggregate factor acceptable to the Engineer, for the class(es) of concrete specified, to conform with the requirements contained herein and in accordance with Construction Bulletin C-11. The Contractor shall perform, at his entire expense, the work required to substantiate the design, except that casting and testing of strength specimens will be done by the Department. Complete concrete design data shall be submitted to the Engineer for approval.

The Contractor shall determine and measure the batch quantity of each ingredient, including all water, not only for batch designs but for all concrete produced for the project. The mixes shall conform to these specifications and other requirements shown on the plans.

For continuous volumetric mixers the materials delivered during a revolution of the driving mechanism, or in a selected time interval, will be considered a batch and the proportion of each ingredient will be calculated in the same manner as for a batch type plant.

The Contractor may accept a design from the Department; however, this acceptance will not relieve the Contractor of the responsibility of providing concrete meeting the requirements of these specifications.

Mix designs from previous or concurrent jobs may be used without trial batches if it is shown that no substantial change in any of the proposed ingredients has been made.

No charge will be made for existing designs furnished by the Engineer. The cost to the Department of preparing a new mix design will be charged to the Contractor and deducted from the payment for the work.

Trial batches shall be made and tested using all the proposed ingredients prior to the placing of concrete, and when the aggregate, and/or type, brand or source of cement, or admixture is changed. When the brand and/or source of cement only is changed, the Engineer may waive trial batch only if a prior record of satisfactory performance of the cement with the other ingredients has been established.

Trial batches generally shall be made in a mixer of adequate capacity to evaluate the design. The trial batches shall be made in a mixer representative of the mixers to be used. Batch size shall not be less than 50 percent of its rated mixing capacity.

Concrete for pneumatically placed concrete shall be in accordance with Item 431, "Pneumatically Placed Concrete".

The coarse aggregate factor shall be selected in accordance with Construction Bulletin C-11 based on grade of the coarse aggregate and the fineness modulus of the sand.

The Contractor shall have the option of using chemical admixtures with all classes of concrete in accordance with Item 437, "Concrete Admixtures", except where the use of specific admixtures is required or prohibited in this or other items.

When a retarding admixture is required for hot weather concreting, the amount to be used will be as required in Item 437, "Concrete Admixtures", subject to change by the Engineer when required. When used for extended retardation, the amount to be used will be established by several trial batches with varying retarder content and simulating the placing conditions to be encountered and tested in accordance with Tex-440-A.

When entrained air is required, the concrete shall be designed to entrain five (5) percent air when Grade 1 or 2 coarse aggregate is used, six (6) percent when Grade 3 or 4 coarse aggregate is used, and seven (7) percent for Grades 5, 6 or 7 unless otherwise specified by the Engineer. Concrete as placed shall contain the proper amount of entrained air as required herein with a tolerance of plus or minus 1-1/2 percentage points. Acceptance of concrete with occasional variations between 1-1/2 and three (3) percentage points over the specified amount will be based on strength tests as required by the Engineer. Such concrete which fails to meet strength requirements may be accepted on the basis of structural reviews subject to the provisions of Article 420.25. When the quantity of entrained air is found to be more than three (3) percentage points over or two (2) percentage points under those values given herein, the concrete will be rejected.

Entrained air will be required for bridge slabs, top slabs of direct traffic culverts, concrete pavement, dense and regular concrete overlays, piers, bents, precast piling (nonprestressed), drilled shafts placed in water, bridge railing, concrete traffic barrier and for other items of work as may be specified, on the plans or in other specifications. Unless otherwise specified, entrained air will not be required when Class "H" concrete is used for precast traffic barrier or precast bridge repair.

Table 3

SLUMP REQUIREMENTS

Concrete Designation	Desired Slump millimeters	Max Slump millimeters
A. Structural Concrete		
(1) All drilled shafts	150	175
(2) Thin-Walled Section (230 mm or less)	100	125
(3) Slabs, Concrete Overlay, Caps, Columns, piers, Wall sections over 230 mm, etc.	75	100
(4) Prestressed Concrete Members	100	125
(5) Concrete traffic Barrier (cast-in-place or precast), Concrete Bridge Railing	100	125
(6) Dense concrete overlay	20	25
(7) Concrete placed underwater	150	175
(8) Concrete with High Range Water Reducer	—	200
B. Concrete Pavement	40	75 max 25 min
C. Riprap, curb, gutter, slip-formed and extruded concrete	As Approved by the Engineer	

Note: No concrete will be permitted with a slump in excess of the maximums shown.

When high range water reducing admixtures are used, the slump shall not exceed 200 millimeters.

421.9. Quality of Concrete. The concrete shall be uniform, workable and of a consistency acceptable to the Engineer. The cement content, maximum allowable water/cement ratio, the desired and maximum slump, the proper amount of entrained air and the strength requirement for all classes of concrete shall conform to the requirements of these specifications. It shall be the responsibility of the Contractor to provide concrete meeting these requirements.

During the progress of the work, the Engineer will cast test cylinders and/or beams, perform slump and entrained air tests and will make temperature checks, as required, to insure compliance with the specifications.

Unless otherwise shown on the plans the Contractor shall furnish and properly maintain all test molds. The test molds shall meet the requirements of Test Methods Tex-418-A and Tex-448-A and, in the opinion of the Engineer, must be satisfactory for use at the time of use. In addition, the Contractor shall be responsible for furnishing personnel to remove the test specimens from the molds and transport them to the proper curing location at the schedule designated by the Engineer and in accordance with the governing specification. For all concrete items the Contractor shall have a wheelbarrow, or other container acceptable to the Engineer, available to use in the sampling of the concrete. The Contractor is responsible for disposing of used, broken test specimens.

All labor and equipment furnished by the Contractor will be considered subsidiary to the various bid items and will not be paid for directly.

A strength test is defined as the average of the breaking strength of two (2) cylinders or two (2) beams as the case may be. Each specimen will be tested in accordance with Test Methods Tex-418-A or Tex-448-A.

Slump tests will be performed in accordance with Test Method Tex-415-A. Entrained air tests will be performed in accordance with Test Method Tex-416-A.

If the required strength or consistency of the class of concrete being produced cannot be secured with the minimum cement specified or without exceeding the maximum water/cement ratio, the Contractor will be required 421.9

to furnish different aggregates, use a water reducing agent, an air entraining agent

or increase the cement content in order to provide concrete meeting these specifications.

All test specimens, beams or cylinders, representing tests for removal of forms and/or falsework shall be cured using the same methods and under the same conditions as the concrete represented.

"Design Strength" beams and cylinders shall be cast and cured in accordance with Test Method Tex-447-A.

The Contractor shall provide, operate and maintain curing facilities as described in Test Method Tex-447-A, for the purpose of curing test specimens.

When the specified concrete strength is by 28 day compressive strength tests, job control testing will be by seven day compressive strength tests. The minimum strength requirement for seven (7) day tests will be 70 percent of the specified minimum 28 day compressive strength. If the required seven (7) day strength is not obtained with the quantity of cement specified in Table 4, changes in the batch design will be made as specified in this article. For an occasional failure of the seven day compressive test, the concrete may be tested at 28 days for final evaluation.

Strength test requirements for Type II cement will govern when Type I/II cement is used.

Table 4

CLASSES OF CONCRETE

Class of Conc.	Cement per cubic meter Min. (kg)	Min. Comp. Sgth (f'c) 28 Day MPa	Min.Flex. Sgth. 7 day kPa	Max. Water Cement Ratio L/kg	Coarse Aggr. Grade No.	General Usage (information only)
A	280	21	2930 2690 (c)	0.58	1-2-3-4-8 (a) (d)	Drilled Shafts; Culverts, except Top Slab of Direct Traffic Culverts; Inlets; Manholes, Headwalls; Appr. Slabs; Curb; Gutter; Curb & Gutter, Conc. Retards; Sidewalks; Driveways; Conc. Pavement; Back-up Walls; Anchors
B	225	14	1930	0.71	2-3-4-5-6-7	Riprap, Small Roadside Signs and Anchors
C	335	25	3520 3240 (c)	0.53	1-2-3-4-5 (d)	Drilled Shafts; Bridge Substructure; Bridge Railing; Culverts, except Top Slab of Direct Traffic Culverts; Wing Walls; Approach Slab; Concrete Traffic Barrier (cast-in-place)

421.9

Class of Conc.	Cement per cubic meter Min. (kg)	Min. Comp. Sgth (f'c) 28 Day MPa	Min.Flex. Sgth. 7 day kPa	Max. Water Cement Ratio L/kg	Coarse Aggr. Grade No.	General Usage (information only)
D	165	10	1480	0.97	2-3-4-5-6-7	Riprap
E	335	21	2930	0.53	2-3-4-5	Seal Concrete
F	335 (445	As specified	3.93	0.49	2-3-4-5	Railroad structures; occasionally for Bridge

	Max)	on plans				Piers, Columns or Bents
H	335	As specified on plans	N.A.	0.49	3-4-5-6	Prestressed Con- crete Beams, Boxes, Piling and Concrete Traffic Barrier (Precast)
S	365	28	3930 3620(c)	0.44	2-3-4-5	Bridge Slab; Top Slab of Direct Traffic Culvert; Bridge Substructure
P	280	N.A.	3830(b)	0.55	2-3	Concrete Pavement
DC	490	38	4960	0.32	6	Dense Concrete Overlay
CO	390	32	4410	0.40	6	Concrete Overlay
SS	390	25	3520	0.49	3-4-5	Slurry Displacement Shafts, Underwater Drilled Shafts
K	Requirements as specified on the plans or in other Items.					

(a) Grade 8 aggregate for use in extruded curbs, unless a larger size is approved by the Engineer.
(b) Minimum running average for concrete pavement (in accordance with construction Bulletin C-ll).
(c) When Type II or Type I/II cement is used.
(d) Unless otherwise permitted by the Engineer, Grade I coarse aggregate may be used only in massive foundations with 100 millimeter minimum clear spacing between reinforcing steel bars. Grade I aggregate may not be used in drilled shafts.

421.10. Measurement and Payment. The work performed, materials furnished and all labor, tools, equipment and incidentals necessary to complete the work under this Item will not be measured or paid for directly, but will be considered subsidiary to the various bid items of the contract.

ITEM 422

REINFORCED CONCRETE SLAB

422.1. Description. This Item shall govern for the method of forming, the materials used, and the construction of a reinforced concrete bridge slab in accordance with the details shown on the plans. Unless otherwise noted on the plans, the Contractor shall have the option of constructing a cast-in-place slab using conventional forms; a cast-in-place slab using permanent metal deck forms; or a slab using prestressed precast concrete panels as a portion thereof.

422.2. Materials. All materials shall conform to the pertinent requirements of the following Items:

Item 420, "Concrete Structures"
Item 421, "Portland Cement Concrete"
Item 426, "Prestressing"
Item 440, "Reinforcing Steel"
Item 443, "Permanent Metal Deck Forms"

Unless otherwise noted on the plans, all cast-in-place concrete shall be Class "S".

422.3. Construction Methods. Unless otherwise shown on the plans any one or combination of the above forming systems may be used

within the same span or structure. Unless otherwise authorized by the Engineer, the combination of permanent metal deck forms and prestressed precast concrete panels shall not be permitted within any one span.

The Contractor shall notify the Fabricator and the Engineer in writing as to the types of forming and the diafram option he proposes to use in the structure.

The construction shall conform to the design and details shown on the plans and to the requirements of the pertinent Items as follows:

Item 420, "Concrete Structures"
Item 424, "Precast Concrete Structures (Fabrication)"
Item 426, "Prestressing"
Item 440, "Reinforcing Steel"
Item 443, "Permanent Metal Deck Forms"

If the work involves the extending of existing slabs, the work shall be done in accordance with Item 430, "Extending Concrete Structures".

When prestressed concrete panels are used, the profile grade line and/or bearing seat elevations may require adjustment to obtain the required cover over the slab reinforcement due to variation in beam camber or other factors.

When profile grade line adjustment is necessary, the Engineer will make adjustments over suitable increments, depending on span lengths, so that the revised grade line will produce a uniform profile and good riding qualities. Actual beam camber in adjacent spans or slab placements shall be considered when adjusting the grade line.

Where possible, the top portion of abutment backwall and wings shall be placed after any adjustment of the profile grade line is made.

422.4. Measurement. Reinforced concrete slab(s) placed under this Item will be measured by the square meter of slab surface area using the nominal dimensions and configuration shown on the plans, transverse measurement being made from outer edge of slab to outer edge of slab (including raised median and/or sidewalk sections), and longitudinal measurement being made between ends of units or spans. Diaframs and haunch concrete, reinforcement and optional steel diaframs, if used, will be considered as a portion of the slab. When required by the plans, concrete and reinforcement for sign mount brackets, luminaire brackets, and/or other **422.5**

concrete appurtenances will not be measured separately, but will be considered subsidiary to this Item.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

The quantities of concrete and reinforcing steel shown on the plans are based on a conventionally formed slab. These quantities include amounts for concrete diaframs, brackets and other required attachments, and for haunch concrete when required, based on the profile grade, theoretical camber, and dead load deflection of the beams.

No additional measurement will be made for concrete or reinforcing steel due to a variation in camber of the beams from theoretical camber, or for additional quantities required by optional methods of forming.

Structural steel, anchor bolts, armor joints, preformed joint seal, rail (including the concrete parapet portion), concrete median barrier and median barrier rail will be measured and paid for in accordance with the items under which they are furnished.

422.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Reinforced Concrete Slab". This price shall be full compensation for furnishing, hauling, mixing, placing, curing and finishing of concrete; furnishing and placing all reinforcing steel; all grouting and pointing; furnishing and placing drains and expansion joint material except where specifically furnished under another item; furnishing and placing metal flashing strips; for all forms (removable and/or permanent) and all falsework; for prestressed precast panels; for furnishing and placing concrete and reinforcement for sign mount and/or luminaire brackets and/or other concrete appurtenances when required; for removing designated portions of existing slab; cleaning, bending and cutting exposed existing reinforcing steel and welding of reinforcing steel when required; cleaning and preparing concrete surfaces; and for all labor, tools, equipment, and incidentals necessary to complete the work.

ITEM 423

RETAINING WALL

423.1. Description. This Item shall govern for furnishing the materials and constructing retaining walls as shown on the plans and required by this Item. Spread footing retaining walls shall consist of reinforced concrete footings and reinforced concrete stems as shown on the plans. Mechanically Stabilized Earth (MSE) walls shall consist of a volume of select backfill with tensile reinforcing elements distributed throughout and a concrete facing. Other types of retaining walls shall be as shown on the plans.

423.2. Materials. All materials shall conform to the pertinent requirements of the following Items:

Item 420, "Concrete Structures"
Item 421, "Portland Cement Concrete"
Item 440, "Reinforcing Steel"
Item 445, "Galvanizing"
Item 458, "Waterproofing for Structures"
Item 556, "Pipe Underdrains"

Unless otherwise shown on the plans, concrete for retaining walls shall conform to the following:

Cast-in-Place, Reinforced	Class "C"
Cast-in-Place, Nonreinforced	Class "A"
Precast	Class "H", f_c=28.0 MPa

Filter fabric material shall conform to Departmental Material Specification D-9-6200.

Materials for earth reinforcements shall be as shown on the plans. All steel elements in contact with soil shall be galvanized or epoxy coated. Epoxy coating shall be in accordance with Item 440, "Reinforcing Steel", except that the coating thickness shall be a minimum of 0.45 millimeters.

Joint fillers, pads, waterstops, and other incidental materials shall be as shown on the plans, or approved by the Engineer.

423.2

Backfill Material.

(1) Backfill for spread footing retaining walls shall be in accordance with Item 132, "Embankment", Type B, unless otherwise shown on the plans.

(2) Backfill for MSE walls shall be free from organic or otherwise deleterious materials, and shall conform to the following gradation limits as determined by Test Method Tex-110-E:

	Sieve Size	Percent Passing
Type A	75 mm	100
	425 µm	0-60
	75 µm	0-15
Type B	150 mm	100
	75 mm	75-100
	75 µm	0-15

Type B material not meeting the 75 micrometer sieve gradation limit stated above may be used if it conforms to the following requirements:

The percent passing the 75 micrometer sieve as determined by Test Method Tex-110-E shall not exceed 25 percent.

The Plasticity Index (P.I.) as determined by Test Method Tex-106-E shall not exceed six (6).

The material, when compacted to 95 percent of Da density as determined by Test Method Tex-114-E at optimum moisture content, shall exhibit an angle of internal friction of not less than 34 degrees as determined by Test Method Tex-117-E.

When the backfill gradation results in 15 percent or less material passing the 425 micrometer sieve, when tested in accordance with Test Method Tex-110-E, the backfill will be considered rock backfill.

Unless otherwise shown on the plans, Type B backfill shall be used.

The pH range shall be from 5.5 to 10.0 as determined by Test Method Tex-128-E.

The resistivity shall not be less than 3000 ohms-cm as determined by Test Method Tex-129-E. Material with a resistivity between 1500 and 3000 ohms-cm may be used provided the chloride content does not exceed 100 ppm and the sulphate content does not exceed 200 ppm as determined by Test Method Tex-620-J.

MSE wall systems using nonmetallic or epoxy coated metallic reinforcements may use backfill which does not comply with the pH and resistivity requirements. Epoxy coated metallic reinforcements may be used only when shown on the plans or approved by the Engineer. All connection hardware used with nonmetallic or epoxy coated reinforcements shall likewise be nonmetallic or epoxy coated. When nonmetallic or epoxy coated reinforcements are used, the maximum allowable backfill particle size shall be 19.0 millimeters.

(3) Unless otherwise shown on the plans, the Contractor shall have the option of stabilizing backfill for MSE walls with five (5) percent portland cement by dry mass of the backfill material.

When Type A backfill is shown on the plans, the Contractor may use Type B backfill stabilized with five (5) percent portland cement by dry mass of the backfill material.

When cement stabilized backfill is used, special drainage provisions shall be provided as shown on the plans.

When cement stabilized backfill is used, gradation, pH, and resistivity testing shall be run on the raw, unstabilized backfill material. Testing for angle of internal friction will not be required.

423.3. General.

(1) Options. When optional or alternate design details are shown on the plans, the Contractor will have the option of constructing any of the types of retaining wall shown. The Contractor will be required to use the same facing design within an area of continuous retaining walls.

When the Contractor proposes two (2) or more systems, or when the plans require a special surface finish, the Engineer may require drawings indicating the proposed design arrangement for his approval.

The Contractor's attention is directed to the fact that retaining wall options shown on the plans may be proprietary. The Contractor shall provide for use of these systems in accordance with Article 7.3.

(2) Working Drawings. When proprietary wall systems are used, or when otherwise shown on the plans, the Contractor shall prepare and submit working drawings and design calculations. Prior to fabrication, the Contractor shall submit to the Engineer seven (7) sets of casting drawings, seven (7) sets of construction drawings and two (2) sets of design calculations. Upon completion of construction, one (1) set of reproducible as-built drawings shall be submitted to the Engineer.

Casting drawings shall include all information necessary for precasting wall elements, including railing and coping when it is to be prefabricated. Casting drawings shall reflect shape and dimensions of panels; size, quantity and details of the reinforcing steel; the quantity, type, size, and details of connection and lifting hardware, and any additional details necessary.

Construction drawings shall include a numbered panel layout, and shall reflect horizontal and vertical alignment of the walls as well as the existing and proposed groundlines, as shown on the plans. The drawings shall also include all information needed to erect the walls including the proposed leveling pad elevations; the type and details of the soil reinforcing system (if applicable); the details and manufacturer of all pads, fillers, and filter fabric; the limits and dimensions of structural backfill; details necessary to incorporate coping, railing, drainage and electrical conduit as shown on the plans; and any additional details necessary to complete the work.

Leveling pad elevations may vary from the elevations shown on the plans. Unless otherwise noted on the plans, 0.3 meter minimum cover shall be provided from the top of the leveling pad to finish grade.

Design calculations shall include a summary of all design parameters used, including material types, strength values and assumed allowables; assumed loads and loading combinations; and factor of safety parameters.

Calculations shall be submitted covering the range of heights and loading conditions on the project. Both internal and external stability calculations will be required.

Construction drawings and design calculations shall bear the seal of a Registered Professional Engineer.

423.4. Construction Methods.

(1) General. Construction of retaining walls shall conform to the design and details shown on the plans and to the pertinent requirements of the following Items:

Item 110, "Excavation"
Item 132, "Embankment"
Item 400, "Excavation and Backfill for Structures"
Item 424, "Precast Concrete Structures (Fabrication)"
Item 458, "Waterproofing for Structures"
Item 556, "Pipe Underdrains"

Any required piling or drilled shafts shall be in accordance with the pertinent specification.

(2) Mechanically Stabilized Earth (MSE) Walls.

The foundation for the structure shall be graded level for a width equal to or exceeding the approved length of the reinforcing system or as shown on the plans. Prior to wall construction, the foundation shall be compacted with a smooth wheel vibratory roller or other roller approved by the Engineer. Any foundation soils found to be unsuitable shall be removed and replaced.

Drilled shafts and piling located within the MSE volume shall be placed prior to construction of the retaining wall.

At each foundation level, a concrete leveling pad shall be provided as shown on the plans. The leveling pad shall be given a wood float finish and shall be in place a minimum of 24 hours before panel erection begins. No curing or strength testing of the leveling pad concrete will be required.

Filter fabric shall be placed behind all wall joints, and at the intersection of retaining walls with other structures, including riprap. Filter fabric shall cover joints a minimum of 150 millimeters on each side and shall be positively held in place.

As fill material is placed, the panels shall be maintained in position by methods acceptable to the Engineer. Care shall be exercised during lifting, setting, and alignment of panels to prevent damage to the panels. Any operation which results in chipping, spalling, or cracking of panels shall be discontinued. Damaged panels shall be removed and replaced, or repaired, as approved by the Engineer, at the Contractor's expense. External bracing may also be required for the initial lift.

Vertical tolerances and horizontal alignment tolerance shall not exceed 20 millimeters when measured along a 3-meter straightedge. The maximum allowable offset in any panel joint shall be 20 millimeters. The overall vertical tolerance of the wall (plumbness from top to bottom) shall not exceed 13 millimeters per three (3) meters of wall height.

Backfill placement shall closely follow the erection of each lift of panels. At each reinforcement level, backfill shall be leveled and compacted before placing the reinforcement. Reinforcements shall be placed perpendicular to the face of the wall, unless otherwise shown on the plans. The normal lift thickness will be 200 millimeters (loose measurement). The Contractor may increase or decrease the lift thickness if necessary to obtain the required compaction. Compaction shall be accomplished without distortion or damage to the reinforcement system. Compaction in a strip one (1) meter wide adjacent to the backside of the wall shall be achieved in accordance with "Ordinary Compaction", of Item 132, "Embankments". Compaction in the one (1) meter strip shall be accomplished with hand operated or walk-behind compaction equipment. If displacement of panels occurs during compaction, the Engineer may increase the width of the strip, or require modified procedures.

For systems utilizing nonmetallic earth reinforcements, each layer of reinforcement shall be pretensioned to remove slack before placement of backfill. The devices used shall be capable of mechanically applying and holding the required force. Before starting work, the Contractor shall demonstrate to the satisfaction of the Engineer the method proposed for pretensioning the reinforcement.

The Contractor shall be responsible for maintaining the stability of the interface area between the embankment or natural ground and the select fill. Any loosening, caving, or other failures in this area shall be removed and replaced at the Contractor's expense.

Unless otherwise shown on the plans, or when rock backfill as previously defined herein is used, each backfill layer shall be sprinkled as required and compacted to the extent necessary to provide the density specified below:

Location	Density, Percent
Top one (1) meter under travel way (roadway plus shoulders)	Not less than 95%
All other areas	Not less than 90%

The laboratory density determination will be made in accordance with Test Method Tex-114-E. Field density determination will be made in accordance with Test Method Tex-115-E.

Rock backfill or material which in the opinion of the Engineer will make density testing impractical shall be compacted by the "Ordinary Compaction" method of Item 132, "Embankment". Vibratory compaction may be required. The upper 0.6 meter of the rock backfill shall contain no stones larger than 75 millimeters in their greatest dimension and shall be composed of material with sufficient fines to fill the voids in a compacted state.

When rock backfill material is used, the same type of filter fabric used behind the panel joints shall be used to cover the rock backfill material prior to placing the upper 0.6 meter. The fabric shall have a minimum overlap of at least 450 millimeters and extend past the edge of the rock backfill material at least 450 millimeters.

The Contractor shall be responsible for preventing surface water or rainwater from damaging the retaining walls during construction. This shall include shaping the backfill to prevent water from ponding or flowing on the backfill or against the wall face. Any damage or movement caused by erosion, sloughing, or saturation of the retaining wall or embankment backfill shall be repaired at the Contractor's expense.

423.5. Measurement. Retaining walls will be measured by the square meter of the front surface area of the wall. Unless otherwise shown on the plans, the area will be measured from 0.3 meters below finished grade to the top of wall including any coping required.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

423.6. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Retaining Walls", of the type and/or special surface finish specified. This price shall be full compensation for excavation in back of retaining walls and for footings; furnishing and placing footings, leveling pads, copings and traffic railing foundations, when required; furnishing, placing and compacting backfill (except as shown below), including cement for stabilization; furnishing and placing concrete, reinforcing steel, waterproofing material, filter material and drain pipe, joint material, water stop, and filter fabric when required; fabricating, curing and finishing all panels; furnishing and placing earth reinforcement, anchorage systems and fasteners; for wall erection; and for all labor, tools, equipment and incidentals necessary for a complete retaining wall.

Retaining wall backfill areas which are also in embankment areas will be measured and paid for as specified in Item 132, "Embankment", of the compaction method specified. Such backfill material shall meet the requirements of the retaining wall type used.

No payment will be made for piling or drilled shafts, except when used as foundations for spread footing or MSE walls.

When piling or drilled shafts are installed beyond limits shown on the plans at the direction of the Engineer, the additional quantity will be paid for in accordance with the appropriate bid item or Article 4.3.

ITEM 424

PRECAST CONCRETE STRUCTURES
(Fabrication)

424.1. Description. This Item shall govern for the fabrication of precast prestressed and precast nonstressed concrete members, in accordance with the plans, approved shop drawings, and this Item.

Prestressed members shall be defined as precast concrete members fabricated by the process of pretensioning, post-tensioning, or a combination of the two (2) methods.

Nonstressed members shall be defined as precast concrete members which are not subject to pretensioning or post-tensioning.

424.2. Materials. Materials shall conform to the material requirements specified in the pertinent item.

424.3. General.

(1) Plant Facilities.

(a) Prestressed Members. An inspection laboratory shall be furnished in accordance with Item 498, "Plant Inspection Laboratory (Equipped)".

Prior to the casting of members, detailed drawings of the complete facilities to be used in fabrication are required. The design of casting beds and facilities for pretensioned construction, including plans and specifications, shall bear the seal of a registered Professional Engineer. The Contractor shall furnish certification stating that the bed, facilities, and hardware have been constructed in accordance with the above plans and specifications.

For central plant fabrication, three (3) copies of facility drawings shall be submitted to the Materials and Tests Division, Texas Department of Transportation, 125 East 11th Street, Austin, Texas 78701-2483. For job site fabrication, three (3) copies shall be submitted to the Engineer.

The facility drawings shall specify the maximum loading for which the bed is to be used. Prior to approval for that loading, the facilities shall be proofloaded to a minimum 10 percent overload for eight (8) hours.

Additional proof loads shall be performed at a minimum 10 percent overload for four (4) hours when deemed necessary by the Engineer. Minor changes in facilities will not require proofloading but will require submission of revised facility drawings accompanied with design calculations. Facility drawings and calculations shall bear the seal of a registered Professional Engineer.

(b) Nonstressed Members. An inspection laboratory shall be furnished in accordance with Item 498, "Plant Inspection Laboratory (Equipped)".

(2) Shop Drawings.

(a) Prestressed Members. The Contractor shall submit to the Engineer a proposed sequence of erection by structure and span or unit number. Shop drawings shall be submitted following this proposed sequence.

When alternate designs are permitted by the plans, the designs proposed shall be submitted in the format and on forms furnished by the Department. Approval of these designs must be given prior to preparation of shop drawings. Once alternate designs are submitted and approved, subsequent changes will not be permitted.

Clear and legible shop drawings shall be prepared on ISO A1 metric sheets (metric units of 841 millimeters x 594 millimeters) or on sheets having English units of 34 inches x 22 inches. The drawing area is to be 787 millimeters x 533 millimeters. The right margin is fixed at seven (7) millimeters with equal top and bottom margins. Drawings may be prepared on half-scale sheets or full size drawings may be reduced to half-scale size, if they are clear and legible. Each sheet shall have a title block in the lower right-hand corner. The title shall include the sheet index data shown on the lower right-hand corner of the project plans, sheet numbering for the shop drawings, name of structure or stream, name of Fabricator, and name of Contractor.

All shop drawings shall be checked by the Fabricator before submitting them for approval. Submission of shop drawings shall be made to the Design Division, Texas Department of Transportation, 125 East 11th Street, Austin, Texas 78701-2483.

Six (6) copies of the Index Sheets, Bearing Sheets, and Fabrication Sheets along with seven (7) copies of Erection Sheets will be required. One (1) additional copy of each sheet will be required for railroad underpass structures. Additional sets may be required by the Engineer.

Shop and/or working drawings for precast post-tensioned members will be in accordance with Item 426, "Prestressing".

When fabrication is to be at more than one (1) casting plant, two (2) additional sets of shop drawings will be required for each additional casting location. Index sheets shall reflect the plant locations where each member is to be fabricated.

After completion of fabrication for railroad underpass structures, the Contractor shall furnish reproducible tracings of approved "as built" shop drawings.

(b) Nonstressed Members. Shop drawings for nonstressed members shall be furnished when required by the plans and/or pertinent item.

(3) Notice Of Beginning Work. The Contractor shall give the Engineer adequate notice prior to the beginning of work in the Fabricator's plant as follows:

Plants in the State of Texas	7 days
Plants in the Contiguous United States	21 days
Plants outside the Contiguous United States	60 days

No work shall be performed in the plant before the Engineer has authorized fabrication.

424.4. Fabrication. Prestressing shall be in accordance with Item 426, "Prestressing". A casting schedule shall be prepared on standard forms furnished by the Department and submitted to the Director of Materials and Tests, or his duly authorized representative, prior to fabrication.

Post-tensioning ducts, when required, shall be placed in accordance with the approved prestressing details, and in accordance with Item 426, "Prestressing". It shall be the Contractor's responsibility to maintain all ducts free of obstructions until all post-tensioning operations are complete.

Construction of forms, reinforcing steel placement, and concrete placement shall be as follows:

(1) Forms.

(a) External Forms. All side and bottom forms for precast concrete construction shall be constructed of steel, unless otherwise noted on the plans. Wood forms, when permitted, shall conform to the requirements of

Item 420, "Concrete Structures". End headers may be of other material as approved on the shop drawings.

Forms shall be of sufficient thickness, with adequate external bracing and stiffeners, and shall be sufficiently anchored to withstand the forces caused by placement and vibration of concrete. Internal bracing and holding devices in forms will not be permitted if such would remain in the finished member.

Corners shall have a chamfer or radius where shown on the plans.

Joints shall be maintained reasonably mortar tight. Where sections of forms are to be joined, an offset of two (2) millimeters for flat surfaces and three (3) millimeters for corners and bends will be permitted. Offsets between adjacent end header sections shall not exceed six (6) millimeters.

The grade and alignment of forms shall be checked each time they are set and shall be maintained during the placement of concrete.

Metal forms shall be reasonably free from rust, grease or other foreign materials. All forms shall be cleaned thoroughly prior to each casting operation.

The facing of all forms shall be treated with form oil or other bond breaking coatings prior to placing of concrete. The oil or other materials used for this purpose shall be of a consistency and composition which prevents build-up on the forms and facilitates form removal. Clear form oil of the same brand shall be used throughout the casting operation for nonstressed retaining wall panels. Materials which appreciably stain or react with the concrete will not be permitted.

The forms shall be constructed to facilitate removal without damage to the concrete.

The soffit for casting prestressed members shall be constructed and maintained to provide a maximum six (6) millimeters variation from the theoretical plane. Additionally, the soffit shall not vary more than six (6) millimeters between any two (2) points in any 15 meter length.

At the Contractor's option, side forms for prestressed bridge deck panels may be constructed with a three (3) millimeters draft to permit ease of removal.

(b) Internal Forms. Materials used for forming internal voids in precast

concrete members shall be of adequate strength to maintain sufficient rigidity to withstand the forces of flow, vibration, buoyancy and
mass of plastic concrete during placing.

Forms for internal voids in members shall be anchored securely to prevent movement or misalignment during placement of concrete. Holddowns for all types of void forms shall be spaced not more than 800 millimeters and shall provide sufficient bearing area on the void form to prevent indentation or penetration into the void form. Splicing of void form sections shall be such as to prevent separation or misalignment.

Internal voids for prestressed piling may be formed with a mandrel provided it can be demonstrated to the Engineer that the correct position and alignment of the mandrel can be maintained throughout the casting operation.

The material used for forming internal voids may be one of the following, except that the material used for forming voids in piling shall be inert and nonabsorptive:

Corrugated cardboard void forms for box voids shall be manufactured from virgin Kraft completely impregnated with a blend of polyethylene and paraffin with a melting point of not less than 55 °C. Void form covers shall be further protected by curtain coating the outside liner with high melting point paraffin at not less than 150 °C. Assembled cardboard void forms shall have all seams, joints and raw edges sealed with waterproof pressure sensitive tape. Joint belts and end caps shall be assembled using clinched box staples spaced not more than 150 millimeters completely around top, sides and, whenever possible, the bottom of the forms.

Cardboard void forms for round voids shall be manufactured from recycled paperboard, spirally wound, with a moisture barrier in the wall of void forms over 75 millimeters in outside diameter. The interior and exterior surfaces shall be wax coated, at 51 °C minimum, with scale wax having a minimum oil content of two (2) percent. The adhesive used between the plies shall be of a type not sensitive to water. End closures can be made of plywood, metal or plastic and nailed or stapled into place. Assembled voids shall have all joints and raw edges sealed with waterproof pressure sensitive tape.

424.4

Expanded polystyrene void forms shall be solid and have a minimum compressive strength of 69 kilopascal, a density of 14 kilograms per cubic meter and an oxygen index of 24.0.

Other materials may be used for void forms provided they meet all applicable requirements and are approved by the Engineer prior to use.

Certification of conformance will be required for all cardboard and expanded polystyrene void forms. The Engineer may require samples to be submitted when deemed necessary.

Prestressed concrete box beam void forms without solid cores shall be vented, except when otherwise required by the Engineer, to eliminate high air pressure caused by heat of hydration. A 19 millimeter diameter plastic tube shall be inserted into the top of the void prior to placing concrete and left in place until there is no possibility of damage from pressure. The plastic tube shall be subsequently removed and the hole sealed with epoxy grout. Other methods of relieving air pressure may be used if approved by the Engineer.

Additionally, for prestressed concrete box beams, each individual void form without a solid core shall be vented through the bottom slab. The vent shall be a 19 millimeter hole either drilled or formed by an acceptable hole forming device.

(2) Placing Reinforcing Steel. Reinforcing steel shall be placed in accordance with Item 440, "Reinforcing Steel". Reinforcing steel required to extend outside of the member shall not project by more than 13 millimeters or less than 19 millimeters from plan dimension, unless otherwise approved by the Engineer.

(3) Quality of Concrete. The values which govern for minimum concrete strengths during different phases of construction shall be as required by the pertinent item. When optional designs are permitted, the minimum concrete strength shall be as shown on the approved shop drawings.

The control of concrete shall be by compressive tests of cylinders. For prestressed and nonstressed members, the making, curing, and testing of all required cylinder test specimens for release or handling strength or design strength shall be in accordance with Test Method Tex-704-I.

(4) Placing Concrete. All concrete shall be placed during daylight hours unless the fabrication plant or site is provided with a lighting system approved by the Engineer.

The method of concrete placement shall minimize segregation of the aggregate and displacement of the reinforcing steel, prestressing steel, or duct. Concrete shall be deposited as near as possible in its final position in the forms. Depositing large quantities of concrete at one location in the forms and running

or working it along the forms will not be permitted.

Special attention shall be directed toward working the coarse aggregate back from the face of the concrete and forcing the concrete under and around the reinforcing steel, prestressing steel, or duct.

Placement of concrete in large members shall be subject to the approval of the Engineer. Concrete may be placed in one (1) lift or in multiple continuous horizontal layers. In the latter case the thickness of the first layer shall be slightly above the juncture of the bottom flange and web of prestressed concrete beams. Not more than one (1) hour shall elapse between the placing of the successive layers. Vibration of subsequent layers of concrete shall extend into the previously placed layers.

Prestressed concrete box beams cast monolithically in two (2) stages shall have the concrete in the bottom slab remain in a plastic state until the side wall concrete is placed and vibrated into the bottom slab. When the side wall concrete is placed and vibrated into the bottom slab, the one (1) hour time limit between placement of layers may be waived.

Concrete placement will not be permitted when impending weather conditions will impair the quality of the finished work. If rainfall should occur after placing operations are started, the Contractor shall provide ample covering to protect the work.

The maximum time interval between the addition of mixing water and/or cement to the batch and the placing of concrete in the forms shall not exceed the following:

Concrete Temperature	Maximum Time
Nonagitated Concrete	
27 °C or Above	15 Minutes
10 °C to 26 °C	30 Minutes
Agitated Concrete	
Above 32 °C	45 Minutes
24 °C to 32 °C	60 Minutes
10 °C to 23 °C	90 Minutes

424.4

The use of an approved retarder in the concrete will permit the extension of each of the above maximum times by 30 minutes, except that for

nonagitated concrete, the maximum time shall not exceed 30 minutes.

Under conditions of extreme temperature or humidity, the Engineer may require the use of an approved retarder in the concrete.

(a) Placing Concrete in Cold Weather. When members are produced in a fabricating plant which has adequate provisions to protect the concrete and which has approved elevated temperature curing facilities, concrete may be placed under low temperature conditions provided:

The temperature of the concrete is not less than 10 °C when mixed and placed in the forms.

The framework and covering are in place and heat is provided for the concrete and forms within one (1) hour after the concrete is placed. This shall not be construed to be one (1) hour after the last concrete is placed but that no concrete shall remain unprotected and unheated for longer than one (1) hour.

The air surrounding the concrete shall be kept between 10 °C and 30 °C for a minimum of three (3) hours prior to beginning the temperature rise which is required for elevated temperature curing.

For central fabricating plants or job site casting operations which do not provide facilities necessary to accomplish the above provisions, concrete may be placed when the atmospheric temperature is 2 °C or greater. The temperature of the concrete at the time of placement shall not be less than 10 °C. The concrete shall not be placed in contact with any material having a temperature less than 0 °C or any material coated with frost.

Aggregates shall be free from ice, frost, and frozen lumps. When required, in order to produce the minimum temperature specified above, the aggregate and/or the water shall be heated uniformly in accordance with the following:

Water may be heated to a temperature not to exceed 82 °C and/or the aggregate may be heated to a temperature not to exceed 65 °C. The equipment furnished shall be capable of heating the aggregate uniformly to eliminate overheated areas in the stockpile which might cause flash set of the cement. The temperature of the mixture of the aggregates and water shall be between 10 °C and 30 °C before introduction of the cement.

Protection shall be provided to maintain the temperature of the concrete

at all surfaces of prestressed members at 10 °C or above until "Release Strength" is reached. All concrete surfaces of nonstressed members shall be maintained at 4 °C or above during the specified curing period. Protection shall consist of providing additional covering and, if necessary, supplementing such covering with artificial heating. When weather conditions indicate the possibility of the need for such temperature protection, all necessary heating equipment and covering material shall be on hand ready for use before permission is granted by the Engineer to begin placement of concrete.

(b) Placing Concrete in Hot Weather. When concrete is to be placed during hot weather, it shall be placed without the addition of more water to the concrete than required by the design. When field conditions are such that additional moisture is needed for the final concrete surface finishing operation, the required water shall be applied to the surface by fog spray only, and shall be held to a minimum. Fog spraying that will wash the fresh concrete surface or cause water to stand will not be permitted. Control of the initial set of the concrete and lengthening the time for finishing operations under adverse humidity and hot weather conditions may be accomplished with the use of an approved retarder in accordance with Item 421, "Portland Cement Concrete".

(c) Consolidation of Concrete. All concrete shall be thoroughly consolidated with approved high frequency vibrators. These vibrators, both internal and external, shall operate at a minimum of 7000 vibrations per minute. External vibrators will be permitted only when steel forms are used. For prestressed concrete beams and box beams, internal vibrators will be required and may be supplemented with external vibrators if desired.

At least one (1) stand-by vibrator of the type(s) being used shall be provided for emergency use.

Internal vibrators shall be inserted systematically into the concrete immediately after placing. When the concrete is placed in more than one (1) layer, the vibrators shall be operated so that they will penetrate into the previously placed layer of concrete.

The size and spacing of external vibrators shall provide sufficient intensity of vibration to the desired area of the form. The spacing, frequency, and/or amplitude of external vibrators shall be varied to produce uniform consolidation of the concrete.

Supplemental vibrators or a modification of the vibration system shall be provided, when deemed necessary by the Engineer, to accomplish thorough consolidation of the concrete and complete embedment of the reinforcing steel, prestressing steel, or duct.

(5) Finishing of Concrete. All unformed surfaces, when finished, shall not have distortions greater than six (6) millimeters. Form marks in excess of permissible tolerances and all fins and rough edges along chamfer lines shall be removed in an acceptable manner.

Concrete on exposed reinforcing steel and loose laitance on concrete surfaces to be in contact with cast-in-place concrete shall be removed from all members.

(a) Prestressed Members. Top surfaces of prestressed concrete beams and bridge deck panels shall be screeded or rough floated to bring mortar to the surface and cover all aggregate. The surface shall have a rough wood float or stiff broom finish. Aggregate shall not be loosened when roughening the surface. Surfaces at anchor bolt locations shall have a smooth metal trowel finish.

The top surface of prestressed concrete piling shall be struck off and finished with a wood or magnesium float by bringing mortar to the surface to cover the aggregate and present a reasonably smooth appearance.

Fabrication holes, except box beam vent holes, in the bottom of all beams shall be filled with nonstain, nonshrink mortar and made flush with the surrounding surface.

Unless otherwise shown on the plans, strands shall be removed flush with the end of the member, or recessed approximately ten (10) millimeters. In either case, the ends of the strands and a minimum of 25 millimeters

around each strand shall be cleaned and coated with approximately 250 micrometer of an approved epoxy or epoxy grout.

(b) Nonstressed Members. All unformed surfaces shall be given a uniform wood float finish, unless otherwise shown on the plans.

(6) Curing of Concrete. Careful attention shall be given to the proper curing of concrete. Prior to placing concrete, the Contractor shall submit the proposed curing methods and procedures to the Engineer for approval. Elevated temperature curing facilities shall be tested for a minimum of 48 hours prior to approval. Approved equipment and materials for curing shall be available for use prior to casting.

Inadequate curing facilities or lack of attention to the proper curing of concrete shall be cause for the Engineer to stop all concrete placement until approved curing is provided. Inadequate curing may be cause for rejection of the member.

Curing shall be commenced prior to the formation of surface shrinkage cracks. The mats, sheets, or blankets shall not be placed in contact with the concrete member until such time that damage will not occur to the surfaces.

Forms may be removed at the discretion of the Contractor at any time after the concrete has reached sufficient strength to prevent physical damage to the member. Removal of the forms shall be done in such a manner that curing is not interrupted on any member for more than 30 minutes.

The following curing requirements shall apply for prestressed members:

All concrete shall be cured by the method of elevated temperature or water curing. Type I-D interim membrane curing will be permitted only on the top surface of prestressed concrete piling.

Concrete shall be cured continuously, except as allowed during form removal, until the compressive strength of the concrete has reached the "Release Strength" and until detensioning has been performed. Prestressed piling shall be water cured an additional three (3) days after attaining "Release Strength". The temperature at all surfaces of prestressed piling shall be maintained above 0 °C during this period.

Removal of piling to a storage area shall be done in such a manner that water

curing is not interrupted on any member for more than four (4) hours.

The following curing requirements shall apply for nonstressed members:

All concrete shall be cured by the method of elevated temperature, water, or membrane curing.

Concrete shall be cured continuously, except as allowed during form removal, for a period of four (4) days or until the compressive strength of the concrete has reached the "Design Strength" designated on the plans and/or shop drawings.

(a) Water Curing. All exposed surfaces of the concrete shall be kept wet continuously for the required curing time. The water used for curing shall meet the requirements for concrete mixing water as specified in Item 421, "Portland Cement Concrete". Sea water will not be permitted. Water which stains or leaves an unsightly residue shall not be used.

Water curing will be permitted as follows:

1. Wet Mat Method. For water curing by the wet mat method, cotton mats, polyethylene sheeting, or polyethylene burlap blankets may be used.

The mats, sheets, or blankets shall be adequately anchored and weighted to provide continuous contact with all concrete surfaces. Any concrete surfaces which cannot be cured by contact shall be enclosed by mats, adequately anchored, so that outside air cannot enter the enclosure. Sufficient moisture shall be provided inside the enclosure to keep all of the surfaces of the concrete wet for the required curing time.

2. Water Spray Method. For water curing by the water spray method, overlapping sprays or sprinklers shall be used so that all concrete surfaces are kept wet continuously.

3. Ponding Method. For water curing by the ponding method, the concrete surfaces shall be covered with a minimum 25 millimeters depth of water. Satisfactory provisions shall be made to provide a dam to retain the water.

424.4

(b) Elevated Temperature Curing. Curing by elevated temperatures will be permitted as follows:

1. Steam Curing. (Steam curing is defined as use of steam

above 30 °C). When steam curing of concrete is provided, the temperature inside the curing jacket shall not exceed 75 °C for more than one (1) hour during the entire steam curing period. Concrete exposed to temperatures exceeding 82 °C will not be accepted.

Sufficient moisture shall be provided inside the curing jacket so that all surfaces of the concrete are wet.

An unobstructed air space of not less than 150 millimeters shall be provided between all surfaces of the concrete and the curing jacket. Steam outlets shall be positioned so that live steam is not applied directly on the concrete, forms, or test cylinders.

The location of steam lines, location of control points for discharge of steam into the curing jacket, and the number and type of openings for steam distribution within the curing jacket shall be arranged so that temperature variation between any points in the enclosure shall not exceed 10 °C.

Steam curing shall not commence until the concrete has been in place a minimum of three (3) hours, or until initial set of the concrete, as determined in accordance with ASTM C 403, is attained.

During the application of steam, the temperature inside the curing jacket shall be raised uniformly at a rate not to exceed 20 °C per hour.

2. Alternate Methods. Other methods of elevated temperature curing may be permitted by the Engineer provided temperature maximums, rate of temperature variation, humidity control, etc., are in accordance with the requirements for steam curing. The use of any alternate method will require the permission of the Engineer, in writing.

(c) Membrane Curing. Type 1-D or Type 2 membrane curing compound may be used where permitted herein or in the pertinent item. Material requirements and construction methods shall be in accordance with Item 526, "Membrane Curing".

424.5. Workmanship.

(1) Defects and Breakage. All members that sustain damage during fabrication, handling, or storage shall be subject to the following:

(a) Prestressed and Nonstressed Members. Fine cracks on the surface of the member which do not extend to the plane of the nearest reinforcement will not be cause for rejection unless they are numerous and extensive. Diagonal cracks, which indicate damage from torsion, will be subject to a structural review prior to acceptance.

Cracks which extend into the plane of the reinforcing steel and/or prestressed tendons, but are acceptable otherwise, shall be repaired by sealing with an approved epoxy or other approved material.

Small damaged or honeycombed areas which are purely surface in nature (not over 25 millimeters deep) may be repaired with an approved epoxy grout or other approved material. Damage or honeycomb in excess of the above will be subject to a structural review.

(b) Prestressed Members. Failure of individual wires in a seven-wire strand, or of wires in a parallel wire tendon is acceptable provided the total area of wire failure is not more than two (2) percent of the total cross-sectional area of tendons in any member. Failure of an entire strand will be subject to structural review.

Vertical or horizontal cracks, which are two (2) millimeters or less in width and which tend to close upon transfer of stress to the concrete, are acceptable. Cracks in excess of this are subject to review prior to acceptance.

Any of the following conditions will be cause for rejection of prestressed bridge deck panels.

1. Any crack that comes within 25 millimeters of two (2) adjacent strands.

2. Corner cracks or breaks that involve two (2) strands.

3. Isolated damage or honeycombed areas larger than approximately 150 millimeters in diameter or length that involves more than one (1) strand.

4. Narrow honeycomb lines caused by grout leakage over 13 millimeters in depth involving more than one (1) strand.

Any condition not covered by the above shall be subject to structural review.

(2) Tolerances.

(a) Prestressed Members. Allowable tolerances for the dimensions and configurations shown on the approved shop drawings are as shown in Table 1.

TABLE 1
ALLOWABLE TOLERANCES IN MILLIMETERS

		Beams	Box Beams	Tees	Panels	Piling
Length (Normal to strands for panels)		± 19	± 25	± 19	± 13	- 25*
Width (Parallel to strands for panels)		+ 19 - 6	± 6	± 19	± 13	+ 13 - 6
Nominal Depth (Thickness in case of panels)		+ 13 - 6	± 6	± 6	+ 6 - 3	+ 13 - 6
Thickness	Top Slab or Flange	+ 13 - 6	± 13	± 6	NA	NA
	Bottom Slab or Flange	+ 13 - 6	± 13	NA	NA	NA
	Web or Wall	+ 19 - 6	± 13	± 6	NA	NA
Horizontal Alignment (Upon Release of Stress) - Deviation from straightness of mating edge of panels		± 3 per 3 meters of length	± 6	± 6	± 3	± 3 per 3 meters of length
Deviation of Ends from Shop Plan Dimension (bearing edge in case of panels)	Horizontal Skew	± 6	± 3 per 0.3 meter of width, 13 max	± 3 per 0.3 meter of width	± 13	± 3
	Vertical Batter	± 3 per 0.3 meter of depth	± 3 per 0.3 meter of depth, 13 max	± 3 per 0.3 meter of depth	NA	± 3

424.5

		Beams	Box Beams	Tees	Panels	Piling

Notched End Areas (for diaframs)	Depth	± 6	± 6	± 6	NA	NA
	Length	+ 50 - 25	+ 50 - 25	+ 50 - 25	NA	NA
Bearing Surfaces	Perpendicular to Vertical Axis	± 3	NA	± 2	NA	NA
	Deviation from Plane	± 2	± 3	± 2	NA	NA
Anchor Hole Location	From End of Member	+ 19 - 6	± 6	+ 19 - 6	NA	NA
	Longitudinal Spacing	± 19	± 13	± 19	NA	NA
	Transverse Location	± 6	± 6	± 6	NA	NA
Diafram or Lateral Tie Location		± 13	± 13	± 13	NA	NA
Position of Void** (Longitudinal for Box Beams)		NA	± 25	NA	NA	± 13
Position of Strands		± 6	± 6	± 6	± 3 Vert.# ± 13 Horiz.	± 6
Position of Hold-Down Points		± 150	± 150	± 150	NA	NA
Position of Handling Devices		± 150	± 150	± 150	NA	± 150

Measured from bottom of panel.
* Maximum length approved by the Engineer.
** Length of Box Beam Void Material +25 millimeters -150 millimeters.

Variations greater than specified in Table 1 shall be corrected to within these tolerances or be subject to structural review. Horizontal alignment (sweep) in beams and girders only, which may increase at a later time over that shown in the table, will be acceptable if the members can be hauled, erected, and aligned to within the allowable tolerance without being damaged. These members shall be stored in a manner that will minimize the sweep.

When prestressed concrete box beams are cast monolithically in one stage the Fabricator shall furnish positive verification to the Engineer that the bottom slab, after casting, is within the dimensional tolerances specified herein.

Weld clips, hangers, and other inserts for forming purposes shall be longitudinally spaced not more than 25 millimeters greater than the spacing specified on the approved shop drawings. Weld clip inserts shall not be placed greater than two (2) millimeters from the beam edge. All inserts shall be firmly held in position to avoid movement during concrete placement.

(b) Nonstressed Members. Unless otherwise shown on the plans, the allowable tolerances (+/-) for nonstressed members shall be as follows:

<u>Concrete Traffic Barrier</u>:

Length	25 mm
Insert Placement	13 mm
Horizontal Alignment	3 mm per 3 meter of length
Deviation of Ends:	
Horizontal Skew	6 mm
Vertical Batter	10 mm per meter of depth

<u>Retaining Wall Panels</u>:

All Dimensions	5 mm
Angular distortion with regard to the height of the panel	3 mm per meter
Formed Surface Defects	2 mm per meter
Connection Hardware	13 mm

<u>Inlets and Manholes</u>:

All Dimensions	6 mm

Thickness in excess of that required shall not be cause for rejection provided proper jointing or operation is maintained as determined by the Engineer.

424.6 to 425.1

<u>Precast (Formed) Box Culverts</u>:

Tolerances for precast (formed) box culverts shall be as specified in Item 462, "Concrete Box Culverts and Sewers".

424.6. Storage and Handling.

(1) Prestressed Members. Storage and handling of prestressed members shall be in accordance with Item 425, "Prestressed Concrete Structural Members".

Prior to shipping to the job site, all beams, box beams, panels, piling and other prestressed members shall be marked for identification, as shown on approved shop drawings, with other project identification as required by the Engineer.

(2) Nonstressed Members. All nonstressed members shall be handled, stored, and shipped in a manner to avoid chipping, cracking, fractures, and excessive bending stresses. These members shall be supported on firm blocking.

Nonstressed members, prior to shipment, shall be marked in accordance with the requirements of the pertinent item.

424.7. Measurement and Payment. The work performed, materials furnished and all labor, tools, equipment and incidentals necessary to complete the work under this Item will not be measured or paid for directly, but will be considered subsidiary to the various bid items of the contract.

ITEM 425

PRESTRESSED CONCRETE STRUCTURAL MEMBERS

425.1. Description. This Item shall govern for the furnishing and erection of precast prestressed concrete members, in accordance with the plans, approved shop and/or working drawings, and this Item.

Prestressed members shall be defined as precast concrete members fabricated by the process of pretensioning, post-tensioning, or a combination of the two (2) methods.

425.2. Materials. All materials shall conform to the pertinent items as follows:

Item 421, "Portland Cement Concrete"
Item 426, "Prestressing"
Item 435, "Elastomeric Materials"
Item 440, "Reinforcing Steel"
Item 442, "Metal For Structures"
Item 575, "Epoxy"

The bedding strip for prestressed precast concrete bridge deck panels may consist of preformed bituminous fiber material conforming to the requirements of Item 433, "Joint Sealants And Fillers", or an expanded polystyrene conforming to the following requirements:

Property	Value	Test Procedure
Compressive Strength	380 kilopascal (Min)	ASTM D 1621 Procedure A-10% Yield
Water Absorption	0.61 kilogram per square meter (Max)	MIL-P-19644C
Oxygen Index	24 (Min)	ASTM D 2863

Adhesive or bonding agents for polystyrene shall be as recommended by the manufacturer.

Other materials may be used as panel bedding strips provided suitable engineering data is submitted for structural review and is approved by the Engineer.

The required dimensions for panel bedding strips shall conform to those shown on the plans.

425.3. General. Requirements for plant facilities, shop drawings, notice of beginning work, fabrication, and workmanship shall conform to the requirements of Item 424, "Precast Concrete Structures (Fabrication)".

425.4. Handling, Storing, Hauling, and Erection. The Con- tractor shall be responsible for proper handling, lifting, storing, hauling, and erection of all members so that they are placed in the structure without damage.

Unless approved on erection and/or shop drawings, prestressed members shall be maintained in an upright position at all times and shall be picked up and supported near the ends of the members in a manner which prevents torsion. Members shall be lifted with the lifting devices as approved on the shop drawings or by other methods approved, in writing, by the Engineer.

No member shall be moved from the casting yard until all requirements for prestressing, curing, and strength requirements have been attained.

Storing of prestressed members shall be done with adequate blocking so that warpage or cracking will not occur. The blocking shall be of such nature that uneven settlement due to wet ground or inadequate material underneath the blocking will not occur. Placement of the blocking from the beam ends shall be at locations not greater than three (3) percent of the beam length. Cantilever beams may be supported at locations other than near the ends when approved on the shop drawings. Concrete box beams shall be supported by the solid end block area during handling, storage, hauling, and erection. Members which are improperly stored and which become cracked, warped, or otherwise damaged in storage will be subject to rejection.

Prestressed members, when stacked, shall be separated by blocking capable of supporting the members. The blocking shall be arranged in vertical planes. Stacking of prestressed members shall be arranged such that lifting devices will be accessible and undamaged.

All concrete beams or girders, when erected, shall be securely tied and/or braced in accordance with the Department's minimum erection and bracing standards, unless otherwise shown on the plans. When railroad or roadway traffic must be maintained beneath girders or beams already placed, traffic shall be protected against falling objects during the erection of diaframs and other structural members, during the placing of cast-in-place concrete, and during the erection and dismantling of forms.

Protection shall consist of nets or flooring with openings not larger than 25 millimeters.

When prestressed precast concrete bridge deck panels are erected, the fit of mating surfaces shall be such that excessive grout leakage will not occur. If such fit is not provided the joint shall be filled with grout or sealed with an acceptable caulking compound prior to placing the cast-in-place portion of the slab.

After slab placement, the outside and bottom surfaces or exterior beams or members shall be given the surface area of finish specified in Item 427, "Surface Finishes For Concrete", unless otherwise shown on the plans.

425.5. Measurement. Precast prestressed concrete members will be measured by the meter, each, or square meter.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown on the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurement or calculations will not be required.

425.6. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Prestressed Concrete" of the specified member and/or type and/or size. This price shall be full compensation for fabrication of the members including furnishing and tensioning of prestressed steel, furnishing and placing reinforcing steel and duct, when required; for furnishing and placing bearing plates, bearing pads and all bars, anchorage plates and appurtenances which are an integral part of the structure; for grouting of holes; for any necessary repairs; for any special treatment of end anchorages and shoes required by the plans; and for all labor, tools, equipment and incidentals necessary to complete the work.

Prestressed precast concrete bridge deck panels will not be measured for payment, but will be considered subsidiary to the various bid items.

ITEM 426

PRESTRESSING

426.1. Description. This Item shall govern for the furnishing, fabricating, storing and handling of prestressing materials, for the prestressing of precast members, and for the prestressing of cast-in-place structural units, in accordance with the plans and with this Item.

426.2 to 426.3

426.2. Definitions. For this Item, the following definitions shall

apply:

(1) Prestressing. The introduction of internal stresses into a structural member by tensioning and anchoring strands, bars, or wires to counteract the stresses that will result from the applied load.

(2) Pretensioning. The application of prestressing force to the tensioning devices prior to the casting of the concrete.

(3) Post-tensioning. The application of prestressing force to the tensioning devices after the concrete has hardened.

(4) Tendon. Any single unit used to apply prestressing forces to the member. For post-tensioned units, a tendon shall be each bar, each group of wires, or each group of strands having common end anchorage.

(5) Post-tension System. A complete tendon with couplers, end anchorage, and all necessary hardware.

426.3. Materials.

All materials shall conform to the pertinent requirements of the following Items except as otherwise required herein:

Item 420, "Concrete Structures"
Item 421, "Portland Cement Concrete"
Item 433, "Joint Sealants and Fillers"
Item 435, "Elastomeric Materials"
Item 440, "Reinforcing Steel"
Item 442, "Metal For Structures"

(1) Prestressing Hardware. Prestressing hardware shall be in accordance with the manufacturer's specifications.

(2) Concrete. Concrete shall be of the class shown on the plans.

(3) Prestressing Steel. Prestressing steel shall conform to one of the following types:

Seven-wire steel strand conforming to ASTM A 416 and Departmental Material Specification D-9-4500; alloy bars conforming to ASTM A 722; or steel wire conforming to ASTM A 421.

When shown on the plans or permitted by approval of optional design, stress relieved seven-wire strand, shall be used.

The Contractor shall furnish the Engineer a copy of the manufacturer's certified Form D-9-PS-1. All seven-wire strand shall be furnished by a prequalified manufacturer. A list of prequalified manufacturers will be maintained by the Materials and Tests Division. The Department reserves the right to require the Contractor to furnish samples to verify compliance with specification requirements.

Strands, bars, or wires not produced in accordance with Departmental Material Specification D-9-4500, ASTM A 722, ASTM A 416 or ASTM A 421 which meet or exceed the physical properties of the material specified may be permitted provided the physical properties are shown on the shop drawings.

Testing shall conform to the applicable ASTM Specifications for the prestressing material used. Samples from each size and each heat of prestressing bars, from each manufactured reel of prestressing steel strand, from each coil of prestressing wire and from each lot of anchorage assemblies and couplers to be used shall be furnished for testing. With each sample of prestressing steel wires, bars, or strands furnished for testing, there shall be submitted a certification stating the manufacturer's guaranteed ultimate tensile strength and modulus of elasticity of the sample furnished.

All materials for testing shall be furnished by the Contractor at his expense. The Contractor shall have no claim for additional compensation in the event his work is delayed awaiting approval of the materials furnished for testing.

All bars of each size from each mill heat, all wire from each coil, and all strand from each manufactured reel to be shipped to the site shall be assigned an individual lot number and shall be tagged in such a manner that each such lot can be accurately identified at the job site. Each lot of anchorage assemblies and couplers to be installed at the job site shall also be identified in a similar manner. 426.3

All unidentified prestressing steel, anchorage assemblies or couplers received

at the site will be rejected and loss of positive identification of these items at any time will be cause for rejection of their use as intended.

Samples of materials and tendons, selected by the Engineer from the prestressing steel at the plant or job site, shall be furnished by the contractor to the Engineer well in advance of anticipated use. Sampling shall be done in accordance with Test Method Tex-710-I.

(4) Post-tensioned Tendons. Unless otherwise shown on the plans, the Contractor has the option of furnishing any type of post-tensioning system meeting the requirements of the specifications. The system selected shall provide the magnitude and distribution of prestressing force and ultimate strength required by the plans without exceeding allowable temporary stresses. Post-tensioned tendons shall be grouted or ungrouted, as shown on the plans. Tendon couplers shall be used only at locations specifically shown on the plans or approved by the Engineer.

(a) Grouted Tendons. For grouted tendons, end anchorages and tendon couplers (when permitted) shall develop a minimum of 95 percent of the required ultimate strength of the tendon with a minimum elongation of two (2) percent of the gage length when tested in the unbonded condition.

Rigid metal ducts may be fabricated with either welded or interlocked seams. Metal ducts shall be bent without crimping or flattening and shall have sufficient strength to maintain their correct alignment during placing of concrete. Joints between sections of ducts shall be positive metallic connections which do not result in angle changes at the joints.

Polyethylene (P.E.) ducts shall be sufficiently rigid to withstand placement of concrete, grouting and construction loads without damage or excessive deformation, while remaining watertight and shall be in accordance with ASTM Designation D 3350, and D 2239, D 2447, or D 3035 with cell classification PE3454336 or ASTM Designation D 1248, Type 3, Grade 34, Cat. 5. Plastic material used shall not react with concrete or enhance corrosion of prestressing steel and shall be free of water soluble chloride. Smooth plastic ducts shall be used in locations embedded in the concrete. Corrugations of the plastic ducts shall be continuous

spirals. The pitch of the spirals shall not be less than one-tenth of the radius (R/10) of the duct.

The Contractor shall provide certified test reports on static pull-out bonding

strength of the corrugated Polyethylene ducts for approval of the Engineer. These reports shall show that a force equal to 40 percent of the ultimate tensile strength of the tendon can be transferred from the tendon through the duct to the surrounding concrete at a length of 760 millimeters. Twelve (12) pull-out tests must be conducted of which ten must meet specified strength. The duct and its connections shall be capable of withstanding the specified pressure for flushing the ducts in the event of an aborted grouting operation.

Standard steel pipe shall have the properties defined in the latest edition of the American Institute of Steel Construction Manual and shall meet the requirements of ASTM A 53, Grade B.

The inside diameter of the duct shall be at least six (6) millimeters larger than the nominal diameter of a single strand, bar, or wire tendon; for multiple strand or wire tendons, the inside cross sectional area of the duct shall be at least two (2) times the net area of the prestressing steel. The duct shall be adaptable for use with transition fittings as required to accommodate the necessary anchoring system. The duct shall be equipped with fittings for injection of grout and ports for venting.

Grout to be used for the grouting of tendons shall be proportioned as follows:

Portland Cement - Type I or II proportioned at a maximum water cement (W/C) ratio of 0.45

Expanding Admixture - to provide 2 to 4 percent expansion (Expanding admixtures shall not contain any chlorides, fluorides, sulfites, nitrates, aluminum powder or any other corrosive elements.)

One (1) kilogram Max. of Type A fly ash conforming to Departmental Material Specification D-9-8900 may be added to the above mixture for every two (2) kilograms of cement if desired. When fly ash is used, additional water may be required to provide workability. Other pozzolans will not be permitted. Other mixtures of equal or better strength, workability, and free of corrosive

elements may be approved by the Engineer. A change of brand or type of cement shall require reevaluation of the grout mix.

(b) Ungrouted Tendons. For ungrouted tendons, end anchorages and tendon couplers (when permitted) shall develop at least 95 percent of the required ultimate strength of the tendon, with a minimum elongation of two (2) percent of the gage length, and shall withstand 500,000 cycles in a stress range of 0.6 F's minimum stress to 0.7 F's maximum stress,

where F's is the guaranteed ultimate tensile strength of the tendon, without failure or slippage.

Ungrouted tendons shall be coated with a nonvolatile, low friction mineral oil base grease, with a rust preventing additive having a relatively uniform viscosity under temperature ranges of -10 °C to 50 °C. A protective sheathing shall be provided around the tendon consisting of a waterproof material capable of maintaining the tendon tightly bundled and containing the lubricant.

426.4. Prequalification. Post-tensioning systems shall be prequalified prior to use on the project. Prequalification shall consist of tests on the complete tendons for compliance with the requirements of Subarticle 426.3.(4). These tests shall be performed by a testing laboratory approved by the Director of Materials and Tests. For post-tensioning systems previously tested and approved on Department projects, complete tendon samples need not be furnished, provided there is no change in material, design, or details previously approved. Shop drawings or prestressing details shall identify the project on which approval was obtained. Prequalification testing will be at the Contractor's expense and the results certified, in writing, to the Engineer.

426.5. Project Samples. For post-tensioning applications only and unless otherwise shown on the plans, the Contractor shall furnish, for ultimate strength tests, one (1) specimen for each size of strand, bar, or wire to be used in the prestressing tendons. These specimens shall be 1.5 meters in clear length. If the results of the test indicate the necessity of check tests, additional specimens shall be furnished without cost to the Department.

For prefabricated tendons, the Contractor shall notify the Director of Materials and Tests at least 10 days prior to the installation of end fittings or the heading of wires in order that sampling and testing may be arranged.

426.6. Packaging, Storing, and Handling. All prestressing steel shall be protected against physical damage and rust or other results of corrosion at all times from manufacture to grouting or encasing in concrete. Prestressing steel that has sustained physical damage at any time shall be rejected. Any reel that is found to contain broken wires shall be rejected and the reel replaced. The wire shall be bright and uniformly colored, having no foreign matter or pitting on its surface.

Prestressing steel shall be packaged in containers or shipping forms for protection of the steel against physical damage and corrosion during shipping and storage. A corrosion inhibitor which prevents rust or the results of corrosion shall be placed in the package or form, or shall be incorporated in a

corrosion inhibitor carrier type packaging material, or when permitted by the Engineer, may be applied directly to the steel. The corrosion inhibitor shall have no deleterious effect on the steel or concrete or bond strength of steel to concrete. Inhibitor carrier type packaging material shall conform to the provisions of Federal Specification MIL-P-3420. Packaging or forms damaged from any cause shall be immediately replaced or restored to original condition.

The shipping package or form shall be clearly marked with a statement that the package contains high-strength prestressing steel, and the care to be used in handling, and the type, kind and amount of corrosion inhibitor used, including the date when placed, safety orders and instructions for use. Low Relaxation (Stabilized) strand shall be specifically designated per requirements of ASTM A 416. All strands not so designated shall be rejected.

When acceptable prestressing steel for post-tensioning is installed in the ducts after completion of concrete curing, and if stressing and grouting are completed within three (3) calendar days after the installation of the prestressing steel, loose rust which may form during said three (3) days will not be cause for rejection of the steel. Prestressing steel installed, tensioned and grouted in this manner, all within three (3) calendar days, will not require the use of corrosion inhibitor in the duct following installation of the prestressing steel. Post-tensioning steel installed as above but not grouted within three (3) calendar days shall have a corrosion inhibitor, approved by the Engineer, used in the ducts and shall be subject to all the requirements in this section pertaining to corrosion protection and rejection because of rust. Tight rust or pitting due to rust at any time will be cause for rejection of the strand.

426.7

When prestressing steel for post-tensioning is installed in the ducts prior to concrete placement, a corrosion inhibitor, approved by the Engineer, shall be placed in the duct immediately after concrete placement. If the corrosion inhibitor is disturbed and stressing of the strand is not anticipated for three (3) days, new corrosion inhibitor shall be installed.

426.7. Equipment. The Contractor shall furnish suitable hydraulic jacks for prestressing the steel. The jacks shall be equipped with instruments for monitoring the hydraulic pressure. Bourdon tube pressure gauges shall be fluid filled and shall be at least 150 millimeters in diameter. Electronic pressure transducers with digital indicators may be used. All pressure gauges or electronic pressure indicators shall indicate the load directly to one (1) percent of the maximum gauge or sensor/indicator capacity or two (2) percent of the maximum load applied, whichever is smaller.

Each jack and its gauge shall be calibrated as a unit with the cylinder extension in the approximate position that it will be at final jacking force. The calibration of the jack and gauge shall be done while the jack is in the identical configuration as will be used on the site, e.g., same length hydraulic lines. Certified calibration charts shall be furnished by an independent laboratory with each jack and gauge used on the project. Certified calibration of each ram shall be made prior to the start of stressing operations on the project and every six (6) months thereafter, or as requested by the Engineer. Any repair of the rams, such as replacing the seals, changing the length of the hydraulic lines, changing the type of pump or using gauges which have not been calibrated with the ram, shall be cause for recalibration of the jack and gauge with a load cell. No extra compensation will be allowed for the initial or subsequent ram calibrations.

For post-tensioning, the jacks shall have provisions for measuring tendon elongation directly on the strand or bar. The jacks shall be capable of slow release of force to properly seat the tendon anchors.

The Contractor shall furnish a grout pump of sufficient capacity to properly place grout in the quantities, pressures, and within the time limits required.

For pretensioning, jacks for multiple strand stressing shall have sufficient capacity to provide the required stressing force and to permit simultaneous release of all straight strands. Single strand stressing will be permitted, but release of strands individually with single strand jacks will

not be permitted. Single strand jacks for pretensioning shall have provisions for measuring the elongation directly on the strand.

426.8. Working Drawings. For cast-in-place prestressed units, in addition to forming and falsework plans required by Item 420, "Concrete Structures", the Contractor shall submit prestressing details. These details shall contain all necessary information for construction including:

(1) Design Calculations. Unless otherwise shown on the plans, all design procedures, coefficients, and allowable stresses as well as tendon spacing and clearances shall be in accordance with the Standard AASHTO Specifications for Highway Bridges. Sufficient calculations to support the system and method of prestressing proposed for use, including realistic friction loss diagrams, shall be submitted. When the required jacking force for a particular type of tendon and duct and configuration is shown on the plans, and that type of tendon and duct and configuration are furnished, design calculations need not be submitted except as necessary to adjust for any

conditions different from those shown on the plans.

(2) Post-tensioning Details. These drawings shall show details of type, size, and number of strand, bar, or wire per tendon, tendon location and identity mark, jacking forces, lubricated tendons, seating loss, end anchorage systems, tendon profile, grouting and venting ports, grouting procedure, total elongation, measurable elongation, and other information necessary to properly complete the work. Jack gauge pressures required to monitor the stressing operation shall be furnished to the Engineer prior to the stressing operation.

If friction reduction lubricants are to be used, the details shall state that use and the calculations shall be based on appropriate friction factors.

A numbered layout and a step-by-step stressing sequence for the tendons shall be submitted. Complete provisions shall be made for each stressing operation, beginning with strand installation and ending with removal of excess strand at the anchors. All data pertaining to the stressing of the tendons, for a structure, shall be furnished in tabular form.

Post-tensioning details shall include the method of support for the duct and location of the duct so that the center of gravity of the enclosed steel will be at the proper position. The details shall show the offsets from the bottom of the duct relative to the position of the prestressing steel within the duct and the distance from the bottom form to the bottom of the duct.

426.9

The post-tensioning details shall be submitted on ISO A1 sheets (metric units of 841 millimeters x 594 millimeters) or on sheets having English units of 34 inches x 22 inches.

Design calculations may be on standard letter size sheets.

Six (6) sets of details and three (3) sets of design calculations shall be submitted to the Engineer, or directly to the Director of Design, Texas Department of Transportation, 125 East 11th Street, Austin, Texas 78701-2483, when so directed.

When a railroad underpass structure is involved, an additional set of details and calculations will be required.

426.9. Construction Methods.

(1) General. The general requirements of Item 420, "Concrete Structures", shall govern for cast-in-place construction and Item 424, "Precast

Concrete Structures (Fabrication)" shall govern for precast concrete units or members.

Prior to stressing, the Contractor shall furnish the Engineer certified copies of load calibration curves on all jacks and gauge systems to be used in the work.

The control of concrete shall be by compressive tests of cylinders. The making, curing, and testing of test cylinders for "Release Strength", "Handling Strength", "Partial Tensioning Strength", and/or "Tensioning Strength" shall be in accordance with Test Method Tex-704-I.

(2) Post-tensioning. The post-tensioning details submitted by the Contractor shall reflect the following general tensioning procedure, modified for each particular installation:

(a) The modulus of elasticity shall not vary by more than one (1) percent for any strand within a tendon.

(b) The tendons shall be tensioned in the sequence designated in the approved post-tensioning details.

(c) Initial tensioning to take the slack out of the tendons will be 10 to 20 percent of the maximum tensioning load.

(d) After the initial tensioning, the tendons shall be reference marked to determine elongation.

(e) After tensioning to the specified jacking force, elongations shall be measured to determine tendon acceptance. After the tendon is accepted, the tendon anchors may be seated.

(f) After stressing and anchoring all tendons and upon the Engineer's approval, projecting tendons shall be trimmed as shown in the approved prestressing details.

If end anchorages permit, tendons may be inserted in the member after placing of the concrete. Positive means of holding the duct and reinforcing steel in the correct position shall be provided in all cases. The duct shall be supported at intervals of not more than 1.2 meters, or as shown on the plans. They shall be securely fastened to prevent movement in any direction during placement of concrete.

Tolerance for vertical positioning of tendons will

be ± 6 millimeters, or 10 millimeters per meter of depth of the member, whichever is greater.

After the concrete has reached a compressive strength equal to the "Partial Tensioning Strength" shown on the plans, as indicated by compressive cylinder tests, the members may be partially post-tensioned for the purpose of form removal or for removal of members from the casting bed to a curing area, provided satisfactory provision is made to bring all stressing units (including units stressed for handling) up to full required stress at the time of final stressing. The units to be stressed and the amount and pattern of the stressing for the partial post-tensioning shall be submitted with the post-tensioning details and approved by the Engineer.

The final post-tensioning force may be applied when the concrete has reached a compressive strength equal to the "Tensioning Strength". These forces may be applied to one or both ends of the tendon, as shown on the post-tensioning details. The sequence of post-tensioning shall prevent overstressing the member in vertical or lateral bending at any time, and shall be indicated on the post-tensioning details.

Calculations for elongation shall be adjusted to utilize either the modulus of elasticity for the strands being stressed or, when a bench test is specified, the apparent modulus derived from the bench test.

426.9

Suitable means shall be provided for measuring the elongation of the steel to the nearest one (1) millimeter. Elongations for determining tendon acceptance shall be made before anchor seating and shall compensate for dead end anchor loss, anchor set, and elongation of strand in the jack. In the event of discrepancies of more than five (5) percent between calculated and measured elongations, the entire stressing operation shall be checked carefully and the source of variation determined and corrected before proceeding further.

Loss of elongation due to anchor set shall be checked for agreement with the anticipated value used in the stress calculations. Adjustments to the jacking force may be required on future tendons to compensate for anchor set greater than anticipated.

Failure of individual wires of a seven (7) wire strand or of wires in a parallel wire tendon is acceptable provided the total number of wire failures is not more than two (2) percent of the total number of wires in the tendon group. Failure of an entire strand will be cause for rejection of the tendon.

Slippage of anchor wedges will be reason to reject the tendon pending

the results of a structural review.

For grouted tendons, the ducts shall be grouted within 48 hours after the completion of the tensioning operation. A sufficient number of 50 millimeters grout cubes shall be made and job cured per grouting period. The temperature of the concrete shall be between 2 °C and 32 °C, from the time of grouting until the average compressive strength of three (3) consecutive cubes exceeds 5.5 megapascal. No individual cube of the three (3) may be less than 90 percent of the specified compressive strength. Grout must be pumped toward an open vent. Grout shall be pumped continuously under moderate pressure at one end of the duct until all entrapped air is forced out the open vents downstream from the grout pump. The open vents shall be closed as soon as grout flows in a steady stream. The grouting procedure shall continue as long as the established grouting time limit (if applicable) is not exceeded. After all grout ports have been closed, the pressure shall be increased to a minimum of 0.5 megapascal and held at this pressure for approximately 15 seconds. The grouting entrance port shall then be closed.

Grout ports will be required at the far end of the tendon, and at the high points of the tendon profile when there is more than 150 millimeters variation in the vertical position of the duct. Tendons with less than

426.9

150 millimeters vertical variation shall have grout ports at the far end and at intervals between the far end and injection end not to exceed 30 meters. Grout ports shall consist of 13 millimeters minimum diameter pipe, with caps, valves, or other positive means of closing the pipe and having a minimum port diameter of 13 millimeters, as approved by the Engineer. The tops of the grout ports shall be set approximately 15 millimeters below the finished surface of the concrete. Upon completion of grouting, recesses caused by the grout ports in the concrete surface shall be filled with mortar and finished to the satisfaction of the Engineer.

(3) Pretensioning. All strands to be pretensioned as a group shall be brought to a uniform initial tension of 4.4 kilonewtons (plus or minus 0.2 kilonewton) per tendon prior to being given their full pretensioning. Initial tension greater than that specified herein may be used when designated and approved on the shop drawings. The tension shall be measured by a dynamometer, or other suitable means to check the computed and measured elongation.

The modulus of elasticity shall not vary by more than one (1) percent for any strands that are being gang tensioned.

After initial tensioning, the straight strands shall be tensioned to a total stress as required by the plans by means of single strand or multiple strand

hydraulic jacks that are equipped with calibrated gauges. The induced stress shall be measured by elongation of the strands and checked by gauge pressure. The results shall agree within five (5) percent.

Means shall be provided for measuring the elongation of the straight strands to an accuracy of one (1) percent of the theoretical elongation or three (3) millimeters, whichever is smaller. In the event of discrepancies of more than five (5) percent between stresses indicated by gauge pressure and elongation, the entire operation shall be checked carefully and the source of variation determined and corrected before proceeding further.

Where a combination of straight and draped strands are used, the measured elongation of the draped strand shall not vary more than five (5) percent from the calculated elongation. Measurements on individual deflected strands to establish differential stresses at selected points on the member shall be averaged at a cross section of the member, and the averages shall be within five (5) percent of the calculated elongation. The measured elongation of any individual strand shall not vary from the calculated elongation more than ten (10) percent at any measured cross section.

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Independent references shall be established adjacent to each anchorage to indicate any yielding or slippage that may occur between the time of initial stressing and final release of the tendons.

One (1) splice per pretensioned strand will be permitted, subject to the following:

Splices shall be located outside the members; strands which are spliced shall have the lay or twist in the same direction to avoid unravelling.

When splices are used in a multiple strand tensioning operation, all the strands shall be spliced so that an adjustment can be made for the average seating loss.

When shown on the plans, strands with bond breakage (debonding) shall be encased in plastic tubing along the entire debonded length and ends of tubing sealed with waterproof tape. Split plastic tubing may be used provided the seam of the tubing is sufficiently sealed with waterproof tape to prohibit grout infiltration. Wrapping of strands with tape to provide debonding will not be permitted.

Full-length debonding of straight strands shall be permitted only as approved by the Engineer and shall be done on an individual basis. Full-length debonding, when permitted, shall be symmetrical about the vertical

centerline of the beam and shall be limited to ten (10) percent of the total number of straight strands or a maximum of six (6) strands, whichever is less. Full-length debonding of draped strands will not be permitted.

With the strands fully stressed as prescribed above and all other reinforcing in place, the concrete shall be cast to lengths necessary to provide the lengths required by the plans, after shrinkage and elastic shortening has occurred.

After concrete strength requirements are attained, the tension in the strands shall be gradually and simultaneously released and the strands cut off as required, using a sequence to minimize shock and reduce premature tendon breakage. Release of strands individually with single strand jacks will not be permitted. Flame release of deflected strands in beams and boxes, and straight strands in piling, panels, and tee beams will be permitted provided the method and sequence is submitted to and approved by the Engineer.

When draped strands are used, positive external hold downs may be required to offset the vertical forces in the beam at the time of stress release.

(4) Combined Pretensioning and Post-tensioning. Where the plans call for a combination of pretensioning and post-tensioning, all of the requirements of both the pretensioning and post-tensioning shall apply.

426.10. Measurement.

(1) All precast concrete members (except piling) either pretensioned, post-tensioned, or combined pretensioned and post-tensioned, will be measured and paid for as specified in Item 425, "Prestressed Concrete Structural Members". Prestressed piling will be measured and paid for as specified in Item 409, "Prestressed Concrete Piling".

(2) Cast-in-place prestressed concrete structures and units will be measured as follows:

(a) Grout and ducts for post-tensioning will not be measured but will be considered subsidiary to this Item.

(b) The prestressing system required and the work involved in prestressing of cast-in-place structures will be measured by the product of the required final prestress force and the horizontal length over which the prestressing is applied, expressed in kilonewton meter (kN·m). Unless otherwise shown on the plans, the required final prestress force used will be the maximum value required within a unit, and the length

of prestressing will be taken as the overall dimensions of the unit, no deductions being made for the clearance distance between the ends of tendons and the ends of the unit.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required. The maximum percent variance from the plans quantity for which no adjustment will be made will be as follows:

Percent Variance

Plans Quantity	Percent
Over 6800 kN·m	1/2%
1400 kN·m through 6800 kN·m	1%
Less than 1400 kN·m	1-1/2%

426.11. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Prestressing (Grouted)" or "Prestressing (Ungrouted)". This price shall be full compensation for furnishing all prestressing steel; for fabrication, transportation, erection and post-tensioning; for furnishing all encasing ducts, grout fittings, grout, end anchorages, and bearing plates; and for all materials, labor, tools, equipment and incidentals necessary to complete the work.

ITEM 427

SURFACE FINISHES FOR CONCRETE

427.1. Description. This Item shall govern for furnishing, surface preparation and application of surface finishes for new or existing concrete surfaces.

427.2. General. The surface areas, class and/or type of finish shall be as described herein and as specified on the plans.

"Surface Area" of finish designates the areas to which a higher finish is to be applied, beyond the requirements of an Ordinary Surface Finish. Three surface areas of finish are included herein.

"Class" of finish designates the materials or the process to be used in providing the surface area of finish. Five classes of finish are included herein.

"Type" of Class designates the specific resin type for Class B coatings.

For structures and surfaces not described herein under surface area of finish, a class of finish only may be specified on the plans.

Where neither surface area nor class is specified, only an Ordinary Surface Finish, as described in this Item, will be required.

Where the plans specify a surface area, class and type of finish; i.e., Surface Area II, Class B, Type II; only that class and type of finish shall be furnished.

Where the plans specify a surface area and class of finish; i.e. Surface Area II, Class C; only that class of finish shall be furnished.

Where the plans specify a surface area of finish only, i.e., Surface Area I Finish, any of the classes and/or types of finish may be furnished. Only one class and/or type of finish shall be furnished on any individual structure, twin structures or on structures in close proximity to each other, except as specified for prestressed concrete members below.

427.3. Ordinary Surface Finish. An Ordinary Surface Finish shall be applied to all concrete surfaces either as a final finish or preparatory to a higher surface area or class of finish. Higher surface areas and classes of finish shall be in accordance with this Item.

Ordinary Surface Finish shall be provided as follows:

After form removal, all porous or honeycombed areas and spalled areas shall be corrected by chipping away all loose or broken material to sound concrete.

Feather edges shall be eliminated by cutting a face perpendicular to the surface. Shallow cavities shall be repaired using latex adhesive grout or epoxy mortar. If judged repairable by the Engineer, large defective areas shall be corrected using concrete or other material approved by the Engineer.

Holes and spalls caused by removal of metal ties, etc., as required by Item 420, "Concrete Structures", shall be cleaned and filled with latex grout or epoxy mortar. Exposed parts of metal chairs on surfaces to be finished by rubbing, shall be chipped out to a depth of 15 millimeters and the surface repaired.

All fins, runs, drips or mortar shall be removed from surfaces which remain exposed. Form marks and chamfer edges shall be smoothed by grinding and/or dry rubbing.

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Repairs shall be dense, well-bonded and properly cured and when made on surfaces which remain exposed and do not require a higher finish,

shall be finished to blend with the surrounding concrete.

Unless otherwise shown on the plans, Ordinary Surface Finish shall be the final finish for the following exposed surfaces: inlets, manholes, sewer appurtenances, inside of culvert barrels, bottom of bridge decks between beams or girders, vertical and bottom surfaces of interior concrete beams or girders, except that form marks and chamfer edges will not require smoothing on the inside of culvert barrels and the bottom of bridge decks between beams or girders.

427.4. Surface Areas of Finish.

(1) Surface Area I. The following areas shall receive a Class A, B, C, D or E Finish, except that prestressed members shall receive either a Class A, B, D or E Finish only.

All concrete surfaces of railing, including the parapet types; exterior vertical faces of slabs, slab spans, arches and box girders (including prestressed members); the outside and bottom surfaces of fascia beams or girders (including prestressed members); the underside of overhanging slabs to the point of juncture of the supporting beam; when shown on the plans, the entire width of the underside of the slab of slab spans; all exposed vertical surfaces of bents and piers and bottom surfaces of bent caps; all surfaces of tie beams, abutments, bridge wingwalls, culvert headwalls and wingwalls and retaining walls exposed to view after all backfill and embankment is placed.

When shown on the plans, exposed surfaces of pump houses and other miscellaneous concrete surfaces shall receive a Class A, B, C, D, or E finish.

(2) Surface Area II. All concrete surfaces of railing, including the parapet types, all exposed surfaces of wingwalls and the exterior vertical faces of slabs shall receive a Class A, B, C, D or E Finish. All other surfaces described under Surface Area I shall receive an Ordinary Surface Finish.

(3) Surface Area III. Only the top and roadway faces of all concrete railing, including the parapet types, and bridge wingwalls shall receive a Class A, B, C, D or E Finish. All other surfaces described under Surface Area I shall receive an Ordinary Surface Finish.

427.5. Class of Finish. The Class of Finish designates either an adhesive grout material, a paint-type material, a blasting process, or a rubbing process applied to surfaces specified in Surface Area of Finish, as required herein and/or as shown on the plans.

Unless otherwise shown on the plans, the color of all coatings and finishes shall be concrete gray.

(1) Class A. Class A finish shall consist of a blast cleaning meeting the requirements set forth under "Construction Methods" followed by the application of an adhesive grout textured coating applied at a minimum 1.5 millimeters thickness.

(2) Class B. Class B finish shall consist of a blast cleaning meeting the requirements set forth under "Construction Methods" followed by the application of a paint-type textured coating applied at a rate of 1.2 to 1.5 square meters per liter or paint-type untextured coating applied in two coats for a total maximum application rate of 3.7 square meters per liter. Two Types of Class B coatings are described. Type I is a textured Acrylate resin solvent based material and Type II is an untextured Acrylic resin water-based material. The texture and color of the applied and cured coating shall be uniform. Class B materials shall not be thinned for application without the approval of the Engineer.

(3) Class C. Class C finish shall consist of a one rub system, meeting the requirements set forth under "Construction Methods".

(4) Class D. Class D finish shall consist of a blast cleaning meeting the requirements set forth under "Construction Methods".

(5) Class E. Class E finish shall consist of a blast cleaning meeting the requirements set forth under "Construction Methods" followed by the application of #742, Gray Appearance Coat (in accordance with Item 446, "Cleaning, Paint and Painting"), at a rate not to exceed 9.8 square meters per liter.

Class E finish is recommended for surfaces which are likely to be exposed to deicing materials. Number 742, Gray Appearance Coat is an untextured coating. When a textured finish is desired, the application of No. 742 shall be followed by the application of Class B, Type I coating.

427.6. Approval of Surface Finishing Materials.

(1) Class A and B Finishes. The (latex) emulsion for Class A finish and the Class B paint-type textured and untextured coatings to be furnished shall meet the requirements of Departmental Materials Specification D-9-8110, and shall be shown on the Department approved list maintained by the Materials and Tests Division, 125 East 11th Street, Austin, Texas 78701-2483. Class A and B materials shall be purchased on the open market.

(2) Class E Finish. The Class E coatings to be furnished shall meet the requirements of Departmental Materials Specification D-9-8100. Class E materials shall be purchased from the Department and will be charged and furnished in accordance with the pertinent parts of Item 446, "Cleaning, Paint and Painting".

(3) Sampling and Testing. Sampling shall be in accordance with Test Method Tex-813-B. Sampling and Testing will be in accordance with the Department's MANUAL OF TESTING PROCEDURES.

427.7. Construction Methods. Prior to application of any of the finishes required herein, concrete surfaces shall be given an Ordinary Surface Finish.

(1) Blast Cleaning. In preparation for application of Class A, B or E finishes, concrete surfaces shall be blast cleaned to remove laitance, curing compound and other contaminants. Air lines shall be equipped with a filter to remove all oil and water from the air.

Blast nozzle distance from the surface shall be such that contaminants are removed with little or no damage to the concrete. The blasted concrete surface shall exhibit a relatively uniform texture. Pronounced surface texture streaks conforming to the blast pattern indicates the blast nozzle is being held too close to the surface. Such practice will not be permitted.

Immediately prior to finish application, all surfaces to be coated shall be blown down with high (at a gage pressure of 620 kilopascal or more) pressure, oil and moisture free, air to remove loose particles accumulated on the surface during and after blasting. The presence of loose particles shall be determined by the following test:

Press a 250 millimeter strip of 50 millimeter wide filament tape on the surface by rubbing with a moderate pressure four times. Leave approximately 50 millimeters of one end of the tape free from the surface. Grasp the free end of the tape and remove the tape from the surface with a sharp jerk. The surface shall be considered contaminated if the removed tape exhibits particle clinging to its surface.

Surface contamination with oil type materials can be detected by spraying the surface with a fine mist of clean water. If the water beads up, the surface is contaminated with oil type materials.

(2) Material Preparation. Class A, B and E materials shall be prepared for application by thoroughly mixing with a mechanical mixer. Mixer speed shall be such that the material being mixed exhibits a positive mixing movement. Complete mixing shall be assure by probing the container with a 25 millimeter by 50 millimeter board or similar device for non-dispersed or settled material. The mechanical mixer shall be in operation at all times when the material is being used from the container. Thoroughness of mixing may be determined in accordance with Test Method Tex-813-B.

Class E materials shall be further prepared by thinning before application with one (1) liter of xylene per five (5) liters of material.

(3) Equipment Requirements. When Class A or B material is applied by spray, the spray gun shall be equipped with an internal mix nozzle and material delivery to the spray gun should be by a fluid pump. The internal mix nozzle and fluid tip shall be a matching set of sufficient size to handle the material. Working fluid pressure and air pressure regulators and gages shall be incorporated on equipment utilized for spray application to allow adjustment of the fluid and atomization pressures to produce a uniform spray pattern with a minimum of overspray and allow the applicator to work at a smooth, comfortable rate. A single pass with well maintained and properly adjusted equipment must exhibit a pattern such that the fan on either side of the fan midpoint is a mirror image of the other half of the fan pattern.

Equipment for application of Class E material shall be in accordance with the pertinent requirements of Item 446, "Cleaning, Paint and Painting".

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(4) Application. The Class A, B and E material shall be applied after the Ordinary Surface Finish and Blast Cleaning have been completed and just

prior to final acceptance of the work unless otherwise approved by the Engineer.

Class A materials shall be applied on moistened surfaces. Class B and E materials require a dry surface. The temperature of the atmosphere, concrete and material shall be above 10 °C for Classes A, B and E materials at the time of application. The finished surfaces shall be protected against rain or freezing for a period of 24 hours after application.

Class A, B and E materials may be applied by spraying, by roller or by brush. When application is by spray, the applicator shall spray in deliberate length passes, triggering the spray gun at the end of each pass, overlapping adjacent passes 20 to 40 percent and aiming the spray gun such that the material is coming into contact with the surface at an angle not less than 80 degrees. When painting surfaces that are vertical in nature, application shall be from bottom to top. Applicators who do not practice these techniques will not be allowed.

Two or more coat applications of Class B material shall not have subsequent coats applied sooner than four hours after application of the preceding coat.

The Class C Finish shall be performed with a carborundum stone after all preparatory work required by Ordinary Surface Finish has been completed, as follows:

> The rubbing shall bring the wetted concrete face to a paste and produce a smooth dense surface without pits, form marks or other irregularities. The use of cement grout to form the paste will not be permitted. The surface shall be striped with a brush and allowed to take a reset after which the surface shall be washed with clean water leaving it with a neat and uniform appearance and texture.
>
> The rubbing shall be done soon after form removal. Membrane curing, if used, shall be applied after the rubbing is completed in accordance with Item 526, "Membrane Curing".

427.8. Special Surface Finishes.

(1) General. When special surface finishes are required, the

Contractor shall submit a satisfactory work plan to the Engineer for approval. The work plan shall include the aggregates, materials, variation of panel or pattern arrangements, dimensions, construction methods and other features affecting the work. Upon approval of the work plan but prior to the start of the work, the Contractor shall prepare a sample panel for approval of the finish and the method of application. Unless otherwise shown on the plans, the dimension of the sample panel shall be two (2) meters by two (2) meters.

(2) Striated Finish. The striated (grooved) pattern shall be as shown on the plans or as approved by the Engineer. A chamfer groove shall be used along all edges of each form panel. All ties, bolts or other forming accessories shall be located along the chamfer grooves or panel edges.

(3) Exposed Aggregate Finish. Exposed aggregate panels may be either raised, recessed or as indicated on the plans with the sides of each panel chamfered as approved by the Engineer. The aggregate used for this kind of finish shall be approved by the Engineer and meet the grading requirements shown on the plans. Gravel of predominantly rounded particles shall be used, except that crushed stone may be used when a bush hammer finish is desired. The aggregate shall be large enough to remain firmly anchored in the face of the final product. The depth of finish shall be ten (10) millimeters minimum to 13 millimeters maximum, unless otherwise directed by the Engineer or shown on the plans.

A concrete surface retarder that penetrates approximately six (6) millimeters shall be applied to the forms or concrete surface as an aid in achieving the desired finish. Wood forms may require 2 to 3 coatings to compensate for absorption. Form joints shall be taped or caulked to prevent escape of the retarder during placing operations. Treated form surfaces shall be protected from sun and rain while exposed to the atmosphere, and shall be retreated if the retarder is damaged by rain or severe exposure.

Adjacent areas of fresh concrete not requiring exposed aggregate finish shall be protected from the retarder when it is applied.

The finish shall be obtained by sandblasting, bush hammering or other method approved by the Engineer. Horizontal surfaces may be

finished by combination of brushing and washing, but only after the concrete has set sufficiently to prevent loosening of the aggregate.

Unless otherwise directed by the Engineer, forms for surfaces requiring exposed aggregate finish shall be removed 12 to 15 hours after concrete placement. The exposed aggregate operation shall be accomplished

immediately after form removal. Except for the time required for obtaining the exposed aggregate finish, curing of all surfaces will be maintained for the minimum four day curing time. All surfaces shall be mat (water) cured or may be cured in accordance with Item 526, "Membrane Curing". The exposed aggregate surfaces shall be recleaned by light blasting or other approved method prior to the application of the acrylic resin sealer.

Exposed aggregate surfaces shall receive a coat of clear acrylic resin sealer as specified in Departmental Materials Specification D-9-8100. The material may be applied in single or multiple coats; however, the total coverage shall be at the rate of not more than six (6) square meters per liter.

(4) Epoxy Waterproofing. The epoxy system shall conform to Type X of Item 575, "Epoxy". The color of waterproofing material shall be white. A sample of the material to be used shall be submitted to the Engineer for testing prior to approval.

The surface of the concrete cap to which waterproofing is applied shall be blast cleaned in accordance with this Item. The waterproofing material shall be applied in a manner to obtain a uniform minimum dry film thickness of 250 micrometer.

427.9. Measurement. Surface finishes on existing concrete will be measured by the square meter. Epoxy waterproofing will be measured by the square meter. Surface finishes on new concrete will not be measured for payment.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

427.10. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Class A Finish for Existing

Concrete", "Class B Finish for Existing Concrete", "Class A or B Finish for Existing Concrete", "Class D Finish for Existing Concrete", "Class E Finish for Existing Concrete" or "Epoxy Waterproofing". This price shall be full compensation for furnishing all materials, for cleaning existing surfaces, for application of material and for all labor, tools, equipment and incidentals necessary to complete the work.

Except when shown on the plans as a bid item, the work performed,

materials furnished and all labor, tools, equipment and incidentals necessary to complete the work under this Item will not be measured or paid for directly, but will be considered subsidiary to the various bid items on the contract.

ITEM 428

CONCRETE SURFACE TREATMENT

428.1. Description. This Item shall govern for the furnishing and application of a linseed oil treatment to concrete surfaces.

428.2. Materials. This material shall consist of boiled linseed oil and mineral spirits for any ambient temperature range above 4 °C. Boiled linseed oil and kerosene may be used at the option of the Contractor for an ambient temperature range above 21 °C. The materials shall meet the following specifications and shall be shipped combined in a mixture containing a minimum of 50 percent and a maximum of 70 percent boiled linseed oil by volume.

(1) Boiled Linseed Oil. Boiled linseed oil shall conform to ASTM D 260.

(2) Mineral Spirits. Mineral Spirits shall conform to ASTM D 235.

(3) Kerosene. Kerosene shall conform to the requirements of Federal Specifications for Kerosene VV-K-211d.

(4) Shipment. The material shall be shipped in clean, leakproof containers with contents clearly stated on them.

428.3. Construction Methods. Unless otherwise noted on the plans, the upper surfaces of the roadway slab (including direct traffic culverts), bridge sidewalks and medians, and the inside faces of curbs shall

be treated. Any surfaces given a higher finish as specified in Item 427, "Surface Finishes for Concrete", will not be given linseed oil treatment.

Before application, final cleaning of concrete surfaces shall be cleaned by air blasting or water blasting, as necessary to remove laitance, curing compound, and other contaminants which may retard or prevent absorption of the mixture by the concrete.

Surface treatment shall not be applied earlier than 14 days after required curing has been completed. The concrete surfaces shall be dry and the ambient temperature shall be 4 °C or above at the time of application.

The mixture shall not be heated.

Unless otherwise shown on the plans, the material shall be applied in two stages at the rate of approximately nine (9) square meters per liter for the first stage and approximately 15 square meters per liter for the second stage for a total coverage of approximately five (5) square meters per liter. The second application shall not be made until 24 hours after the first application is made.

Application to slabs shall be made with a herbicide, insecticide or similar type spray machine equipped with a spray bar and driven at such speed as to provide the required coverage. The application may be made using a hand operated pressured pump equipped with spray nozzles when the total area to be treated is approximately 70 square meters or less.

Any excess liquid remaining on the surface after four hours shall be broomed off or covered with an application of fine sand.

Traffic shall not be permitted on treated surfaces for a minimum of 24 hours after the final application has been completed.

428.4. Measurement. This Item will be measured by the square meter of concrete surface using the dimensions shown on the plans.

428.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Concrete Surface Treatment".

This price shall be full compensation for all materials, tools, labor, equipment and incidentals required to perform the work prescribed herein.

ITEM 429

CONCRETE STRUCTURE REPAIR

429.1. Description. This Item shall govern for the repair of spalled and chipped areas of concrete structures, for the removal of unsound concrete at locations indicated on the plans, or as required by the Engineer, and for replacement with materials in accordance with these specifications and as shown on the plans.

429.2. Materials. All materials shall conform to the pertinent requirements of the following items:

Item 420, "Concrete Structures"
Item 421, "Portland Cement Concrete"
Item 431, "Pneumatically Placed Concrete"
Item 440, "Reinforcing Steel"
Item 575, "Epoxy"

Concrete for repair shall contain Grade 1 fine aggregate, Grade 7 coarse aggregate and a minimum of 390 kilograms of cement per cubic meter. Concrete shall have a maximum slump of 75 millimeters with a minimum seven (7) day design flexural strength of 3520 kilopascals or a 28 day compressive strength of 25 megapascals.

Epoxy mortar for repair shall conform to the epoxy manufacturer's recommendations.

Steel drive pins, studs, or expansion bolts, used for attachment of new reinforcement, shall conform to the requirements of Item 431, "Pneumatically Placed Concrete".

429.3. Construction Methods. Concrete, as defined above, shall be used for repair of areas with depths of 25 millimeters or greater. Mortar, conforming to Item 421, "Portland Cement Concrete", shall be used for repair of areas with depths less than 25 millimeters. Epoxy mortar may be used in lieu of concrete or mortar for repair, if approved by the Engineer.

Replacement of concrete may be accomplished in accordance with Item 431, "Pneumatically Placed Concrete", or other alternate methods, if approved by the Engineer. A satisfactory demonstration of the adequacy of any alternate method shall be performed by the Contractor and approved by

the Engineer prior to the actual replacement of the concrete on the various structure members.

For small areas the Contractor may mix the concrete or mortar in a small motor-driven mixer using the volume method of measuring the ingredients. The method used to measure ingredients and the mixing procedure shall be approved by the Engineer.

Placement of concrete or mortar shall not be permitted when the atmospheric temperature (taken in the shade away from artificial heat) is below 10 °C. The minimum temperature of the new concrete or mortar at the time of placement shall be 16 °C.

Existing concrete designated to be repaired shall be prepared by chipping or other methods to remove all loose or defective concrete. Feather edges shall be eliminated by saw cutting and/or chipping a perpendicular or back-tapered face, approved by the Engineer, along the periphery of the area to be repaired so that the minimum depth of repair is approximately 15 millimeters. The area being prepared shall be cleaned by sandblasting, high pressure water or other means approved by the Engineer to remove all loose particles, dirt, deteriorated concrete or other substance that would impair the bond between the old concrete and the repair material.

Exposed reinforcing steel shall be cleaned of old concrete and corrosion, as approved by the Engineer. Final cleaning of the concrete surface and reinforcing steel shall be by high pressure air blast.

Air lines shall be equipped with a filter designed to remove all oil from the air.

Size and location of drive pins, studs, or expansion bolts and method of attachment of new reinforcement shall be as detailed on the plans or as directed by the Engineer. Installation of drive pins, studs, or expansion bolts shall be in accordance with Item 431, "Pneumatically Placed Concrete".

Prior to the application of new concrete or mortar, the concrete and steel surfaces shall be painted with an approved epoxy bonding agent, unless otherwise specified. Application of the bonding agent shall be in accordance with the manufacturer's recommendations.

All repair shall be done in such a manner as to restore the original lines and surfaces of the structure. Care shall be taken in applying the concrete or mortar so that it will be firmly in place and free of voids.

Concrete or mortar repairs shall be water cured in accordance with Item 420, "Concrete Structures", for a period of four (4) days. Pneumatically placed concrete repairs shall be cured in accordance with Item 431, "Pneumatically Placed Concrete". Epoxy mortar repairs shall be cured in accordance with the epoxy manufacturer's recommendations. Removal of forms will be as approved by the Engineer. Care shall be taken to prevent freezing of the concrete or mortar during the curing period. Upon completion of curing, any repaired areas found defective shall be removed and repaired at the complete expense of the Contractor.

429.4. Measurement. Concrete repair will be measured by the square meter, in place, as measured on the surface of the repair. When a repair involves multiple surfaces, such as a corner, measurement will be made of all surfaces repaired.

429.5. Payment. The work performed and material furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid per square meter for "Concrete Structure Repair". This price shall be full compensation for furnishing and placing all materials, removing all loose or defective concrete, saw cutting as required, cleaning reinforcing steel, for furnishing and placing new reinforcing steel, drive pins, studs, or expansion bolts, and for all labor, equipment, tools and incidentals necessary to complete the work.

ITEM 430

EXTENDING CONCRETE STRUCTURES

430.1. Description. This Item shall govern for construction of structure extensions and widenings, including preparation of the existing structure, in accordance with the details on the plans and this Item.

430.2. Materials. All materials shall conform to the pertinent requirements of the following items:

Item 420, "Concrete Structures"
Item 421, "Portland Cement Concrete"
Item 433, "Joint Sealants and Fillers"
Item 440, "Reinforcing Steel"

430.3. Construction Methods. The work shall be performed in accordance with the provisions of Item 420, "Concrete Structures", and in conformance with the requirements herein.

The Contractor shall verify all pertinent dimensions of the existing structure, prior to ordering materials required for the extensions.

Portions of the existing structure shall be removed to the lines and dimensions shown on the plans, and these materials shall be disposed of as shown on the plans or as directed by the Engineer. Unless otherwise noted on the plans, metal railing shall be removed in such a manner that it will not be damaged, and then stacked neatly on the right-of-way at convenient loading points which will not interfere with traffic or construction and will remain the property of the Department. The Contractor shall restore any portion of the existing structure, outside of the limits designated for removal, that has been damaged through his operations. The structure shall be restored at the Contractor's expense to the condition prior to damage. Explosives shall not be used in the removal of portions of the existing structure unless approved by the Engineer, in writing.

When the headwalls, wingwalls and apron are specified on the plans to be reused in the extended structure, the portion to be reused shall be severed from the old structure to the lines and details shown on the plans. The headwall unit shall be moved to the new location specified, using methods approved by the Engineer. The extension concrete and reinforcement shall be placed according to the plan details. The Contractor shall restore any portion of the existing headwall, outside of the limits designated for removal, that has been damaged through his operations. The headwall shall be restored at the Contractor's expense to the condition prior to damage.

Before breaking back bridge slabs, the top surface shall first be sawed along the "break" line 13 millimeters deep, avoiding any damage to the reinforcement. The concrete shall be severed at the "break" line using pneumatic tools. During removal of the designated portion of the existing structure, care shall be taken to avoid damage to the remaining reinforcement within one lap length of the "break" line.

Break back of box culverts will be as shown on the plans or as approved by the Engineer.

Unless otherwise shown on the plans or approved by the Engineer, a demolition ball, other swinging weight or impact equipment will not be permitted. The final removal of concrete at the "break" line shall be with pneumatic tools of a size approved by the Engineer.

Unless otherwise shown on the plans, new reinforcing bars shall be spliced to exposed bars in the existing structure using lap splices in accordance with Table 1 of Item 440, "Reinforcing Steel". When welded splices are permitted by the plans, they shall conform with Item 448, "Structural Field Welding". New reinforcing steel need not be tied to existing steel where spacing and/or elevation does not match that of existing steel provided the proper lap length is attained.

Dowels, if required by the plans, shall be installed in accordance with Item 420, "Concrete Structures".

Concrete surfaces which will be in contact with new construction shall be roughened and cleaned prior to placing of forms. These construction joint surfaces shall be further prepared in accordance with Item 420, "Concrete Structures".

Roadway slabs shall be finished in accordance with Item 420, "Concrete Structures".

The widened portions of bridges and direct traffic culverts shall not be opened to construction traffic or to the traveling public until authorized by the Engineer in accordance with "General Requirements" of Item 420, "Concrete Structures".

430.4. Measurement. This Item will be measured by the quantity of concrete as provided under "Measurement" in Item 420, "Concrete Structures".

430.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Concrete for Extending Structures" of the class specified. Payment for this Item will be made under this Item, but will be as defined under "Payment" in Item 420, "Concrete Structures", except as shown below:

In addition to that work described in Item 420, "Concrete Structures", the unit prices bid for the various classifications of concrete shown shall be full compensation for removing the designated portion of the existing structure; for removing, stockpiling, if necessary, and replacing headwall units for reuse; for cleaning, bending and cutting of exposed reinforcing steel; for splicing of new reinforcing steel to existing reinforcing steel; for installation of dowels; and for cleaning and preparing existing concrete surfaces.

ITEM 431

PNEUMATICALLY PLACED CONCRETE

431.1. Description. This Item shall govern for furnishing and placing of "Pneumatically Placed Concrete" for encasement of designated structural steel members, the repair of deteriorated or damaged concrete and for other work as shown on the plans.

431.2. Materials. Unless otherwise specified on the plans, Class II concrete shall be used for encasement and Class I concrete shall be used for repair.

All material shall conform to the pertinent requirements of the following items:

Item 421, "Portland Cement Concrete"
Item 433, "Joint Sealants and Fillers"
Item 437, "Concrete Admixtures"
Item 440, "Reinforcing Steel"

with the following exceptions:

(1) Portland Cement Concrete. Fine aggregate shall conform to the requirements of Table 2, Grade 1, and coarse aggregate shall conform to the requirements of Table 1, Grade 7, unless otherwise shown on the plans.

(2) Joint Sealants and Fillers. Unless otherwise shown on the plans, Preformed Bituminous Fiber Material shall be used.

(3) Reinforcing Steel. Steel drive pins, studs or expansion bolts used for the attachment of reinforcement for repair of deteriorated or damaged concrete shall have a minimum diameter of three (3) millimeters and a minimum length of 50 millimeters. Size and location of drive pins or studs and method of attachment of reinforcement shall be as specified herein or as shown on the plans.

The equipment used for driving the pins or studs shall be of the type which uses an explosive for the driving force and shall be capable of inserting the stud or pin to the required depth without damage to the surrounding concrete.

Expansion hook bolts (six (6) millimeters diameter) shall be placed in a drilled hole of the size and depth recommended by the manufacturer.

The Engineer may require that a test be made of the driving equipment for steel drive pins and check the resistance to pullout of the expansion bolts, prior to approving their use.

431.3. Proportioning and Mixing. The Contractor shall submit a mix design for approval of the Engineer. The basic mix design shall conform to the following:

TABLE 1

CLASSES OF CONCRETE

Class	Ratio of Cement of Total Aggregate*	Minimum 7 Day Compressive Strength Cores (MPa)**
I	1:4	17
II	1:5	14
III	1:7	10

* The Contractor may use a design containing more cement than required by this specification, when approved by the Engineer.

** 7 Day compressive strength is based on 70 percent of 28 day compressive strength.

The cement and aggregates shall be measured by volume with enough water added to bring the materials to the desired consistency.

Test panel(s) will be required prior to approval of the mix design. The concrete shall be applied to a plywood sheet and each test panel shall be a minimum size of 450 x 450 x 75 millimeters. The panel(s) shall be shot with approximately the same air pressure, nozzle tip and position to be used for the production work. The panel(s) shall be cured in the same manner required for the work.

Three (3) cores, 50 millimeters diameter, will be taken from each test panel and tested in compression at seven (7) days. The average strength of the cores shall conform to the strengths shown in Table 1, herein. Testing of cores shall be in accordance with Test Method Tex-424-A.

The Engineer may require additional test panels during the progress of the work if there is any change in materials, equipment or nozzle operator.

Unless otherwise specified, mixing and application may be done by either the dry mix or wet mix process. The materials shall be thoroughly and uniformly mixed using a mixer designed for use with pneumatic application. It may be either a paddle type or drum type mixer. Transit mix concrete may be used for the wet process.

All mixing and placing equipment shall be cleaned at regular intervals and be kept in acceptable working condition. The nozzle liner, water and air injection system should be inspected daily and replaced when the parts are worn.

431.4. Construction Methods.

(1) Surface Preparation. All surfaces on which pneumatically placed concrete is to be applied shall be cleaned thoroughly of all paint, rust, loose mill scale, grease or oil, deteriorated or loose concrete, or any other foreign materials which are likely to prevent adequate bond. Concrete and reinforcing steel surfaces which will be in contact with pneumatically placed concrete shall be abrasion blasted clean, and then the surface cleaned of loose material with filtered compressed air.

Concrete surfaces on which pneumatically placed concrete is to be applied shall be thoroughly moistened by wetting just prior to placement. Excess water shall be allowed to drain or shall be removed by filtered air blasting.

Where standing or running water is encountered it shall be removed before applying the concrete.

The periphery of repair areas shall be saw cut 25 millimeters deep and existing concrete removed as necessary to prevent feather edges.

Concrete adjacent to a crack shall be removed in such a manner as to leave the existing reinforcing steel throughout the repair area as intact as possible.

(2) Reinforcement. All reinforcement to be embedded in pneumatically placed concrete shall be clean and free from loose mill scale, rust, oil or other coatings which might prevent adequate bond.

Reinforcement shall be secured rigidly in the position shown on the plans. The clear distance between reinforcing bars shall be at least 65 millimeters.

Minimum clear distance between forms and reinforcement and for cover shall be as shown on the plans. Space shall be provided for splicing bars in the approved manner.

For repair of structures, welded wire fabric shall be held securely approximately 20 millimeters out from the surface to be covered. Adjacent sheets shall lap at least 150 millimeters and sheets shall be fastened together securely by tying at intervals not to exceed 450 millimeters. For attaching wire fabric, steel drive pins shall be driven to a penetration of not less than 25 millimeters into the face of the designated portions to be covered or repaired. In lieu of steel drive pins, the Contractor may use six (6) millimeter hook bolts installed in accordance with the manufacturer's recommendation. The wire fabric shall be fastened securely to each pin or bolt. Any pin that does not reach the desired depth or hook bolt that does not anchor properly in its hole may remain in place but must be supplemented by an additional pin or bolt installation. The welded wire fabric shall have a minimum of 25 millimeters cover to the finished concrete surface.

For the encasement of designated portions of steel structures, the welded wire fabric shall be bent to a template to conform as nearly as possible to the outlines of the steel members to be encased. Drilled holes not less than 13 millimeters nor more than 25 millimeters in diameter shall be provided in the webs of the members as near as practicable to the flanges for the purpose of attaching the reinforcing fabric. These holes shall be spaced approximately one (1) meter on centers. The welded wire fabric shall be held securely approximately 20 millimeters from the surfaces of the members to be encased. Adjacent sheets shall lap at least 150 millimeters and sheets shall be fastened together securely by tying at intervals not to exceed 450 millimeters. In placing the wire fabric, 11.3 millimeter diameter rods shall be placed through the holes provided in the webs of the structural steel members to be encased, and the wire fabric tied securely to these rods. Ties shall be spaced approximately 300 millimeters on centers.

(3) Placing of Pneumatically Placed Concrete.

(a) General. The existing concrete surface shall be in approximately a saturated surface dry condition when concrete is placed.

The mix shall be sufficiently wet to adhere properly and sufficiently dry so that it will not sag or fall from vertical or inclined surfaces, or separate in horizontal work.

No work shall be done without the permission of the Engineer when the temperature is lower than 2 °C. Concrete shall not be applied to a surface containing frost or ice. After placing, the concrete shall be protected from freezing and/or quick drying.

The concrete may be applied in one coat; however, if the concrete begins to sag, it shall be applied in two or more coats. In covering vertical surfaces, placing of the concrete shall begin at the bottom and be completed at the top.

Any sag or other defects shall be corrected to proper section by the Contractor at his expense and as directed by the Engineer.

The nozzle shall be held at approximately 0.6 meter to 1.2 meters from the surface and positioned so that the concrete shall impact as nearly as possible at right angles to the surface. Any deposit of loose sand shall be removed prior to placing any initial or succeeding layers of

pneumatically placed concrete. Should any deposit of loose sand be covered with pneumatically placed concrete, the concrete shall be removed and replaced with a new coat of pneumatically placed concrete after the receiving surface has been properly cleaned.

The original surface and the surface of each layer which is permitted to harden before applying succeeding layers shall be washed with water and filtered air blasted to remove loose material. Any material which rebounds and does not fall clear of the work or which collects on horizontal surfaces shall be blown off from time to time to avoid leaving sand pockets.

A steel edged screed shall be used to cut the fresh concrete to proper section followed by floating, as necessary, and a final steel trowel finish.

The use of the wet mix process will not be permitted for the repair of deteriorated or damaged concrete.

(b) Dry Mix Process. The compressor or blower used to supply air shall be capable of delivering a sufficient volume of oil free air, at the pressure shown in Table 2. Steady pressure must be maintained throughout the placing process.

The water pump shall be of sufficient size and capacity to deliver the water to the nozzle at a pressure of not less than 100 kilopascals in excess of the required air pressure.

TABLE 2

COMPRESSOR CAPACITIES

Compressor Capacity m^3/min	Compressor Capacity CFM	Hose Diameter, mm	Maximum Size of Nozzle Tip, mm	Operating Air Pressure Available kPa
7.1	250	25.4	19.0	275.8
8.9	315	31.8	25.4	310.3
10.3	365	38.1	31.8	379.2
14.2	500	41.3	38.1	448.2
17.0	600	44.4	41.3	517.1
21.2	750	50.8	44.4	586.0

The values shown in Table 2 are based on a hose length of 45 meters with the nozzle not more than eight (8) meters above the delivery equipment. Operating pressures shall be increased approximately 35 kilopascals for each additional 15 meters of hose and approximately 35 kilopascals for each eight (8) meters the nozzle is raised.

(c) Wet Mix Process. The pump shall operate so that the line pressure is between 690 kilopascals and 2070 kilopascals for delivery hoses from 38 to 75 millimeters in diameter. The mixing equipment shall be capable of thoroughly mixing the materials in sufficient quantity to maintain continuous placement. When transit mix concrete is used, the equipment shall conform to Item 522, "Portland Cement Concrete Plants".

(4) Construction Joints. Particular care shall be given to the formation of construction joints. Unless otherwise noted on the plans, all joints subject to compressive stress or over existing construction joints shall be square butt joints. Tapered joints will be permitted at other locations except the outside 25 millimeters shall be perpendicular to the surface.

(5) Rebound. Accumulation of loose particles of concrete which do not adhere to the surface being covered shall be removed and discarded. Concrete shall not be placed over such material.

431.5 to 431.6

(6) Curing. Encasements shall be water cured for four (4) curing days.

The repair area shall be cured using a piece of wet cotton mat taped into place over the repaired area followed with a covering of 100 micrometer minimum sheet plastic also taped into place. The sheet plastic shall be larger than the mat and shall be continuously taped at the edges with 75 millimeters minimum width tape (air duct tape or better) to completely enclose the mat and hold in the moisture. After four (4) days or longer, the mat and cover may be removed.

After the required curing period, the repaired area will be tested by striking with a hammer to check for soundness and bond to existing concrete.

431.5. Measurement. Measurement of pneumatically placed concrete for encasement of structural members will be by the square meter, in place, of the actual contact area.

Measurement of pneumatically placed concrete for repair and restoration of concrete structures, will be by the cubic meter, in place, using the surface area times the average depth of the patch.

431.6. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid per square meter for "Pneumatically Placed Concrete (Encasement)", or per cubic meter for "Pneumatically Placed Concrete (Repair)".

This price shall be full compensation for all cement, aggregate, water, reinforcement, furnishing and driving all steel drive pins, furnishing and placing expansion bolts, for the removal of deteriorated concrete, for mixing and placing and curing pneumatically placed concrete, and for all labor, tools, equipment and incidentals necessary to complete the work.

ITEM 432

RIPRAP

432.1. Description. This Item shall govern for the furnishing and placing of riprap of the type and details shown on the plans and in accordance with this Item.

432.2. General. Riprap furnished under this Item shall be Concrete; Stone (Type R)(Dry or Grouted); Stone (Type F)(Dry, Grouted or Mortared); Stone (Common)(Dry or Grouted); Pneumatically Placed Concrete (Class II); or Cement Stabilized.

Dry Riprap is defined as Stone Riprap of the required type with voids filled only with spalls or small stones.

Grouted Riprap is defined as Stone Riprap (Type R, F or Common) of the required type with voids filled with grout after all the stones are in place.

Mortared Riprap is defined as Stone Riprap (Type F) laid and mortared as each individual stone is placed.

432.3. Materials. All materials shall conform to the pertinent requirements of the following items:

Item 420, "Concrete Structures"
Item 421, "Portland Cement Concrete"
Item 431, "Pneumatically Placed Concrete"
Item 440, "Reinforcing Steel"

(1) Concrete Riprap. Concrete shall be Class B unless otherwise shown on the plans. Wire reinforcement used in Concrete Riprap shall consist of welded wire fabric meeting the requirements of ASTM A 185.

(2) Stone Riprap. Unless otherwise shown on the plans, stone for riprap shall meet the following requirements:

Riprap stone shall be a durable, natural stone and have a minimum bulk specific gravity of 2.40 when tested in accordance with Test Method Tex-403-A. The maximum loss of 18.0 percent with magnesium sulfate and 12.0 percent with sodium sulfate when subjected to 5 cycles in accordance with Test Method Tex-411-A. When testing riprap stones for soundness, crushing may be required. The soundness test will be performed on the particles passing the 63 millimeter sieve and retained on the 4.75 millimeter sieve.

A verification test for the size of finished riprap stone in place shall be performed by the Contractor at a location determined by the Engineer. The test area size shall be a square, each side of which will measure a minimum of three (3) times the specified thickness of riprap. Additional tests may be required by the Engineer for each 4200 square meters of surface area of riprap or fraction thereof. Placement of subsequent 4200 square meter riprap areas shall not begin until previously placed stone has been approved by the Engineer.

Grout or mortar, when required, shall conform to Item 421, "Portland Cement Concrete". Grout shall have a consistency such that it will flow into and completely fill all voids.

Filter fabric shall meet the requirements of Departmental Material Specification D-9-6200, Type 2.

(a) Stone (Type R). Unless otherwise shown on the plans all stones except spalls shall weigh between 25 and 115 kilograms each, and at least 50 percent of the stones shall weigh more than 45 kilograms each.

(b) Stone (Type F). Stones shall have at least one broad flat surface. Unless otherwise shown on the plans all stones except spalls shall weigh between 25 and 115 kilograms each, and at least 40 percent of the stones shall weigh more than 45 kilograms each.

(c) Stone (Common). Stones shall not be less than 0.01 cubic meter in volume and not less than 75 millimeters in their least dimension. The width of the stone shall not be less than twice its thickness. The material used for Stone Riprap (Common) may consist of broken up concrete removed under the contract or obtained from other approved sources.

(3) Pneumatically Placed Concrete Riprap. Pneumatically placed concrete for riprap shall be Class II in accordance with Item 431, "Pneumatically Placed Concrete", unless otherwise shown on the plans.

(4) Cement Stabilized Riprap. The aggregate for this riprap shall be material conforming to Item 247, "Flexible Base", except for measurement and payment, of the type and grade shown on the plans. Unless otherwise shown on the plans, Cement Stabilized Riprap shall contain 165 kilograms of portland cement per cubic meter of cement stabilized riprap.

(5) Special Riprap. Special Riprap shall be as shown on the plans.

432.4. Construction Methods. The slopes and other areas to be protected shall be dressed to the line and grade shown on the plans prior to the placing of riprap. Riprap and toe walls shall be placed in accordance with the details and to the dimensions shown on the plans, or as established by the Engineer, or as specified herein.

Mortar or Grouted Riprap shall not be placed on embankment slopes until the embankment has been compacted to the satisfaction of the Engineer.

No mortar or grout shall be placed when the air temperature is below 2 °C. The work shall be protected from rapid drying for at least three (3) days after placement.

Spalls and small stones weighing less than ten (10) kilograms shall be used to fill open joints and voids in stone riprap and shall be placed to a tight fit.

When filter fabric is required by the plans, the fabric strips shall be placed with the length running up and down the slope, and shall have a minimum overlap of 0.6 meter. Fabric shall be secured to the slope with nails, 300 millimeter minimum length and washers or U-shaped pins with a 225 millimeter minimum length and a maximum spacing of three (3) meters, 1.5 meters on seams. Alternate anchorage devices and spacings may be used when approved by the Engineer.

(1) Concrete Riprap. Unless otherwise shown on the plans, concrete riprap shall be reinforced using wire or bar reinforcement.

When wire reinforcement is used, it shall be a 152 x 152 - MW19 x

MW19 welded wire fabric or its equal. A minimum lap of 150 millimeters shall be used at all splices. At the edge of the riprap, the wire fabric shall not be less than 25 millimeters nor more than 75 millimeters from the edge of the concrete and shall have no wires projecting beyond the last member parallel to the edge of the concrete. Wire reinforcement shall be adjusted during concrete placement to maintain its position approximately equidistant from the top and bottom surface of the slab.

When bar reinforcement is used, the sectional area of steel in each direction shall not be less than the sectional area of the wire fabric described above. The spacing of bar reinforcement shall not exceed 450 millimeters in each direction and the distance from the edge of concrete to the first parallel bar shall not exceed 150 millimeters.

Bar reinforcement shall be supported properly throughout the placement to maintain its position approximately equidistant from the top and bottom surface of the slab.

If the slopes and bottom of the trench for toe walls are dry and not consolidated properly, the Engineer may require the entire area to be sprinkled, or sprinkled and consolidated before the concrete is placed. All surfaces shall be moist when concrete is placed.

After the concrete has been placed, compacted and shaped to conform to the dimensions shown on the plans, and after it has set sufficiently to avoid slumping, the surface shall be finished with a wooden float to secure a reasonably smooth surface or broom finished as approved by the Engineer.

Immediately following the finishing operation the riprap shall be cured in accordance with Item 420, "Concrete Structures".

(2) Stone Riprap. Stone riprap shall be constructed in accordance with the specified type as shown in Figure 1.

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(a) Stone Riprap (Type R). The stones shall be placed in a single layer with close joints. The stones shall be placed so that the greater portion of their mass is carried by the earth and not by the adjacent stones. The upright axes of the stones shall make an angle of approximately 90 degrees with the embankment slope. The courses shall be placed from the bottom of the embankment upward, the larger stones being placed in the lower courses. Open joints shall be filled with spalls. Stones of greater dimension than the required riprap thickness shall be embedded in the embankment to present a uniform finished top surface such that the variation between tops of adjacent stones shall not exceed 150 millimeters. Stones that project more than the allowable amount in the finished work shall be replaced, embedded deeper, or chipped.

When the plans require this riprap to be grouted, care shall be taken to prevent earth or sand from filling the spaces between the stones. After the stones are in place, the stones shall be wetted thoroughly and the spaces between the stones shall be completely filled with grout. The surface of the riprap shall be swept with a stiff broom after grouting.

(b) Stone Riprap (Type F). When the plans require this riprap to be placed dry, the flat surface shall be placed on a prepared horizontal earth bed and so placed as to overlap the underlying course, the intent being to secure a lapped or "shingled" surface. These stones shall be placed first and roughly arranged in close contact. The spaces between the large stones then shall be filled with stone of suitable size so placed as to leave the surface evenly stepped, conforming to the contour required, and capable of shedding water to the maximum degree practicable.

When the plans require Stone Riprap (Type F) to be mortared they shall be lapped or "shingled" as described for dry placement. Before placing mortar, the stones shall be wetted thoroughly, and as each of the larger stones is placed, it shall be bedded in fresh mortar and adjacent stones shall be shoved into contact. After the larger stones are in place, all of the spaces or openings between them shall be filled with mortar and the smaller stones then placed by shoving them into position, forcing excess mortar to the surface and insuring that each stone is carefully and firmly embedded. After the work has been completed as described above, all excess mortar forced out shall be spread uniformly to completely fill all surface voids. All joints then shall be pointed up roughly either with flush joints or with shallow, smooth raked joints.

When the plans require Stone Riprap (Type F) to be grouted, stone shall be selected as to size and shape in order to secure fairly large, flat-surfaced stone which may be laid with a true and even surface and a minimum of voids. Stones shall be placed with the flat surface uppermost and parallel to the slope. The largest stones shall be placed near the base of the slope. The spaces between the larger stones shall be filled with stone of suitable size, leaving the surface smooth, reasonably tight, and conforming to the contour required. In general, the stones shall be placed with a degree of care that will insure for plane surfaces a maximum variation from the true plane of not more than 150 millimeters in three (3) meters. Warped and curved surfaces shall have the same general degree of accuracy as specified for plane surfaces. Care shall be taken to prevent earth or sand from filling the spaces between the stones. After the stones are in place, the stones shall be wetted thoroughly and the spaces between the stones shall be completely filled with grout. The surface of the riprap shall be swept with a stiff broom after grouting.

(c) Stone Riprap (Common). Stones shall be placed on a suitable bed excavated for the base course or layer. The base course or layer of stone shall be bedded well into the ground with their edges in contact. Each succeeding course or layer shall be well bedded into and placed on even contact with the preceding course or layer. Spalls and small stones used to fill open joints and voids in the riprap shall be placed to a tight fit. The finished surface shall present an even, tight surface true to the line and grades of the typical sections.

When the plans require Stone Riprap (Common) to be grouted, care shall be taken to prevent earth or sand from filling the spaces between the stones. After the stones are in place, the stones shall be wetted thoroughly and the spaces between the stones shall be completely filled with grout. The surface of the riprap shall be swept with a stiff broom after grouting.

(3) Pneumatically Placed Concrete Riprap, Class II. Pneumatically placed concrete for riprap shall be placed in accordance with the details and to the dimensions shown on the plans or as established by the Engineer. Pneumatically placed concrete shall conform to the requirements of Item 431, "Pneumatically Placed Concrete". Reinforcement shall conform to the details on the plans and with Item 440, "Reinforcing Steel". Reinforcement shall be supported properly throughout placement of concrete. The subgrade surfaces shall be moist when concrete is placed.

The surface shall be given a wood float finish or a gun finish as directed by the Engineer.

Immediately following the finishing operation, the riprap shall be cured with membrane curing compound in accordance with Item 420, "Concrete Structures".

(4) Cement Stabilized Riprap. Cement Stabilized Riprap shall conform to the requirements of the plans and to the provisions for Concrete Riprap except reinforcement will not be required. Design and mixing of Cement Stabilized Riprap shall be as approved by the Engineer.

432.5. Measurement. This Item will be measured by the cubic meter of material complete in place. Cubic meters will be computed on the basis of the measured area and the thickness shown on the plans.

Concrete in toe walls will be measured as riprap of the type with which it is placed.

432.6. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Riprap" of the various classifications specified. This price shall be full compensation for furnishing, including all royalty, hauling, and placing all materials including mortar, grout, reinforcement, filter fabric, premolded expansion joint material, and for all labor, tools, equipment, and incidentals necessary to complete the work.

Payment for excavation of toe wall trenches and for all necessary excavation below natural ground or bottom of excavated channel will be included in the unit price bid per cubic meter of riprap.

Payment for all necessary excavation for riprap below natural ground or bottom of excavated channel, and for shaping of slopes for riprap will be included in the unit price bid per cubic meter for riprap, except that when the header banks upon which riprap is to be placed were built by prior contract, the excavation or embankment required for shaping of slopes will be paid for in accordance with Item 400, "Excavation and Backfill for Structures" and Item 132, "Embankment".

ITEM 433

JOINT SEALANTS AND FILLERS

433.1. Description. This Item shall govern the material requirements for joint sealants, backing materials and joint fillers.

433.2. Materials. The materials for this item shall conform to the following:

(1) Joint Sealant Materials. Joint sealant material shall be the class indicated on the plans or in the governing specifications. The various classes of sealant described herein shall be in accordance with Departmental Material Specification D-9-6310. Copies of specification D-9-6310 are available from the Texas Department of Transportation, Director of Materials and Tests, 125 E. 11th Street, Austin, TX 78701-2483.

(2) Storage. Class 1 and 2 sealants shall be stored at temperatures between 5 °C and 40 °C. Class 4 and 5 sealants shall be stored in sealed containers at a temperature of 40 °C or below and the material must be used within two (2) months of receipt on the project.

(3) Classes of Joint Sealants.

(a) Class 1. Two Component, Synthetic Polymer, Non-sag. The components shall be proportioned and mixed in accordance with the manufacturer's recommendations.

(b) Class 2. Two Component, Synthetic Polymer, Self-leveling. The components shall be proportioned and mixed in accordance with the manufacturer's recommendations.

(c) Class 3. Hot Poured Rubber. This sealant shall be a rubber asphalt compound which when heated shall melt to the proper consistency for pouring and shall solidify on cooling to ambient temperatures.

(d) Class 4. Non-sag Low Modulus Silicone. The material shall be a single component formulation not requiring addition of a catalyst.

(e) Class 5. Self-leveling Low Modulus Silicone. The material shall be a single component formulation not requiring addition of a catalyst.

(f) Class 6. Preformed Joint Sealant (PJS). The preformed joint sealant shall be an extruded elastomeric material having a multi-channeled shape.

The size shown on the plans shall be the nominal width of the sealant. The uncompressed depth of the seal shall be equal to or greater than the width.

All preformed joint sealants installed by the Contractor shall have been prequalified for compliance with the requirements. Each size and configuration of seal produced by a manufacturer must be approved by the Engineer prior to use on Department projects. For a sealant manufacturer to prequalify and obtain approval of a sealant, detailed dimensions and configuration of each size of sealant and certified test results indicating compliance with Departmental Materials Specification D-9-6310 and any requirements shown on the plans and specifications shall be submitted to the Engineer.

Submission shall be done sufficiently in advance of work to allow for testing and evaluation of the material.

The Engineer will confirm by visual inspection that the sealant proposed for installation is the same size, configuration and manufacture as shown on plans. The Engineer will examine the sealant for any undue distortions, such as dissymmetry, warping, thick webs or uneven width which are likely to impair the performance of the joint. If the magnitude of the distortions are sufficient to create doubts as to the performance of the sealant, the Engineer may direct that the sealant be replaced or that samples representing the worst of the lot be subjected to further testing to verify their performance.

(g) Class 7. Self-leveling, Rapid Curing, Low Modulus Silicone. The material shall be a two component, rapid curing, self-leveling, low modulus formulation. The components shall be proportioned and mixed in accordance with the manufacturer's recommendations.

(4) Backer Rods and Backing Materials. These materials shall be capable of holding the fluid sealant in open joints in place. In all cases, these materials shall be of such a type that will not bond to the sealant. The backing materials shall meet the requirements of the sealant manufacturer. They shall be compressible type materials, such as closed-cell, resilient

foam or sponge rubber stock of vinyl, butyl or neoprene, or expanded polyethylene or polyurethane.

The diameter of the backer rod shall be at least 25 percent larger than the joint reservoir width.

(5) Joint Fillers. Joint fillers shall be of the size, shape and type indicated on the plans and shall conform to the following requirements:

(a) Timber Boards. Timber boards shall be obtained from redwood, cypress, gum, southern yellow pine or Douglas fir timber. They shall be sound heartwood and shall be free from sapwood, knots, clustered bird's-eye, checks and splits. Occasional sound or hollow bird's-eye, when not in clusters, will be permitted provided the board is free from any other defects that will impair its usefulness as a joint filler. All boards, except redwood and cypress, shall have a creosote or pentachlorophenol treatment conforming to Item 492, "Timber Preservative and Treatment", Table 1. When oven dried at 110 °C to a constant mass, the mass of the board per cubic meter (minus treatment) shall not be less than 320 kilograms nor more than 560 kilograms.

(b) Asphalt Boards. Asphalt boards shall consist of two (2) suitable asphalt-impregnated liners filled with a mastic mixture of asphalt and vegetable fiber and/or mineral fiber. Asphalt boards shall be smooth, flat and sufficiently rigid to permit installation. When tested in accordance with Test Method Tex-524-C, the horizontal deflection shall not be more than 25 millimeters in 90 millimeters.

(c) Preformed Fiber Material.

(1) Preformed Bituminous Fiber Material. Preformed bituminous fiber material shall meet the requirements of ASTM D 1751.

(2) Preformed Nonbituminous Fiber Material. Preformed non-bituminous fiber material shall meet the requirements of ASTM D 1751, except that the requirements pertaining to bitumen content, density and water absorption shall be voided.

(d) Rebonded Neoprene Filler. Rebonded neoprene filler shall consist of ground closed-cell neoprene particles, rebonded and molded into sheets of uniform thickness of the dimensions shown on the plans, meeting

the requirements of ASTM D 1752, Type I. Certification that the material meets these requirements shall be furnished to the Engineer.

433.3. Measurement and Payment. The work performed, materials furnished and all labor, tools, equipment and incidentals necessary to complete the work under this Item will not be measured or paid for directly, but will be considered subsidiary to the various bid Items of the contract.

ITEM 434

SLIDING ELASTOMERIC BEARINGS

434.1. Description. This Item shall govern for the furnishing and installation of sliding elastomeric bearings in accordance with the details shown on the plans and the requirements of this Item. These bearings consist of a steel plate with a stainless steel facing (upper component) bearing on a preformed fabric pad to which is bonded a layer of polytetrafluoroethylene (PTFE) material (lower component).

434.2. Materials. Unless otherwise shown on the plans, steel plates shall be ASTM A 36, finished to ANSI #500 or better on the surface interfacing with the stainless steel. Stainless steel sheet shall be Type AISI 304 conforming to ASTM A 240. Unless otherwise shown on the plans the minimum thickness shall be 1.5 millimeters.

Preformed fabric pads shall be manufactured of new materials and composed of multiple layers of prestressed duck, 64 plies per 25 millimeters of finished pad thickness, impregnated and bound with a high quality rubber compound, containing rot and mildew inhibitors and antioxidants, compounded into resilient pads of uniform thickness. The Shore A Durometer hardness of the pad shall be not less than 85 nor more than 95. Preformed fabric pads shall be capable of withstanding 69 megapascals compressive stress without breakdown. A tolerance of plus or minus five (5) percent will be allowed from the pad thickness shown on the plans.

The PTFE materials shall be pure virgin polytetrafluoroethylene fluorocarbon resin, unfilled, or with a suitable inert filler and/or reinforcement to minimize the cold flow tendencies while maintaining the friction properties of the PTFE fluorocarbon resin. The amount of filler in

the filled PTFE sheet shall be between 10 percent and 35 percent by mass. The finished materials shall exhibit the following physical properties:

Requirement	Test Method	Filled Value	Unfilled Value
Hardness at 25.5 °C	ASTM D 2240, Shore "D"	50-60	50-65
Tensile Strength, MPa	ASTM D 1457	14 min	19 min
Elongation, percent	ASTM D 1457	150 min	200 min
Deformation Under Load percent @ 23 °C, 14 MPa	ASTM D 621, Method A	10 max	15 max
Specific Gravity	ASTM D 1457	2.16 min	2.14 min

The thickness of the finished PTFE sheet shall not be less than 1.5 millimeters nor more than three (3) millimeters.

434.3. Manufacturing Processes. The stainless steel sheet shall be attached to the steel plate by continuous fillet welding all around the edges with an approved welding electrode. The sliding surface shall be protected from damage due to weld spatter. The finished stainless surface shall be flat to a tolerance of one (1) millimeter.

After attachment to the steel plate, the stainless steel sheet shall be polished to a bright mirror finish less than 0.5 micrometer, rms and solvent cleaned to remove all traces of polishing compound.

The PTFE material shall be bonded to the preformed fabric pad using approved adhesive methods or by vulcanizing through an appropriate polychloroprene interlayer.

434.4. Testing and Acceptance. One additional bearing lower component shall be manufactured for testing purposes. As soon as all bearings have been manufactured for a given project, notification shall be given to the Director of Materials and Tests, 125 East 11th Street, Austin, Texas 78701-2483, who will select the above prescribed test bearing component at random from the lot. Testing performed by the Department will be in accordance with procedures published in the Department's Manual of Testing Procedures. A manufacturer's certification that the steel,

stainless steel, preformed fabric and PTFE material meet the requirements of this Item shall be furnished along with notification of fabrication completion.

After a portion of the lower component has been compressed to ten (10) megapascals for five (5) days, adhesion between the PTFE and preformed fabric will be determined by the 90 degree peel test specified in Test Method Tex-622-J. The minimum peel strength shall be 4.4 newtons per millimeter.

If deemed necessary by the Engineer, check tests will be performed on the steel, preformed fabric pads or PTFE material to verify the properties required under "Materials".

Bearings represented by test specimens passing the above requirements will be approved for use in the structure subject to on-site inspection by the Engineer for visible defects.

434.5. Storage. Bearings shall be stored horizontally in a dry, sheltered area. Wrapping shall be moisture and dust resistant and maintained in good condition until installation. Bearings shall be lifted by their undersides only and shall be protected at all times from damage, dirt, oil, grease, and other foreign substances.

434.6. Measurement. This Item will be measured by each sliding elastomeric bearing.

434.7. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Sliding Elastomeric Bearing" of the type specified. This price shall be full compensation for the stainless steel faced plate, the PTFE faced preformed fabric pad, the sole plates and the anchor bolts required to connect the bearing between superstructure and substructure and for all materials, labor, tools, equipment and incidentals necessary to complete the work.

ITEM 435

ELASTOMERIC MATERIALS

435.1. Description. This Item shall govern for the furnishing and installation of elastomeric materials in accordance with the details shown on the plans and the requirements of this Item.

435.2. Materials.

(1) Elastomeric Bearings. When shown on the plans, structural members shall be seated on elastomeric bearings.

These bearings may be either "plain" (consisting of elastomer only) or "laminated" (consisting of alternating individual layers of elastomer and steel laminates) as shown on the plans. Elastomeric bearings will be designated by hardness (Durometer), size and configuration and, in the case of laminated bearings, by the thickness of the individual layers of elastomer and the size and position of special connection members, if any, required to be vulcanized with the bearing.

(a) General. Unless otherwise shown on the plans, the elastomer for bearings shall be formulated from previously unvulcanized 100 percent virgin polychloroprene or 100 percent virgin polyisoprene rubber polymers. Rubber-like polymers employed in the elastomer formulation shall be exclusively of the polychloroprene or natural polyisoprene type. Bearings will not be acceptable if the elastomer employed contains previously vulcanized natural or synthetic rubber or other synthetic rubber-like polymers.

Steel laminates shall be commercial grade steel strip or sheet with a thickness of three (3) millimeters ± 0.4 millimeter. Metal for special connections, including sole plates and bearing plates, shall conform to ASTM A 36, unless otherwise shown on the plans.

(b) Physical Properties of the Elastomer. Elastomer formulated from polychloroprene and polyisoprene shall meet the requirements of AASHTO M251, Table 1. Certified test results showing actual test values obtained and the required values for the physical properties of the elastomer shall be furnished for each formulation. Material tests shall be made by the bearing manufacturer in accordance with the applicable test methods except

that all tests shall be made on the finished product. Standard laboratory test slabs will not be utilized for this purpose. The apparatus employed in preparing test specimens from the finished product shall be in accordance with ASTM D 15, "Sample Preparation for Physical Testing of Rubber Products".

(c) Formulation Prequalification and Certification. All bearings furnished by the Contractor shall be produced by a bearing manufacturer prequalified by the Materials and Tests Engineer. Each elastomer formulation produced by a manufacturer must be approved by the Materials and Tests Engineer prior to initial use on Department projects. To prequalify and obtain initial approval of a particular formulation, the bearing manufacturer shall submit to the Materials and Tests Engineer, in advance of anticipated use of his product, certified test results. The results must show actual test values obtained when the physical properties of the elastomer to be furnished were tested for compliance with the minimum requirements of AASHTO M251, including the Cold Temperature Shear Test.

In addition, the manufacturer shall forward prequalification test samples, freight prepaid, to the Materials and Tests Engineer, Texas Department of Transportation, 3800 Jackson Ave., Building No. 5, Austin, Texas 78703, for testing and evaluation of compliance with prequalification requirements. The Department will test all laminated prequalification samples for adhesion in accordance with Texas Test Method Tex-601-J. Only elastomer of the type or types to be supplied shall be submitted (polychloroprene, polyisoprene). Prequalification samples shall consist of two (2) finished bearings typical of the formulation and workmanship intended for use on Departmental projects. When both laminated and plain bearings are required, two (2) samples of each type shall be submitted.

Plain sample bearings shall measure 225 millimeters x 480 millimeters x 25 millimeters, 70 Durometer.

Laminated sample bearings shall measure 225 millimeters x 355 millimeters x 38 millimeters with the following number of steel laminates:

50 durometer - three (3) steel laminates

60 durometer - two (2) steel laminates

The bearing manufacturer shall certify that all of the samples submitted are of the same basic elastomer formulation and of equivalent cure to that used in the finished products to be furnished on Department projects.

The bearing manufacturer shall perform the complete prequalification testing procedure during later production should the Engineer feel such action appropriate.

(d) Manufacturing Requirements. All components of a "laminated" bearing shall be molded together to form an integral unit free of voids or separations in the elastomer or between the elastomer and the steel laminates or special connections unless otherwise shown on the plans. The elastomer between the laminates or special connections and on the outer surfaces of the bearing shall be well-vulcanized, uniform and integral such that the elastomer is incapable of being separated by any mechanical means into separate, definite, well-defined elastomeric layers. Evidence of this layered construction, either at the outer surfaces or within the bearing, shall be cause for rejection of such laminated bearing shipments.

All edges of steel laminates shall be covered by a minimum of three (3) millimeters of elastomer except that exposure of the laminates will be permitted at approved laminate restraining devices and around holes that will be entirely enclosed in the finished structure. All laminates shall be properly positioned within three (3) millimeters of design (plan) location.

Plain bearings may be molded individually, cut from previously molded strips or slabs molded to the full thickness of the finished bearings, or extruded and cut to length. The finished bearings shall have no voids or separations detectable either at the bearing surfaces or within the bearing. Plain elastomeric bearings shall be well-vulcanized, uniform and integral units of such construction that the bearing is incapable of being separated by any mechanical means into separate, definite and well-defined elastomeric layers. Evidence of layered construction either at the outer surfaces or within the bearing shall be cause for rejection of such bearing shipments.

The finish of cut surfaces shall be ANSI 250, or smoother. The batch or lot number and the dimensions or piece mark shall be marked on the surface of each bearing. The markings shall remain legible until placement in the structure. In addition, all laminated bearings shall be permanently marked with: the Manufacturer's Name or Trademark, Lot Number, Date of Manufacture (Month-Year), and Direction of Slope. Unless otherwise shown on the plans, this marking shall be on a face which is visible after erection of the bridge.

(e) Appearance and Dimensions. Flash tolerance, finish and appearance shall meet the requirements of the latest edition of the Rubber Handbook as published by the Rubber Manufacturers Association, Inc., RMA F3 and T.063 for molded bearings and RMA F2 for extruded bearings.

For both plain and laminated bearings the permissible variation from the dimensions and configuration shown on the plans shall be as listed in AASHTO M251, Table 2.

(f) Routine Inspection, Sampling and Testing. After prequalification approval, the inspection, sampling and testing of actual bearing production will be as outlined below:

Plain Bearings. A minimum of one (1) plain bearing will be taken by a representative of the Materials and Tests Division from each batch or lot. Routine tests for compliance with the requirements of AASHTO M251 will be performed by the Materials and Tests Division. Samples will not be returned.

Laminated Bearings. Each laminated bearing shall be subjected, by the manufacturer, to an average compression of ten (10) megapascals or a stress approved by the Engineer. This compression test will be performed in the presence of a representative of the Materials and Tests Division who will perform visual inspection and accept or reject the bearings. The performance of each bearing will be considered satisfactory provided there is no visible evidence of bond failure or other damage to the bearing and provided the finished bearing meets all other pertinent portions of this specification. Samples of laminated bearings may be taken if the quality of the plant production becomes questionable.

The manufacturer shall furnish certified laboratory test results on the elastomer properties of each batch or lot of compound used in the manufacture of bearings, both plain and laminated. Copies of Certified Mill Test Reports shall be required for all metal for special connections, including sole plates and bearing plates.

(2) Waterstops. Waterstops shall be furnished and installed in accordance with the details shown on the plans. Except where otherwise shown on the plans, waterstops may be manufactured from either natural or synthetic rubber or from polyvinyl chloride (PVC) as specified below:

(a) General. Natural rubber waterstops shall be manufactured from a stock composed of a high-grade compound made exclusively from new plantation rubber, reinforcing carbon black, zinc oxide, accelerators, anti-oxidants and softeners. This compound shall contain not less than 72 percent by volume of new plantation rubber.

Synthetic rubber waterstops shall be manufactured from a compound made exclusively from neoprene or butadiene styrene rubber (GRS), reinforcing carbon black, zinc oxide, polymerization agents and softeners. This compound shall contain not less than 70 percent by volume of neoprene or GRS.

Physical properties of natural or synthetic rubbers for waterstops shall be as shown in Table C below:

TABLE C

Physical Properties for Rubber for Waterstops

	Natural (Plain) Rubber	Synthetic (Neoprene or GRS) Rubber
Original Physical Properties:		
Hardness, ASTM D 676 (Durometer)	60 ± 5	55 ± 5
Tensile Strength, Minimum MPa, ASTM D 412	24.1	17.2
Elongation at Break, Minimum percent	550	425
Accelerated Tests to Determine Aging Characteristics (Alternate tests):		
(1) after 7 days in air at 70 °C ± 1 °C, ASTM D 573 or:		
(2) after 48 hours in oxygen at 70 °C ± 1 °C and 2 MPa pressure, ASTM D 572;		
Tensile Strength, % change, Maximum	35	35
Maximum Elongation, % change, Maximum	35	--

Unless otherwise shown on the plans, polyvinyl chloride (PVC) waterstop materials shall conform to the Corps of Engineers Specification Number, CRD-C-572-60.

(b) Manufacturer's Certification. The manufacturer shall furnish certified test results, indicating compliance with this specification, for each batch or lot of waterstops furnished under this contract.

(c) Manufacturing Requirements. Rubber waterstops shall be manufactured with an integral cross section which shall be uniform within plus or minus three (3) millimeters in width, and the web thickness or bulb

diameter, within plus two (2) millimeters and minus three (3) millimeters. No splices will be permitted in straight strips. Strips and special connection pieces shall be well cured so that any cross section shall be dense, homogeneous and free from all porosity. All junctions in the special connection pieces shall be

full-molded.

Requirements for PVC waterstops shall be the same as for rubber waterstops except that splicing of PVC shall be done by heat sealing the adjacent surfaces in accordance with the manufacturer's recommendations. A thermostatically controlled electric source of heat shall be used to make all splices. The heat shall be sufficient to melt but not to char the plastic.

(3) Nylon Reinforced Neoprene Sheet. Nylon reinforced neoprene sheet shall consist of weather resistant neoprene reinforced with one (1) layer of nylon fabric at mid-thickness and shall be of the thickness shown on the plans. The neoprene and neoprene sheet shall conform to the requirements shown below:

Neoprene

Minimum Tensile Strength, ASTM D 412	14 MPa
Minimum Tear Strength, ASTM D 624, Die B	31,523 N/m
Minimum Elongation, ASTM D 412	400%
Durometer Hardness, Shore A - ASTM D 2240	65 ± 5
Change in Durometer Hardness, Shore A	
Heat aged 70 h @ 100 °C max - ASTM D 2240	± 15
Ozone - 1 ppm, 20% strain, 100 h - ASTM D 1149*	No Cracks

Finished Sheet

Thickness (2 or 3 millimeters)	± 10%
Breaking Strength, ASTM D 751, Grab Method, Minimum	
2 mm sheet	52,538 N/m
3 mm sheet	70,051 N/m

* Samples shall be wiped with solvent before testing to remove surface impurities.

The manufacturer shall furnish the Engineer a certification indicating the actual test results obtained on the material furnished to the project. In addition, the manufacturer shall furnish representative samples of the finished sheet to the Materials and Tests Division for testing.

(4) Elastomeric Pads. When shown on the plans, rail posts, rail members, metal shoes or minor structural members shall be insulated, leveled, shimmed or otherwise protected by elastomeric pads, sheets or washers.

Such pads may be any elastomeric material, plain, preformed fabric or laminated, having a hardness (durometer) between 70 and 100, unless otherwise shown on the plans or required by this Item.

Acceptance testing will not be required.

(5) Other Elastomeric Products. Other elastomeric products shall be in accordance with the requirements shown on the plans.

435.3. Construction Methods.

(1) Elastomeric Bearings. Unless otherwise shown on the plans, concrete bearing seats shall be float finished to the required elevation. Variation from a level plane shall not exceed two (2) millimeters within the limits of the bearing.

Welding in the vicinity of the bearings shall be done with care to avoid damage to the elastomer. Bearings damaged by field welding shall be replaced by the Contractor at his expense.

(2) Waterstops. Field splices shall be either vulcanized; mechanical, using stainless steel parts; or made with a rubber splicing union of the same stock as the waterstop, at the option of the Contractor. All finished splices shall have a tensile strength not less than 50 percent of the unspliced material.

(3) Nylon Reinforced Neoprene Sheet. Fabrication and installation of nylon reinforced neoprene sheet shall be as shown on the plans. Fabrication shall be such that there are no sharp re-entrant cuts and all cuts shall be made to a circular punched hole. No splices shall be made in the material except as shown on the plans or approved by the Engineer. Any splices, approved by the Engineer, shall be made using a neoprene adhesive and reinforcing strips in accordance with the manufacturer's recommendations.

435.4. Measurement. Unless otherwise shown on the plans, elastomeric bearings used with prestressed (pretensioned) concrete units, elastomeric pads, waterstops and other miscellaneous elastomeric materials will not be measured for payment but will be considered subsidiary to the various pertinent bid items in the contract.

Unless otherwise shown on the plans, elastomeric bearings used in conjunction with steel and post-tensioned concrete superstructures will be measured by each elastomeric bearing.

435.5. Payment. When this Item is specified as a pay item, the work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Elastomeric Bearing" of the type specified. This price shall be full compensation for all materials including anchor bolts and top plates, tools, equipment, labor, and incidentals necessary to complete the work.

ITEM 437

CONCRETE ADMIXTURES

437.1. Description. This Item shall govern for the admixtures used in portland cement concrete, in accordance with the plans, specifications and requirements herein.

437.2. Materials. Admixtures shall be in a liquid state and conform to the following requirements:

Chemical Admixtures - ASTM C 494
Air Entraining Admixtures - ASTM C 260

437.3. Approval of Admixtures. A list of pretested and approved admixtures will be maintained by the Director of Materials and Tests. This list specifies the dosage rates to be used except as modified herein. Admixtures will be considered for addition to this list when the manufacturer of the admixture submits a written request certifying that the material to be furnished meets the requirements of this Item. The manufacturer also shall furnish test reports from an approved laboratory, routinely inspected by the Cement and Concrete Reference Laboratory (CCRL). At the time of this original request for approval of admixtures, the manufacturer shall state in writing the chloride content of the admixtures.

437.4

Admixtures to which chlorides have been added during manufacture will not be permitted.

In addition to the above, the manufacturer shall furnish, to the Director of Materials and Tests, the following:

(1) An infrared spectrophotometry scan, solids content, pH value, and unit weight together with the normal manufacturing tolerances.

(2) A 250 milliliters sample of the admixture.

(3) Each six (6) months after approval of the admixture, a notarized certification indicating that the admixture as originally approved has not been changed or altered in any way.

The Department reserves the right to perform any or all of the tests required by ASTM C 260 and ASTM C 494 as a check on the tests reported by the manufacturer. In case of any variance the Departmental tests will govern. Any change in formulation of an admixture shall require retesting, and shall be approved by the Director of Materials and Tests prior to use.

A change in formulation discovered by any of the tests prescribed herein, or other means, and not reported and retested, may be just cause to remove a manufacturer from the pre-certified list for Departmental projects.

All documentation and correspondence shall be submitted to the Director of Materials and Tests, Texas Department of Transportation, Materials and Tests Division, 125 East 11th Street, Austin, Texas 78701-2483.

All material samples shall be submitted to the Director of Materials and Tests, Texas Department of Transportation, Materials and Tests Division, 3800 Jackson Avenue, Building No. 5, Austin, Texas 78731-6033.

437.4. Dispensing Equipment. Each admixture shall be measured and dispensed by a separate readily adjustable dispenser. When set to a predetermined volume the dispenser shall fill to the preset amount and hold it without leakage until the operator releases the content by some positive means. Unless otherwise shown on the plans, completely automatic dispensing will not be required, except for use with a fully automatic plant.

437.5

The calibrated container shall be constructed in such a manner that the level of the admixture is visible at all times. A strip gauge with shall be

securely attached to the measuring apparatus. The increments on the strip gauge shall be such that the admixture can be measured to within three (3) percent of the specified dosage.

For individual concrete placements of less than 1.5 cubic meters at the placement site, the Engineer may waive the requirements for mechanical dispensing equipment.

437.5. Construction Use of Admixtures. When used in accordance with the governing specifications, the Contractor will be allowed to use any admixture which has been approved. The Contractor shall submit to the Engineer one (1) copy of the invoice showing the admixture or admixtures to be used on the project. Prior to using an admixture in the work, trial mixes shall be made and tested in the field using the materials and equipment to be used on the project. If more than one (1) admixture is used, they shall be used in such manner that the desirable effects of each are realized.

Mix designs from previous or concurrent jobs may be used without trial batches if it is shown that no substantial change in any of the proposed ingredients has been made.

Admixture dosage rates shall generally conform to those shown on the "List of Approved Admixtures" and shall be incorporated into the mix design in accordance with Construction Bulletin C-11.

The volume of liquid admixtures shall be taken into account when determining the water/cement ratio of the mix.

When necessary to adjust dosage rates to values exceeding those shown on the "List of Approved Admixtures", such dosage rates shall be based on trial batches.

The dosage rate for air-entraining admixtures shall be adjusted as necessary to produce the required air content in the concrete. The air content shall be in accordance with Item 421, "Portland Cement Concrete", unless otherwise shown on the plans.

When a retarding admixture is required for extended retardation, the amount to be used shall be established by several trial batches with varying retarder content and simulating the placing conditions to be encountered. When water reducing or retarding agents are used at the option of the Contractor, reduced dosage of the admixture will be permitted.

Accelerators will be used only to meet special requirements and will require the written approval of the Engineer on each specific project. Accelerating admixtures will not be permitted in bridge decks, top slab of direct traffic culverts, nor when Type II cement is specified.

All accelerating admixture dosages will be based on trial mixes and approved by the Engineer.

High range water reducers will be used only to meet special requirements and will require written approval of the Engineer on each specific project. A work plan for control shall be submitted by the Contractor for approval and an evaluation of the concrete containing the admixture will be performed by the Engineer. Recommended guidelines for developing a work plan are shown in Construction Bulletin C-11.

Suitable measures shall be taken to prevent admixtures from freezing. Admixtures shall be agitated as required to prevent separation or sedimentation of solids. Air agitation of air entraining agents will not be permitted.

Air entraining agents shall be charged into the mixer with the first one-third of the mix water. Retarding or water reducing admixtures, except for high-range water reducers, shall be charged into the mixer during the last one-third of the mix water. Each admixture shall be dispensed separately but at the same time as the mixing water. No admixture shall be dispensed on dry aggregates.

Alternate charging sequences based on trial batches may be used subject to approval by the Engineer.

High range water reducing admixtures shall be used and/or dispensed in accordance with the approved work plan.

Should the desired effects of an admixture not be achieved in the concrete, the Engineer may take a sample of the admixture being used for further testing. Further use of the admixture will not be allowed until the results of such tests confirm that the admixture has not been changed or altered in any way.

437.6. Measurement and Payment. The work performed, materials furnished and all labor, tools, equipment, and incidentals necessary to complete the work under this Item will not be measured or paid for directly, but will be considered subsidiary to the various bid Items of the contract.

ITEM 438

CLEANING AND/OR SEALING JOINTS AND CRACKS
(Portland Cement Concrete)

438.1. Description. This Item shall govern for cleaning and/or sealing joints and cracks in either new or existing portland cement concrete pavements and bridge decks in accordance with the requirements herein and the details shown on the plans.

438.2. Materials. Materials shall conform to the requirements of Item 433, "Joint Sealants and Fillers". The type and/or class of material to be used shall be as shown on the plans. Primers, if required, shall be as recommended by the manufacturer of the sealant. Backer rods, when required, shall be compatible with the sealant and shall not react or bond together.

438.3. Equipment. All equipment shall be in accordance with the sealant manufacturer's recommendations.

Air compressors shall be equipped with appropriate filters for removing oil and water from the air.

438.4. Construction Methods. Prior to beginning operations, the Contractor shall submit a statement from the sealant manufacturer showing the recommended equipment and installation procedures to be used. All equipment and procedures will be subject to approval by the Engineer.

The use of any equipment which damages dowels, reinforcing steel, concrete, base, subbase or subgrade shall be discontinued, and the joint and/or crack shall be cleaned by other methods which do not cause such damage.

(1) Joint and Crack Preparation. At the time of sealing, the crack or joint shall be free of all debris, dirt, dust, saw cuttings or other foreign material.

(a) Joint Preparation. The joints shall be cleaned by a method approved by the Engineer. Unless otherwise shown on the plans, hand tools, air guns, power routers, abrasive blasting equipment or other equipment may be used to clean the joints. Where shown on the plans, the joint sealant space shall be resized by sawing to the width and depth shown on the plans to accommodate the type of sealant specified.

The vertical faces of armored joints shall be given a Class "A" blast cleaning in accordance with Item 446, "Cleaning, Paint and Painting". After abrasive blasting, the joint shall be air blasted to remove all loose dust.

(b) Crack Preparation. Unless otherwise required, the crack shall first be grooved at the surface so that a reservoir of rectangular cross section is provided for the sealant. Grooves shall be cut to the dimensions shown on the plans. Devices used for grooving, such as diamond blade random cut saws, random-crack grinders, etc., shall be capable of following the path of the crack without causing excessive spalling or other damage to the concrete.

(2) Joint and Crack Sealing. The Contractor shall install the sealant in accordance with the manufacturer's recommended procedure. Joint and crack surfaces shall be surface dry unless otherwise recommended by the manufacturer of the sealant. The surface temperature at the time of sealing shall be not less than 5 °C. The top of the sealant shall be three (3) millimeters to six (6) millimeters below the pavement surface. The

minimum depth of sealant shall be 13 millimeters or as recommended by the sealant manufacturer.

(a) Primer. Primer, if required, shall be applied as soon as possible after cleaning. Primer shall be applied uniformly at the approximate rate recommended by the sealant manufacturer. The primer shall be applied to metal surfaces before new corrosion begins and shall be allowed to cure a minimum of thirty minutes but not more than eight (8) hours before applying the sealant, unless otherwise recommended by the sealant manufacturer.

(b) Backer Rods. Backing material shall be used to prevent fluid type sealant from flowing through the joint or crack and to hold the sealant at its required elevation. The use of such material shall be as recommended by the sealant manufacturer and approved by the Engineer.

438.5. Measurement. When specified on the plans to be a pay item, "Cleaning and/or Sealing Joints and Cracks" will be measured by the meter of sealant complete in place.

438.6. Payment. The work performed and materials furnished as required by this Item will not be paid for directly but will be considered subsidiary to the various bid items of the contract, unless specified as a pay item in the contract.

When shown as a pay item, the work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Cleaning of Existing Joints", "Cleaning and Sealing of Existing Joints", and "Cleaning and Sealing Cracks". This price will be full compensation for furnishing all materials; for all sawing, routing, and cleaning and installing; and for all manipulations, labor, equipment, tools and incidentals necessary to complete the work.

ITEM 439

CONCRETE OVERLAY OF STRUCTURE DECKS

439.1. Description. This Item shall govern for the materials to be used and for overlaying of a previously constructed concrete structure surface with a concrete overlay or a dense concrete overlay and for the

removal and replacement of deteriorated and/or delaminated concrete, in accordance with the details shown on the plans and the requirements of this Item.

439.2. Materials. All materials shall conform to the pertinent requirements of the following items except as noted herein:

Item 421, "Portland Cement Concrete"
Item 428, "Concrete Surface Treatment"
Item 440, "Reinforcing Steel"

(1) Portland Cement Concrete.

(a) Cement. The same type, brand and source of cement shall be used for overlaying any one structure. Unless otherwise shown on the plans, Type I cement shall be used for concrete overlay. Type II cement shall be used for dense concrete overlay.

(b) Coarse Aggregate. The coarse aggregate shall be a crushed or broken aggregate and, unless otherwise shown on plans, shall conform with the gradation Grade No. 6 of Article 421.2. Eighty-five percent of the coarse aggregate particles retained on the 4.75 millimeter sieve shall have one (1) or more mechanically induced crushed faces as determined by Test Method Tex-413-A (Particle Count).

For dense concrete overlays the aggregate shall not have an absorption exceeding three (3) percent when tested in accordance with Test Method Tex-403-A.

(c) Classification and Mix Design. Classification and mix design shall conform to Item 421, "Portland Cement Concrete", together with the following requirements:

(i) Concrete Overlay. The concrete shall be Class CO and shall have a coarse aggregate factor of not less than 0.55. The entrained air content of the fresh concrete shall be six (6) percent with a tolerance of plus or minus one (1) percent when tested in accordance with Test Method Tex-416-A.

(ii) Dense Concrete Overlay. The concrete shall be Class DC and shall have a coarse aggregate factor which will provide equal absolute volume of fine aggregate and absolute volume of coarse aggregate with a tolerance of plus or minus five (5) percent; and the entrained air content of the fresh concrete shall be six (6) percent with a tolerance of plus or minus one (1) percent when tested in accordance with Test Method Tex-416-A.

A water reducing admixture will be required for dense concrete overlay.

(d) Grout. The grout for bonding new concrete to existing concrete shall consist of equal parts by mass of portland cement and sand, mixed with sufficient water to form a stiff slurry which can be applied with a stiff brush or broom to the existing concrete in a thin, even coating that will not run or puddle in low spots.

439.3. Equipment. The equipment used shall be subject to the approval of the Engineer and shall comply with the following:

(1) Surface Preparation Equipment. The surface preparation equipment shall be as follows:

(a) Scarifying equipment shall conform to the requirements of Item 483, "Scarifying Concrete Bridge Slab".

(b) Sandblasting equipment shall be capable of removing oil, dirt, slurry, curing compound, laitance, etc., from the surface of the concrete. Equipment for wet sandblasting shall be in accordance with Item 485, "Wet Sandblasting".

(c) Sawing equipment, when required, shall be capable of sawing concrete to the specified depth of overlay.

(d) Power-driven chipping tools not heavier than the nominal 13.6 kilogram class will be permitted for removal of concrete.

(e) Chipping hammers not heavier than a nominal 6.8 kilogram class shall be used to remove concrete beneath any reinforcing bars.

(2) Proportioning and Mixing Equipment.

(a) Grout Mixer. A continuous mixer or mortar mixer, using volumetric measurements, may be used for mixing grout.

(b) Concrete Overlay. Applicable provisions of Item 421, "Port- land Cement Concrete", shall govern.

(c) Dense Concrete Overlay. Applicable provisions of Item 421, "Portland Cement Concrete", shall govern together with the following:

The concrete shall be proportioned and mixed at the project site.

A mobile, continuous, volumetric mixer, or a volumetric or mass batch mixer of the rotating paddle type will be required.

(3) Placing and Finishing Equipment.

(a) Hand Tools. Sufficient and appropriate hand tools for placing and finishing stiff plastic concrete and for working it to correct level for strike-off shall be provided.

(b) Finishing Equipment Concrete Overlay. A surface vibrator moving ahead of the finishing machine or a vibrating screed, approved by the Engineer, will be required for overlay consolidation. Work bridges or other suitable facilities shall be provided from which to perform all finishing operations.

(c) Finishing Equipment Dense Concrete Overlay. A mechanical strike-off will be required to provide a uniform thickness of concrete in front of the screed.

The screed shall be designed to consolidate the dense concrete overlay to 98 percent of the unit weight determined in accordance with Test Method Tex-417-A. The bottom face of the screed shall be designed to minimize tearing of the surface of the plastic concrete.

The finishing machine shall be capable of forward and reverse motion under positive control. Provisions shall be made for raising the screed(s) to clear the screeded surface for traveling in reverse. The finishing machine shall be equipped to travel on and screed off of any adjacent completed lane without damaging it.

Manual type screeds with approved vibrators shall be used to consolidate and finish small or irregular areas inaccessible to the finishing machine.

Work bridges or other suitable facilities shall be provided from which to perform finishing operations and for checking density.

439.4. Construction Methods.

(1) General. The Contractor shall furnish to the Engineer, for his approval, a work plan including equipment and manpower before work is started.

Side and end forms will be required for supporting the screed and containment of the overlay and will be subject to the approval of the Engineer.

The Contractor will be required to place concrete during night hours if daytime temperature and wind conditions are detrimental to the proper placing of overlay. The Engineer will inform the Contractor, in writing, if night placements become necessary. Additional compensation will not be made for night placements of concrete.

In the event that the Contractor decides to place concrete during night hours, sufficient lighting shall be provided, as necessary, to make quality workmanship and adequate inspection possible. Adequacy of such lighting must meet the approval of the Engineer before operations begin.

The overall combination of labor and equipment for proportioning, mixing, placing and finishing concrete overlay shall produce not less than 12 meters of finished overlay per hour.

Traffic other than construction equipment for the overlay will not be permitted on any portion of the bridge deck which has undergone the required scarifying or cleaning and before the overlay has been placed.

Concrete shall not be placed when the air or deck temperature is below 5 °C. The temperature of the concrete when placed shall be between 10 °C and 30 °C.

Carting concrete batches over completed overlay will not be permitted until the overlay concrete has attained a 21 megapascals compressive or 3.6 megapascals flexural strength. If carts are used, timber planking (minimum 20 millimeters thickness) will be required for the remainder of the curing period. Carts shall be equipped with pneumatic tires. Curing operations shall not be interrupted for the purpose of carting concrete over finished slabs.

Opening of the structure with the completed overlay to normal construction traffic, and when necessary to the traveling public, shall be in accordance with Article 420.3.

Reinforcement, if shown on the plans, shall conform to the requirements of Item 440, "Reinforcing Steel", and details shown on the plans.

(2) Preparation of Surface. Concrete surfaces, finished in accordance with Articles 420.19 and 424.4.(6) regarding surfaces to be overlaid with concrete, will not require scarifying. These surfaces shall receive a surface preparation which consists of cleaning by wet or dry abrasion blasting, to remove dirt, oil, curing compound, laitance, surface mortar or other material that would inhibit bonding of the overlay, but shall leave the striations intact.

For rehabilitation of slabs, scarifying of surfaces to the specified depths shall be required and will be in accordance with Item 483, "Scarifying Concrete Bridge Slab".

Deteriorated and/or delaminated areas of concrete shown on the plans or as determined by use of a sounding hammer, chain drag or other acceptable device, and by visual inspection after scarifying, shall be removed and disposed of as approved by the Engineer.

For concrete overlay and dense concrete overlay, Slab Repair (Type 1) shall consist of the removal of deteriorated concrete from the top of the scarified surface to 1/2 the depth of the slab and replacement with concrete as specified for the overlay. For those areas where removal of deteriorated concrete extends below mid-depth of the slab, the concrete shall be removed full depth; these areas will be designated as Type 2 repairs.

For concrete overlay, Slab Repair (Type 2) shall consist of the removal of deteriorated concrete from the top of the scarified surface to the bottom of the slab and replacement with concrete as specified for concrete overlay. For dense concrete overlay, Slab Repair (Type 2) shall consist of the removal of deteriorated concrete from the top of the scarified surface to the bottom of the slab and replacement with Class S concrete. Following removal of the concrete to the maximum depth for a Type 1 repair, any portion of that area in which the remaining concrete is found to be unsound shall be designated as a Type 2 repair and the remaining concrete shall be removed in accordance with the requirements for a Type 2 repair.

A jack hammer not heavier than a nominal 13.6 kilogram class may be used for the removal of deteriorated concrete in small areas not accessible to the mechanical scarifier, and for spot removal of small areas of deteriorated concrete, to a depth down to the existing top reinforcing steel. This class of jack hammer may also be used for concrete removal between existing reinforcing bars to a greater depth, but chipping hammers, not heavier than a nominal 6.8 kilogram class, shall be used for removal of concrete from beneath any reinforcing bars. Care shall be taken to prevent cutting, stretching or damage to exposed reinforcing steel by direct impact of these power tools. All jack hammers and chipping hammers shall be operated at an angle of 45 degrees or less measured from the surface of the slab.

When bond between existing concrete and reinforcing steel that will remain in place has been destroyed, the concrete adjacent to and below the bar shall be removed to a minimum 25 millimeters depth below the bar to permit new concrete to bond to the entire periphery of the exposed bar.

Prior to placing concrete, all exposed reinforcing steel, scarified surfaces and newly exposed concrete surfaces, including construction joints against curbs or parapet walls, shall be cleaned by wet or dry sandblasting. Wet sandblasting methods shall be in accordance with Item 485, "Wet Sandblasting".

Any reinforcing steel damaged, cut or broken by the Contractor's operations shall be restored with new bars of the same size by lapping or welding as directed by the Engineer.

When wet or dry abrasion blasting is used, the surface shall then be cleaned by water blasting. The prepared surface shall be moist and in an approximately saturated surface dry condition before placing bonding grout. Just prior to placing grout, the surfaces shall be filtered air blasted to remove windblown dust, dirt, debris or standing water.

(3) Placing and Finishing Concrete. Rails or headers, upon which the screed travels, shall be placed in a position to insure finishing the concrete to the required profile and shall be placed outside the area to be overlaid. Anchorage of headers or supporting rails shall provide for horizontal and vertical stability. A hold-down device shot into the concrete will not be permitted unless the concrete is to be subsequently overlaid. Plans for anchor support of headers or rails shall be submitted to and approved by the Engineer prior to beginning work.

The thickness of the overlay concrete shall be as specified on the plans. The screed and/or screed rails shall be adjusted to provide an approved grade line and sufficient thickness. The clearance between the screed and existing surface shall be checked as follows:

For nonreinforced overlays, a filler block having a thickness three (3) millimeters less than the overlay thickness shall be attached to the bottom of the screed. With the filler block in place, the screed shall be passed over the area to be overlaid. Areas which have insufficient clearance shall be corrected by adjustments of the screed and/or rail system, or by chipping or scarifying as approved by the Engineer.

For reinforced overlays, other methods shall be used for checking screed clearance and reinforcement cover, as approved by the Engineer.

Location of longitudinal joints shall be as shown on the plans or as approved by the Engineer. At transverse and longitudinal joints, the overlay course previously placed shall have a straight and vertical edge. Joints shall be sawed before the adjacent overlay course is placed.

Unless otherwise required on the plans or by this specification, bonding grout shall not be used. The prepared surface shall be in a saturated surface dry condition when the overlay concrete is placed.

When bonding grout is required on the plans or by this specification, the surface shall be prepared as specified and, immediately before placing concrete, a thin coating of bonding grout shall be scrubbed into the prepared surface. Care shall be exercised to insure that all surfaces, including vertical joints, receive a thorough, even coating and that no excess grout is permitted to collect in pockets. Grout placement shall be applied so that it does not become dry before it is covered with concrete.

Areas of the bridge deck where concrete has been removed below the top mat of reinforcing steel, shall be coated with bonding grout, filled with overlay concrete or Class S concrete as applicable to cover the reinforcing steel, adequately consolidated and rough floated just ahead of the placement of overlay.

The overlay concrete shall be placed and mechanically struck off slightly above final grade. It shall then be mechanically consolidated and screeded to final grade. All concrete shall be vibrated to insure complete consolidation into the corners and angles of the edges. Hand finishing with a float may be required in order to produce a tight, uniform surface.

Dense Concrete shall be consolidated to 98 percent density as tested in accordance with Test Method Tex-451-A, after screeding and prior to texture being applied.

Construction joints shall be assured of a dense, watertight finish by proper consolidation of the concrete and float finishing the top surface of the joint, flush with adjacent concrete.

For this Item, the straight edge and texture depth requirements specified in Article 420.19 shall govern for the finishing of the concrete overlay.

(4) Curing. The overlay shall receive a wet burlap cure as soon as possible after the concrete has been textured. Failure to apply the wet burlap before the overlay has dried out or cracked shall be cause for rejection of the area of overlay so affected. The wet burlap shall be kept continuously wet for 24 hours. The overlay shall then be water cured as outlined in Article 420.20 for an additional seven (7) days. The surface temperature of the concrete shall be maintained above 5 °C for the curing period required. Rejected overlay concrete shall be removed and replaced at no additional cost to the Department.

(5) Concrete Surface Treatment. Concrete Surface Treatment shall be applied to the overlay in accordance with Item 428, "Concrete Surface Treatment".

439.5. Measurement. The removal of deteriorated or delaminated concrete for Slab Repair (Type 1) and Slab Repair (Type 2) will be measured by the square meter of surface area, measured in place.

Concrete overlay or dense concrete overlay will be measured by the square meter of roadway surface overlaid, using the dimensions shown on the plans.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

439.6. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Slab Repair (Type 1)", "Slab Repair (Type 2)", "Concrete Overlay" and "Dense Concrete Overlay" of the specified depth.

Payment for "Slab Repair (Type 1)" and "Slab Repair (Type 2)" repair shall be full compensation for removal of deteriorated or delaminated concrete below the top of scarified surface, for cleaning and restoration of reinforcing steel as required and for replacement with concrete.

Payment for "Concrete Overlay" or "Dense Concrete Overlay" shall be full compensation for abrasion blasting of the surface, if required; for furnishing and placing of grout, if required; and for furnishing, placing, finishing and curing of the concrete overlay. Scarifying when required shall be paid for in accordance with Item 483, "Scarifying Concrete Bridge Slab".

The above payments shall be full compensation for all materials, tools, labor, equipment and incidentals necessary to complete the work.

ITEM 440

REINFORCING STEEL

440.1. Description. This Item shall govern for the furnishing and placing of deformed and smooth reinforcing steel, of the sizes and details shown on the plans and in accordance with this Item.

All Producing Mills of reinforcing steel for the Texas Department of Transportation use shall be preapproved by the Materials and Tests Division prior to furnishing reinforcing steel. Preapproval will be in accordance with Test Method Tex-741-I. A list of Department approved Producing Mills will be maintained by the Materials and Tests Division. Reinforcing steel obtained from unapproved sources will not be permitted.

All reinforcing steel to be epoxy coated will be designated on the plans. Epoxy coating of reinforcing steel shall be in accordance with "Epoxy Coating of Reinforcing Steel" of this Item.

All epoxy applicators shall be preapproved by the Materials and Tests Division prior to furnishing epoxy coated reinforcing steel. Preapproval will be in accordance with Test Method Tex-742-I. A list of Department approved applicators will be maintained by the Materials and Tests Division.

440.2. Materials. Unless otherwise shown on the plans or specified herein, the reinforcing steel shall be Grade 400 and all bar reinforcement shall be deformed, conforming to one of the following:

(1)ASTM A 615, Grades 300 or 400, open hearth, basic oxygen, or electric furnace new billet steel.

(2)ASTM A 617, Grades 300 or 400, axle-steel.

(3)ASTM A 616, Grade 400, rail steel will be permitted in concrete pavement only. ASTM A 616 bars shall be furnished as straight bars only and bending is prohibited. Bend tests will not be required.

(4)ASTM A 706, Grade 400, weldable reinforcing steel.

(5)Smooth Bars. Smooth bars for concrete pavement shall have a minimum yield strength of 400 megapascals.

All other smooth bars, larger than 15M, may be steel conforming to the above or may be furnished in any steel that meets the physical requirements of ASTM A 36.

(6)Spiral reinforcement shall be either smooth or deformed bars, or wire, of the minimum size or diameter shown on the plans, or as specified herein.

Bars for spiral reinforcement shall comply with ASTM A 675, Grade 550 (reference to ASTM A 29 is voided) A 615 or A 617, Grade 300, unless otherwise shown on the plans. Smooth wire shall comply with ASTM A 82 and deformed wire shall comply with ASTM A 496.

In cases where the provisions of this Item are in conflict with the provisions of the ASTM Specification, the provisions of this Item shall govern.

Reinforcing steel to be structurally welded shall comply with ASTM A 706 or shall have a carbon equivalency (C.E.) of not more than 0.55 percent. A report of chemical analysis, showing the percentages of all elements necessary to establish the carbon equivalency, will be required for

all reinforcing steel that is to be structurally welded. The above requirements do not pertain to miscellaneous welds on reinforcing steel as defined in Item 448, "Structural Field Welding".

Carbon equivalency will be calculated using the following formula:

$$C.E. = \%C + \frac{\%Mn}{6} + \frac{\%Cu}{40} + \frac{\%Ni}{20} + \frac{\%Cr}{10} - \frac{\%Mo}{50} - \frac{\%V}{10}$$

The nominal size, area and mass of reinforcing steel bars covered by this specification are as follows:

BAR SIZE DESIGNATION	NOMINAL DIMENSIONS		
	MASS (kg/m)	DIAMETER (mm)	AREA (mm^2)
10M	0.785	11.3	100
15M	1.570	16.0	200
20M	2.355	19.5	300
25M	3.925	25.2	500
30M	5.495	29.9	700
35M	7.850	35.7	1000
45M	11.775	43.7	1500
55M	19.625	56.4	2500

Smooth round bars shall be designated by size number through 15M. Smooth bars above 15M shall be designated by diameter in millimeters.

(7) Wire for fabric reinforcement shall conform to ASTM A 82 or A 496. Wire fabric shall conform to ASTM A 185 or A 497.

When wire is ordered by size numbers, the following relation between size number, diameter in millimeters and area shall apply unless otherwise specified. Where deformed wire is required, the size number shall be preceded by "D", and for smooth wire the prefix shall be "W".

Size (MW = Plain)	Area (mm^2)	Diameter (mm)
MW200	200	16.01
MW130	130	12.9
MW120	120	12.4
MW100	100	11.3
MW90	90	10.7
MW80	80	10.1
MW70	70	9.4
MW65	65	9.1
MW60	60	8.7
MW55	55	8.4
MW50	50	8.0
MW45	45	7.6
MW40	40	7.1
MW35	35	6.7
MW30	30	6.2
MW26	26	5.7
MW25	25	5.6
MW20	20	5.0
MW19	19	4.9
MW15	15	4.4
MW13	13	4.1
MW10	10	3.6
MW9	9	3.4

Note: Fractional sizes between the sizes listed above are also available and acceptable for use.

Welded wire fabric will be designated as shown in the following example:

152 x 305 - MW19 x MW26; indicating 152 millimeter longitudinal wire spacing and 305 millimeter transverse wire spacing with smooth number 19 wire longitudinally and smooth number 26 wire transversely.

(8) Epoxy Coating. The epoxy coating material and the material used for the repair of the coating shall comply with the Departmental Materials Specification D-9-8130, "Epoxy Powder Coating For Reinforcing Steel". Copies of the Departmental Materials Specifications are available from the Texas Department of Transportation, Materials and Tests Division, 125 East 11th Street, Austin, Texas 78701-2483. A 250 grams sample of epoxy powder and manufacturer's certifications will be required for each lot of epoxy powder used to coat materials for Department projects.

440.3. Bending. The reinforcement shall be bent cold, true to the shapes shown on the plans. Fabrication shall preferably be done in the shop. Field fabrication, if permitted, shall be done with equipment approved by the Engineer. Misfabricated, damaged or broken bars shall be rejected and replaced at the Contractor's expense. Damaged or broken bars imbedded in a previous concrete placement may be repaired with the approval of the Engineer.

Unless otherwise shown on the plans, the inside diameter of bar bends, in terms of the nominal bar diameter (d), shall be as follows:

Bends of 90° and greater in stirrups, ties and other secondary bars that enclose another bar in the bend shall be:

10M, 15M	4d
20M, 25M	6d

All bends in main bars and in secondary bars not covered above shall be:

10M thru 25M	6d	
30M, 35M		8d
45M, 55M (Grade 300 bars)	10d	

Where bending of Grade 400 bars, sizes 45M or 55M, is required, bend testing shall be performed on representative specimens as described for smaller bars in the applicable ASTM Specification. The required bend shall be 90 degrees around a pin having a diameter of 10 times the nominal diameter of the bar.

440.4. Tolerances. Fabricating tolerances for bars, from plan dimensions, shall not be greater than shown in Figure 1.

440.5. Storing. Steel reinforcement shall be stored above the surface of the ground upon platforms, skids, or other supports and shall be protected from damage and deterioration as approved by the Engineer. When placed in the work, reinforcement shall be free from dirt, paint, grease, oil, or other foreign materials. Reinforcement shall be free from defects such as cracks and laminations. Rust, surface seams, surface irregularities or mill scale will not be cause for rejection, provided the minimum cross-sectional area of a hand wire brushed specimen meets the requirements for the size of steel specified.

440.6. Splices. Splicing of bars, lap spliced or welded, shall be as shown on the plans or specified herein. Additional splices will require written approval of the Engineer.

Splices not provided for on the plans will be permitted in slabs 375 millimeters or less in thickness, columns, walls and parapets, but will not be included for measurement, subject to the following:

Unless otherwise approved by the Engineer, splices will not be permitted in bars nine (9) meters or less in plan length. For bars exceeding nine (9) meters in plan length, the distance center to center of splices shall not be less than nine (9) meters minus one splice length, with no more than one individual bar length less than three (3) meters. Lap splices not shown on the plans, but permitted herein, shall be made in accordance with Table 1. The specified concrete cover and proper spacing shall be maintained at such splices and the lap spliced bars placed in contact and securely tied together.

TABLE 1
Minimum Lap Requirements
(for laps not shown on plans in Slabs 375 mm or less in thickness, columns, walls and parapets)

TABLE 1 (continued)
Minimum Lap Requirements in Millimeters (mm)
(for laps not shown on plans)

Millimeters (mm)		
SIZE	UNCOATED	COATED
10M	500	760
15M	700	1060
20M	860	1300
25M	1440	2160
30M	2000	3000
35M	2860	4300

Spiral steel shall be lapped a minimum of one (1) turn.

Bar sizes 45M and 55M shall not be lapped.

Welded splices shall conform to the requirements of the plans and Item 448, "Structural Field Welding". End preparation for butt welding reinforcing bars shall be done in the field. Delivered bars shall be of sufficient length to permit weld preparation.

Welded wire fabric shall be spliced using a lap length that will include the overlap of a minimum of two (2) cross wires plus 50 millimeters on each sheet or roll. Splices using bars which develop equivalent strength and lapped in accordance with Table 1 will be permitted.

For box culvert extensions with less than 0.3 meter of fill, the existing longitudinal bars shall have a lap with the new bars as shown in Table 1. For extensions with more than 0.3 meter of fill, a minimum of 150 millimeters lap will be required.

440.7. Mechanical Couplers.

(1) General. When shown on the plans, mechanical couplers may be made in reinforcing steel using one of the types shown in Departmental Material Specification D-9-4510. However, sleeve-wedge type couplers will not be permitted on coated reinforcing. All couplers furnished by the Contractor shall be produced by a prequalified manufacturer. Prequalification shall be in accordance with Departmental Material Specification D-9-4510.

(2) Project Samples. For purposes of sampling couplers for use on an individual project, a lot of couplers shall be defined as 500 couplers, or fraction thereof, for each size and type. Prior to use on the project, three (3) test specimens shall be assembled using couplers selected at random from each lot received on the project. All test specimens shall be assembled from materials consigned to the project and shall be assembled in the presence of the Engineer. A test specimen shall consist of a coupler connecting two (2) 525 millimeters, or longer, bars using the same splice materials, position, equipment and procedures to be used to make splices in the work. The assembled test specimens shall be submitted to the Materials and Tests Division for testing. Each lot of couplers shall be identified with tags or markings identifying the lot from which the samples were taken.

(3) Testing. Project samples will be tested to 125 percent of specified yield strength and for total slip requirements. When a test representing a lot of couplers fails to meet the requirements, four (4) additional couplers from that lot will be tested. If all four (4) tests meet the requirements, the lot will be accepted for use in the work. If any of the four (4) tests fail to meet the requirements, that lot of couplers will be rejected and not used in the work.

(4) Construction Methods. All coupling devices shall be installed in accordance with the manufacturer's recommendations. Protection of threaded male or female connections shall be provided and the threaded connections shall be clean when making the connection. Damaged threads shall not be repaired.

(5) Alternate Equivalent Strength. Alternate equivalent strength arrangements to be accomplished by substituting larger bar sizes, or more bars, will be considered if approved by the Engineer, in writing, prior to the fabrication of the systems.

440.8. Placing. Unless otherwise shown on the plans, dimensions shown for reinforcement are to the centers of the bars. Reinforcement shall be placed as near as possible in the position shown on the plans. In the plane of the steel parallel to the nearest surface of concrete, bars shall not vary from plan placement by more than 1/12 of the spacing between bars. In the plane of the steel perpendicular to the nearest surface of concrete, bars shall not vary from plan placement by more than six (6) millimeters. Cover of concrete to the nearest surface of steel shall meet the above requirements but shall never be less than 25 millimeters.

For bridge slabs, the clear cover tolerance for the top mat of reinforcement shall be - 0 millimeters, + 13 millimeters.

The reinforcement shall be accurately located in the forms, and firmly held in place, before and during concrete placement, by means of bar supports, adequate in strength and number in order to prevent displacement and to keep the steel at the proper distance from the forms. Bars shall be supported by standard bar supports with plastic tips, plastic bar supports approved by the Engineer or precast mortar or concrete blocks when supports are in contact with removable or stay-in-place forms. Bright basic bar supports may be used to support reinforcing steel placed in slab overlays on concrete panels or on existing concrete slabs. Bar supports in contact with soil or subgrade shall be as approved by the Engineer.

For bar supports with plastic tips, the plastic protection shall have a minimum thickness of 2.5 millimeters and extend upward on the wire to a point at least 15 millimeters above the formwork.

All accessories such as tie wires, bar chairs, supports or clips used with epoxy coated reinforcement shall be of steel, fully coated with epoxy or plastic. Plastic supports approved by the Engineer may also be used with epoxy coated reinforcement.

Mortar or concrete blocks shall be cast to uniform dimensions with adequate bearing area. A suitable tie wire shall be provided in each block

for anchoring to the steel. The blocks shall be accurately cast to the thickness required in molds approved by the Engineer. The surface placed adjacent to the form shall be a true plane, free of surface imperfections. The blocks shall be cured by covering with wet burlap or mats for a period of 72 hours. Mortar for blocks shall contain approximately one (1) part portland cement to three (3) parts sand. Concrete for blocks shall contain 500 kilograms of portland cement per cubic meter of concrete.

Individual bar supports shall be placed in rows at 1.2 meters maximum spacing in each direction. Continuous type bar supports shall be placed at 1.2 meters maximum spacing. Continuous bar supports will be required when permanent metal deck forms are used.

The exposure of the ends of longitudinals, stirrups and spacers used to position the reinforcement in concrete pipe and precast box culverts or sewers shall not be cause for rejection.

Reinforcing steel for bridge slabs, top slabs of direct traffic culverts and the top slabs of prestressed box beams shall be tied at all intersections except that where the spacing is less than 300 millimeters in each direction, alternate intersections only need to be tied. For reinforcing steel cages for other structural members, the steel shall be tied at a sufficient number of intersections to provide a rigid cage of steel. Mats of wire fabric shall be fastened securely at the ends and edges.

Before concrete placement, all mortar, mud, dirt, etc., shall be cleaned from the reinforcement. Concrete shall not be placed until authorized by the Engineer.

If the reinforcement is not adequately supported or tied to resist settlement, floating upward, overturning of truss bars, or movement in any direction during concrete placement, concrete placement will be halted until corrective measures are taken.

440.9. Epoxy Coating of Reinforcing Steel.

(1) General. When shown on the plans, coating with epoxy of reinforcing bars, plain wire, deformed wire or welded wire fabric to be used as reinforcement for concrete shall conform to the requirements herein.

(2) Surface Preparation. The reinforcing steel shall be free of surface contaminants such as oil, grease or paint when received at the manufacturer's plant and prior to cleaning and coating. The surface of steel to be coated shall be cleaned by abrasive blast cleaning to near white metal in accordance with the requirements of Item 446, "Cleaning, Paint and Painting", Class A Blast Cleaning. All traces of grit and dust from the blast cleaning shall be removed prior to coating. Other methods of cleaning may be submitted to the Engineer for approval.

(3) Application of Coating. The applicator shall notify the Engineer at least 30 days before the date of production. The coating shall be applied as recommended by the manufacturer of the coating material.

The coating shall be applied to the cleaned surface as soon as possible after cleaning and before oxidation of the surface discernible to the unaided eye occurs. The coating shall be a smooth uniform coat and shall have a thickness of from 178 to 305 micrometers, after curing. The thickness of the coating shall be measured using magnetic thickness testing gauges in accordance with Test Method Tex-728-I.

The coating film shall be fully cured. Sufficient checks shall be made to assure that each coated production lot is supplied in a fully cured condition.

(4) Continuity of Coating. The applicator shall check the coating for continuity after curing. The coating shall be free from holes, voids, cracks, contamination and damaged areas discernible to the unaided eye.

For reinforcing bars a 67 1/2 volt D.C. in-line holiday detector, such as Tinker and Rasor Model M-1 or approved equivalent, shall be used to check the coating for holidays. There shall be no more than two (2) holidays (pinholes not visually discernible) in any 0.3 meter of a coated reinforcing bar.

Holiday checks to determine acceptability of wire or welded wire fabric shall be made at the manufacturer's plant with a 67 1/2 volt D.C. holiday detector. For wire, there shall not be more than an average of two (2) holidays per 0.3 meter of wire. For welded wire fabric, there shall not be more than an average of four (4) holidays per 0.3 meter of wire in welded wire fabric when the wire spacings are 100 millimeters or more, or six (6) holidays per 0.3 meter of wire when the spacings

are less than 100 millimeters. Uncoated areas at cut ends shall not be counted, nor shall sharp edges (weld spurs) at intersections be counted as holidays. When measuring the number of holidays, at least 15 millimeters of wire must be included on each side of the intersections being checked.

(5) Repair of Coating. Material for repair of the coating shall comply with the requirements in "Epoxy Coating" of this Item. Repairs shall be made in accordance with procedures recommended by the manufacturer of the epoxy coating powder. Areas to be patched shall receive at least the same coating thickness as required for the original coating.

All visible damage to the coating shall be repaired.

Sawed and sheared ends, cuts, breaks and/or other damage shall be repaired promptly before additional oxidation occurs. Areas to be repaired shall be clean and free from surface contaminants. Repairs shall be made in the shop or in the field as required.

The acceptable amount of patched area at the applicator shall not exceed six (6) millimeters total length in any 300 millimeters.

(6) Sampling and Testing. Sampling and testing of coated reinforcement shall be in accordance with Test Method Tex-739-I.

(7) Identification and Documentation. Identification of all reinforcing shall be maintained throughout the coating and fabrication process and until delivery to the project site.

For all production of coated reinforcing steel to be used on Department projects, the manufacturer shall furnish to the Engineer two (2) copies of a written certification that the coated reinforcing steel meets the requirements of this specification and two (2) copies of the manufacturer's control tests.

(8) Handling. All systems for handling coated reinforcement shall have padded contact areas. Bundling bands shall be padded or suitable banding shall be used to prevent damage to the coating. Bundles of coated

reinforcement shall be lifted with a strong back, spreader bar, multiple supports or a platform bridge. The bundled reinforcement shall be transported with care and stored on protective cribbing. The coated reinforcement shall not be dropped or dragged.

(9) Construction Methods. Flame cutting will not be permitted on coated reinforcement. Saw or shear cutting will be permitted with permission of the Engineer. Cut ends shall be coated as specified in "Repair of Coating" of this Item.

Welding or mechanical coupling of coated reinforcing steel will not be permitted except where specifically shown on the plans. The epoxy coating shall be completely removed a minimum of 150 millimeters beyond the weld limits prior to welding and 50 millimeters beyond the limits of the coupler prior to assembly. After welding or coupling, the steel shall be cleaned of all oil, grease, moisture, dirt, welding contamination (slag and/or acid residue) and rust to a near white finish. The existing epoxy shall be checked for damage. Any damaged or loose epoxy shall be removed back to sound epoxy coating.

After proper cleaning, the splice area shall be coated with epoxy repair material to a thickness of 178 to 305 micrometers. A second application of repair material shall be applied to the bar and coupler interface to insure complete sealing of the joint.

440.10. Measurement and Payment.

Except as specified below, the work performed, materials furnished, and all labor, tools, equipment and incidentals necessary to complete the work under this Item will not be measured or paid for directly, but will be considered subsidiary to the various bid items of the contract.

The quantities of reinforcing steel shown on the plans are estimates and are for the Contractor's information.

Compensation for adjustment of reinforcing steel quantities will be as follows:

(1) When the reinforcing steel quantity for a complete structure element has been erroneously included in or omitted from the quantities shown on the plans, the quantity for that element will be added or deducted for payment. A complete structure element will be the smallest portion of a total structure for which a corresponding quantity of concrete is included on the plans. Additional payment or reduction in payment for quantities revised in this manner will be made accordingly, in accordance with Article 4.3.

(2) When the plan quantity for reinforcing steel for a complete structure element is in error by five (5) percent or more, a recalculation will be made and payment will be increased or reduced accordingly in accordance with Article 4.3.

(3) When quantities for reinforcing steel are revised by a change in design, the change in quantities will be calculated. Additional payment or reduction in payment for quantities revised in this manner will be made accordingly, in accordance with Article 4.3.

The party to the contract requesting the adjustment shall present to the other one (1) copy of the description and location, together with calculations of the quantity for the structure element involved. When this quantity is certified correct by the Engineer, it will become the basis for additional or reduced payment.

ITEM 441

STEEL STRUCTURES

441.1. Description. This Item shall govern for the fabrication and erection of structural steel and other metals used for steel structures or steel portions of structures as shown on the plans and in accordance with this Item.

441.2. Materials. The metal used for the various portions of the structures shall conform to the requirements of Item 442, "Metal for Structures".

441.3. General.

(1) Qualification of Plant and Personnel. Bridge fabrication plants will be investigated by the Department for competency of the plant, equipment, organization, experience, knowledge, and personnel to produce quality work. Fabrication plants found to be in conformance with guidelines outlined in the AASHTO Standard Specifications for Highway Bridges will be approved by the Director of Materials and Tests. In addition, the contractor of bridge structures of major steel bridges (all bridge structures other than simple rolled beam bridges) shall possess a current Category III Certification from the American Institute of Steel Construction (AISC) Quality Certification Program.

(2) Erection Drawings. All erection drawings shall be checked by the Contractor before submitting them for approval. The requirements for the Title Block stated in "Shop Drawings" shall also apply to Erection Drawings. Submission of five (5) sets of preliminary erection drawings and seven (7) sets of detailed erection plans shall be made to the Director of Design, Texas Department of Transportation, 125 East 11th Street, Austin, Texas, 78701-2483. One (1) additional copy of detailed erection plans will be required if the structure is a railroad underpass. Additional sets may be required by the Engineer.

(a) Preliminary Erection Drawings. For plate girder units, preliminary erection drawings showing the sequence of erection and the location of ground and air splices and supports shall be submitted to the Director of Design for approval prior to the submission of shop drawings.

(b) Field Erection Drawings. Prior to field erection the Contractor shall prepare and submit for approval detailed erection plans, bearing the seal of a registered professional engineer, for plate girders (bolted or welded), trusses, and for all railroad underpass structures showing procedures, sequence of work, equipment to be used, falsework, adjacent structures loaded, etc. This detailed procedure shall follow the preliminary procedure previously submitted. Field erection plans for I-beam units will not be required unless specified on the plans.

(3) Shop Drawings. The Contractor shall prepare and submit detailed shop drawings for each detail of the general plans requiring the use

of structural steel, forgings, wrought iron, castings, or bearings. Shop drawings for plate girder units shall not be submitted before preliminary erection drawings are submitted for approval and will not be returned until the preliminary erection plan has been approved. Camber, sweep, and shop assembly drawings will be required. Values for camber (vertical curvature) and sweep (horizontal curvature) shall be detailed along the length of the girder section at the same locations shown on the contract plans. If not shown on the contract plans, values shall be detailed at a minimum spacing of 1/4 points. Shop assembly drawings (combination of two or more girder sections) shall be detailed at a minimum of 1/4 points for each girder section in the shop assembly. Members that are to be heat curved shall be noted on the shop drawings. All shop splices subject to tension or reversal of stresses shall be so noted on the shop drawings. Fracture critical members shall be identified on the shop drawings by the designation of "FCM". The full size drawings shall be prepared on ISO A1 sheets (841 millimeters x 594 millimeters) or on sheets having English units of 34 inches x 22 inches. The drawing area is to be 787 millimeters x 533 millimeters. The right margin is fixed at seven (7) millimeters with equal top and bottom margins. Drawings may be prepared on half-scale sheets or full size drawings may be reduced to half-scale size, if they are completely clear and legible. Each sheet shall have a title block in the lower right-hand corner. The title shall include the sheet index data shown on the lower right-hand corner of the project plans, sheet numbering for the shop drawings, name of structure or stream, name of contractor of bridge structures and name of Contractor. Each sheet shall have a bill of material, including the Charpy V-Notch requirement for each piece.

The Contractor shall have the contractor of bridge structures check shop drawings before submitting the drawings for approval. Submission shall be made to the Director of Design, Texas Department of Transportation, 125 East 11th Street, Austin, Texas, 78701-2483. Six (6) copies of shop drawings will be required, except that one (1) additional copy of each will be required for Railroad Underpass Structures. Additional sets may be required by the Engineer. Upon completion of fabrication, reproducible tracings of approved shop drawings, incorporating all changes, will be required for railroad underpasses only.

The Contractor shall be responsible for the correctness and completeness of the drawings and for the fit of shop and field connections.

Contract plans will indicate details of joints to be used with the shielded metal arc welding process. When the use of submerged arc welding, gas metal-arc welding or flux cored arc welding processes are anticipated, the shop drawings shall state the correct joint details and welding procedure number.

(4) Welding and Fabrication Procedures.

(a) Welding Procedures. When structural members are to be fabricated by welding, welding procedures shall be in accordance with the following welding codes:

ANSI/AASHTO/AWS D1.5(D1.5) Bridge Welding Code for bridge structures

ANSI/AWS/D1.1(D1.1) Structural Welding Code for all structures not considered bridges

Welding procedures shall be submitted to the Director of Materials and Tests, 125 East 11th Street, Austin, Texas 78701-2483. One copy of each required procedure shall be submitted on the applicable form. Upon approval, the welding procedures will be assigned Welding Procedure Numbers. The shop drawings shall include these numbers adjacent to the appropriate welding symbols. The same procedure, when proposed for subsequent projects, will not require resubmission unless required by the Fracture Control Plan.

The applicable approved welding procedure specification for the welding being performed shall be posted on each welding machine. The approved welding procedure shall state the type and thickness of material; the welding process; welding position; electrode classification and size; type of flux; type, grade and flow of shielding gas; number, placement and sequence of weld passes; methods of cleaning; method of backgouging, if applicable; preheat and interpass temperatures; amps; volts; travel speed; joint detail; and other pertinent information required by the Engineer.

(b) Galvanized Weldments. Where weldments are to be galvanized, the galvanizing procedure shall be approved prior to its use. The Fabricator shall prepare a test specimen with a minimum length of

300 millimeters using the same base material, having the same joint configuration and using the welding procedure proposed for production work. This test specimen shall be cleaned and galvanized using the same conditions and procedure to be applied to the production galvanizing.

After galvanizing, the test specimen shall be examined and there shall be no evidence of excessive buildup of zinc coating over the weld area. Evidence of excessive zinc coating build up will require modification of the galvanizing procedure.

The zinc shall be removed from the weld area of the test specimen as described in ASTM A 90 and the weld area visually examined. There shall be no evidence of loss of weld metal or any deterioration of the base metal due to the galvanizing and/or welding procedure. If evidence of deterioration or loss of weld metal is noted, the contractor shall modify the galvanizing and/or welding procedure as required and run a satisfactory retest on the modified procedures prior to production work.

When a galvanizing procedure is approved in combination with a welding procedure, the approved procedure may be used without requalification as long as the step by step galvanizing procedure and welding procedure, including base metal, welding process, amperage, voltage, speed of travel, and cleaning remain the same. At any time that problems develop during production galvanizing, a retest of the compatibility of the galvanizing and welding procedures as described above may be required.

(c) Fabrication Procedures. When main structural members, as defined in Item 442, "Metal for Structures", are fabricated by welding or bolting, a fabrication procedure will be required from all contractors of bridge structures who are new to Department construction and may be required from any contractor of bridge structures when deemed necessary. A fabrication procedure shall include a list of equipment to be used, sequence of assembly, sequence and detail of connections made, special processes such as planing, facing, etc., detail of heat treating, heat curving, and heat straightening procedures and any other information concerning fabrication, as required by the Engineer. Contractors of bridge structures shall have an approved fabrication procedure for each type of structure (rolled beam with welded or bolted splices, plate girders with welded or bolted splices, trapezoidal steel girders with welded or bolted splices, steel box girders, steel plate girder bents, railroad thru-girder and plate girder,

orthotropic deck segments, or other major bridge structure types) prior to starting fabrication.

(5) Notice of Beginning Work. Contractors of steel structures shall give the Engineer notice prior to the beginning of work in the fabrication shop as follows:

Shops in the State of Texas	7 days
Shops in the Contiguous United States	21 days
Shops in Foreign Countries	60 days

No work shall be performed in the shop before the Engineer has authorized fabrication and returned approved shop drawings. Any purchases of material prior to fabrication authorization shall be at the Contractor's risk.

(6) Inspection and Testing. Contractors of steel structures shall provide facilities, materials and equipment (temperature indicators, weld gauges, etc.) that are required for the inspection of material and workmanship in the shop.

Unless otherwise authorized by the Engineer, contractors of bridge structures shall provide an office for use by the State, or the State's authorized representative, which is separate from that occupied by the Contractor's personnel. The office shall be located as near as possible to the work being performed. The office shall be a minimum of 14 square meters and be equipped with desks, chairs, filing cabinets, layout table, and plan rack. The office shall be weather tight, adequately lighted, heated, and air-conditioned. Rest room facilities shall be either incorporated or located nearby. The office and equipment shall be maintained so that it will continue to function properly for the intended use. The office shall be approved by the Engineer.

The Contractor shall provide the Inspector with as many helpers and equipment as is needed to properly inspect the work. The Inspector shall be allowed free access to the necessary parts of the work.

The Department will not perform quality control for the contractor of steel structures. Quality control shall be solely the responsibility of the Contractor of steel structures. The contractor of steel structures shall have a quality control staff qualified in accordance with Welding Codes D1.5 or

D1.1, whichever is applicable. The quality control staff shall provide necessary inspection of all materials and workmanship prior to inspection by the Department.

When fabrication of structural steel is accomplished outside of the contiguous 48 states, the additional cost of inspection will be in accordance with Article 6.2.

The Inspector will have the authority to reject any material or work which does not conform to the requirements of the plans and specifications. In case of dispute, the Contractor may appeal to the Engineer, whose decision will be final.

Prior to beginning fabrication, the contractor of steel structures shall furnish the Engineer with two (2) copies of the completed material identification form with supporting mill test reports. These material identification forms will be furnished to the Contractor by the Department without charge. The mill test reports shall reflect:

Specification to which material is produced.

Heat number of material.

Chemical and physical properties of the material required by the material specification.

Impact test data when required.

Grain size or statement that fine grain practice was used, when required.

As material is shipped or placed in approved storage, the Contractor shall furnish the Engineer with two (2) copies of his shipping or storage invoice which shall reflect:

Member piece mark identification and calculated mass per piece from the contract drawings.

Number of pieces shipped or in storage.

Total calculated mass for each invoice, per bid item.

The shipping or storage invoice shall have a unique identification number.

The acceptance of any material or finished members by the Inspector will not prohibit subsequent rejection if found damaged or defective. Rejected material shall be replaced promptly by the Contractor.

(7) Welding.

(a) All shop welding operations, processes, equipment, materials, qualifications of welders and welding procedures, workmanship, non-destructive testing, and inspection shall be in accordance with the ANSI/AASHTO/AWS D1.5 Bridge Welding Code (D1.5) or the ANSI/AWS/D1.1 Structural Welding Code (D1.1), except as amended by this Item.

(b) Approved Electrodes and Flux-Electrode Combinations. Lists of approved electrodes and flux-electrode combinations will be maintained by the Director of Materials and Tests. All electrodes and flux-electrode combinations used on Department projects must be on the approved lists. For approval of electrodes or flux-electrode combinations, the Contractor or Manufacturer will submit to the Materials and Tests Division, Austin, Texas, certified copies of all tests required by the applicable AWS Electrode and Electrode Flux Specification in accordance with the applicable Welding Code D1.5 or D1.1.

441.4. Fabrication - General.

(1) Handling and Storage of Materials. All material shall be handled in a manner that will prevent damage. If damage to material is caused by handling devices it shall be removed or repaired by acceptable means as outlined in ASTM A 6, prior to subsequent fabrication steps.

The handling of materials, fabrication, blocking of partially completed members and movement of completed members shall be done in such a manner that the safety of workmen and inspection personnel will not be impaired at any time.

Stored material, either plain or fabricated, shall be placed above the ground on platforms, skids, or other supports and kept clean and properly drained. The material shall be kept free from dirt, grease, and other foreign matter and shall be protected from damaging corrosion or coating deterioration.

Structural steel shall be protected from salt water or other corrosive environments during either storage or transit.

(2) Material Identification. The Contractor's system of assembly-marking individual pieces, and the issuance of cutting instructions to the shop (generally by cross-referencing of the assembly-marks shown on the shop drawings with the corresponding item covered on the mill purchase order) shall be such as to maintain identity of the original piece.

The Contractor may furnish from stock material that can be identified by heat number and mill test report.

Structural steel for bridge main members shall be identified by color coding and mill identification numbers (heat numbers). All other structural steel may be identified by color code only. Loss of color code marking on any piece, with no other positive identification, or loss of heat number identification on any main member piece, will require testing to establish acceptability to the satisfaction of the Engineer. Testing shall be performed by a commercial agency at the Contractor's expense.

(a) Color Coding. Each approved steel shall be identified by color code in accordance with ASTM A 6. The color "white" shall be used for ASTM A 36 steel. Color codes for steels not specified in ASTM A 6 shall be submitted to the Engineer for approval. Color codes shall differentiate between various material toughness requirements (CVN), as well as, any other special physical requirements. Contractors of steel bridges shall submit for approval the color code system that is to be used in their shop.

The appropriate color(s) shall be placed on the material upon entry into the shop and shall be carried on all pieces to final fabrication.

(b) Transfer of Mill Identification Numbers (Heat Numbers). Pieces of steel for main members of bridge structures which are to be cut to smaller pieces shall, before cutting, have heat numbers transferred using either paint or low-stress stencils.

(3) Workmanship.

(a) Railroad Structures. For railroad underpass structures, shop workmanship shall be in accordance with Chapter 15 of the latest American Railway Engineering Association (A.R.E.A.) Specification, except that cleaning of faying surfaces of bolted connections shall be in accordance with Article 441.9.

(b) Tolerances.

Sections. Fabrication and rolling tolerances for rolled shapes, plates, bars, wide flange sections and miscellaneous steel shall be in accordance with ASTM A 6. Tolerances for fabricated girders shall be in accordance with Welding Code D1.5 and this Item.

Rolled sections or fabricated sections of slightly different dimensions and mass than the standard sections shown will be acceptable, provided equal or greater Moment of Inertia and Section Modulus for the completed section are provided.

Maximum deviation from flatness for webs of wide flange sections shall be the same as for built-up girders.

Flanges of completed girders shall be free of kinks, short bends and waviness that depart from straightness or the specified camber by more than three (3) millimeters in any three (3) meters along the flange.

I-beams and girders shall be fabricated with a tolerance not greater than the following:

The plane of the bearing area of beams and girders shall be perpendicular to the vertical axis of the beam within two (2) millimeters.

Correction of bearing areas of shoes, beams and girders to the above tolerances, shall be with heat and/or external pressure. Grinding or milling will be permitted if reduction of the required thickness of the member is not reduced by more than two (2) millimeters.

Box girders shall be fabricated with tolerances not exceeding the following:

The plane of the bearings supporting the box girder shall be perpendicular to the vertical axis of the girder within two (2) millimeters and true to each other, in that plane, to two (2) millimeters.

Each bearing shall be true to one (1) millimeter across its entire width in the short direction.

The plane of the beam supports on the box girder are bearing areas and shall be true to the box girder bearings to two (2) millimeters in the short direction and true to the vertical axis of the nesting beams/girders to two (2) millimeters.

After fabrication, box girders shall be placed on their bearings to field grade, in the shop, and the plane of all bearing areas shall be verified by a method approved by the Engineer.

Rolled material must be straight before being laid off or worked.

Bearing Devices. Shoes shall be fabricated with a tolerance not greater than the following:

The top bolster shall have the center 75 percent of the long dimension true to one (1) millimeter, with the remainder true to two (2) millimeters, and shall be true to one (1) millimeter across its entire width in the short dimension.

The bottom bolster shall be true to two (2) millimeters across its diagonal.

For a pin and rocker type expansion shoe, the axis of rotation shall coincide with the central axis of the pin.

When the shoe is completely assembled and the top bolster is moved horizontally simulating the movement of the shoe in the finished structure, no point in the plane of the top bolster shall change elevation by more than two (2) millimeters for the full possible travel of the rocker both ways from the neutral position, nor shall the top bolster change inclination with respect to the horizontal by more than one (1) degree during this same travel.

(c) Pins, Pinholes, and Rockers. Pinholes shall be bored true to the specified diameter, smooth and straight, at right angles with the axis of the member, and parallel with each other, unless otherwise required.

The diameter of the pinhole shall not exceed that of the pin by more than 0.5 millimeter for pins, 125 millimeters or less in diameter, or one (1) millimeter for larger pins.

(d) Finish Requirements for Weathering Steel Structures in Unpainted Applications. All weathering steel shall be maintained at all levels of fabrication and construction as nearly as possible in the condition received from the mill. All shop welds shall be cleaned as necessary by power grinding or by blast cleaning to remove welding flux, slag and splatter prior to shipment from the plant.

No marking will be permitted on the outside face of any fascia beam.

(4) Cutting, Planing, Facing, and Fit of Members. Sheared edges of main member plates of more than 16 millimeters in thickness shall be planed to a depth of five (5) millimeters.

Unless otherwise permitted by the plans, steel plates for main members shall be cut and fabricated so that the primary direction of rolling is parallel to the direction of the main tensile and/or compressive stresses.

Steel and weld metal may be oxygen cut by the use of a mechanical guide, to a true profile and a smooth and regular surface free from cracks and notches is obtained. Hand cutting shall be done only where approved by the Engineer. Mill scale and extraneous material shall be removed from the cutting side of A 514/A 517 steel plates along the lines to be cut. Hand cutting of radii for beam copes and weld access holes is permitted if an acceptable profile and an acceptable finish is produced by grinding. Uses of other cutting processes shall require the approval of the Engineer prior to use.

Oxygen gouging shall not be used on A 514/A 517 or A 588 weathering steel.

The surface finish of bearing and base plates and other bearing surfaces that are to come in contact with each other or with concrete shall

meet the ANSI surface roughness requirements as defined in ANSI B46.1, Surface Roughness, Waviness and Lay, Part I:

Steel Slabs	ANSI 2000 (50 μm)
Heavy plates in contact in shoes to be welded	ANSI 1000 (25 μm)
Milled ends to compression members, milled or ground ends of stiffeners and fillers	ANSI 500 (10 μm)
Bridge rollers and rockers	ANSI 250 (5 μm)
Pins and pin holes	ANSI 125 (3 μm)

In planing the surfaces of expansion bearings, the cut of the tool shall be in the direction of expansion.

Finished machining, boring and straightening shall be subsequent to annealing or normalizing structural members. Normalizing and annealing (full annealing) shall be as defined in ASTM E 44. The temperatures shall be maintained uniformly throughout the furnace during the heating and cooling so that the temperature at any points on the member will not differ by more than 50 °C.

When required by the plans, bridge shoes, pedestals or other parts which are built up by welding sections of plate together shall be stress relieved in accordance with Welding Code D1.5.

(5) Bending. Bending shall be such that no cracking of the plate occurs. Minimum bend radii, measured to the concave face of the metal, are given in the following Table 1:

Table 1
Thickness In Millimeters

	Up thru 14	Over 14 thru 25	Over 25 thru 40	Over 40 thru 60	Over 60 thru 100
All grades of structural steel in this specification	2 t	2-1/2 t	3 t	3-1/2 t	4 t

Allowance for springback of ASTM A 514 and A 517 steels shall be approximately three (3) times that for structural carbon steel. For break press forming, the lower die span shall be at least 16 times the plate thickness. Multiple hits are advisable.

If a shorter radius is essential, the plates shall be bent hot at a temperature not greater than 620 °C, except for ASTM A 514 and A 517 steels. If ASTM A 514 or A 517 steel plates to be bent are heated to a temperature greater than 610 °C, the plates must be requenched and tempered in accordance with the producing mill's practice. Hot bending shall be such that no cracking of plate occurs.

Before bending, the corners of the plate shall be rounded to a minimum radius of two (2) millimeters throughout the portion of the plate at which the bending is to occur.

(6) Repair of Defects Not Outlined in ANSI/AASHTO/AWS D1.5. The Contractor shall submit a repair proposal to the Engineer for approval. No repair work shall begin before approval is received from the Engineer. Repair procedures shall include sketches or full-size drawings as necessary to adequately describe the deficiency and proposed method of
repair. These sketches will be dated, and signed by the Inspector, verifying the accuracy of the details.

All repair work shall be in strict compliance with the approved repair procedure.

(7) Straightening Bent Material. The straightening of plates, angles, other shapes, and built-up members, when permitted by the Engineer, shall be done by methods outlined in an approved procedure that will not produce fracture or other damage. Straightening of individual pieces shall be done prior to assembly into a built-up member. Distorted built-up members shall be straightened by mechanical means or, if approved by the Engineer, by the carefully planned and supervised application of a limited amount of localized heat. When heat is used in connection with mechanical force to straighten material, the mechanical force shall be applied, and held at a constant, prior to any application of heat.

Heat straightening of A 514/A 517 steel members shall be done only under rigidly controlled procedures, each application subject to the

approval of the Engineer. In no case shall the maximum temperature of the A 514/A 517 steel exceed 610 °C, nor shall the temperature exceed 510 °C at the weld metal or within 150 millimeters thereof. Heat shall not be applied directly on weld metal.

In all other steels the temperature of the heated area shall not exceed 620 °C (a dull red). In all cases the temperature of the steel shall be controlled by approved temperature indicating devices, such as crayons, liquids, or bimetal thermometers.

Kinks and short bends over three (3) millimeters in any three (3) meters will be cause for rejection of the material.

Following the straightening of a bend or buckle, the surface of the metal will be inspected for evidence of fracture. Nondestructive testing may be required by the Engineer.

(8) Camber. Girders shall be cambered before heat curving. The web shall be cut to the prescribed camber with suitable allowance for shrinkage due to cutting, welding, and heat curving. Camber for rolled beams may be obtained by heat-cambering methods approved by the Engineer. The heat-curving process may tend to change the vertical camber present before heating.

(9) Heat Curving.

Steels with a specified minimum yield strength greater than 345 megapascals shall not be heat-curved. Rolled beams and welded I-section plate girders of lower yield strengths may be heat-curved to obtain a horizontal curvature if all the following conditions are met. The Contractor shall submit a detailed procedure to the Engineer for approval prior to heat curving any beam or girder.

Minimum Radius of Curvature: For heat-curved beams and girders, the horizontal radius of curvature measured to the centerline of the girder web shall not be less than 50 meters and shall not be less than the larger of the values calculated (at any and all cross sections throughout the length of the girder) from the following two equations:

$$R = \frac{0.037bD}{(Fy)^{.5}At}$$

$$R = \frac{50b}{FyA}$$

In these equations, Fy is the specified minimum yield point in megapascal of steel in the girder web, A is the ratio of the total cross-sectional area to the cross-sectional area of both flanges, b is the widest flange width in millimeters, D is the clear distance between flanges in millimeters, t is the web thickness in millimeters, and R is the radius in meters.

In addition to the above requirements, the radius shall not be less than 300 meters when the flange thickness exceeds 80 millimeters or the flange width exceeds 750 millimeters. The Contractor of steel bridges shall furnish calculations on the shop drawings substantiating that the above requirements have been met if members are to be heat curved.

Type of Heating: Beams and girders may be curved by either continuous or V-type heating as approved by the Engineer. For the continuous method, a strip along the edge of the top and bottom flange shall be heated simultaneously; the strip shall be of sufficient width and temperature to obtain the required curvature. For the V-type heating, the top and bottom flanges shall be heated in truncated triangular or wedge-shaped areas having their base along the flange edge and spaced at regular intervals along each flange; the spacing and temperature shall be as required to obtain the required curvature, and heating shall progress along the top and bottom flange at approximately the same rate.

For the V-type heating, the apex of the truncated triangular area applied to the inside flange surface (surfaces that intersect the web) shall terminate just before the juncture of the web and the flange is reached. To avoid unnecessary web distortion, heat shall not be applied directly to the web. When the radius of curvature is 300 meters or more, the apex of the truncated triangular heating pattern applied to the outside flange surface shall extend to the web. When the radius of curvature is less than 300 meters, the apex of the truncated triangular heating pattern applied to the outside flange surface shall extend past the web for a distance equal to 1/8 of the flange or 75 millimeters, whichever is less. The truncated triangular pattern shall have an included angle of approximately 15 to 30 degrees, but the base of the triangle shall not exceed 250 millimeters. Variations in the patterns prescribed above may be made with approval of the Engineer.

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The flange edges to be heated are those that will be on the inside of the horizontal curve after cooling. Heating both flange surfaces is mandatory only when the flange thickness is 32 millimeters or greater, in which case both surfaces

shall be heated simultaneously.

Temperature: The heat-curving operation shall be conducted in such a manner that the temperature of the steel does not exceed 620 °C as measured by temperature indicating crayons or other approved methods. The heated member shall not be artificially cooled.

Position for Heating: The girder may be heat-curved with the web in either a vertical or a horizontal position. When curved in the vertical position, the girder must be braced or supported to prevent overturning. When curved in the horizontal position, the girder must be supported near its ends and at intermediate points, if required, to obtain a uniform curvature. The bending stress in the flanges due to the dead load of the girder must not exceed 0.5 of the specified minimum yield strength. When the girder is positioned horizontally for heating, intermediate safety catch blocks must be maintained at the midlength of the girder within 50 millimeters of the flanges at all times during the heating process to guard against a sudden sag due to plastic flange buckling.

Sequence of Operations: The girder shall be heat-curved in the fabrication shop before it is painted. The heat curving operation may be conducted either before or after the required welding of intermediate stiffeners to web only is completed. Flange to stiffener connections shall be welded after heat curving has been completed. However, unless provisions are made for girder shrinkage, connection plates, diafram stiffeners and bearing stiffeners shall be located and attached after heat curving. If longitudinal stiffeners are required, they shall be heat-curved or oxygen-cut separately and then welded to the curved girder. When cover plates are to be attached to rolled beams, they may be attached before heat curving if the total thickness of one flange and cover plate is less than 65 millimeters and the radius of curvature is greater than 300 meters. For other rolled beams with cover plates, the beams must be heat-curved before the cover plates are attached; cover plates must be either heat curved or oxygen-cut separately and then welded to the curved beam.

441.5. Fabrication of Bolted Structures. High-strength bolts and bolting shall be in accordance with Item 447, "Structural Bolting".

(1) Pitch and Edge Distance of Bolt Holes. Pitch and edge distance not shown on the plans shall be detailed in accordance with the latest edition of AASHTO Standard and Interim Specifications for Highway Bridges.

The minimum as fabricated distance from the center of a bolt hole to an edge shall be as follows;

Fastener Size (mm)	Sheared or Flame Cut Edges (mm)	Rolled or Planed Edges (mm)	Beams or Channels (mm)
24 mm	45 mm	40 mm	32 mm
22 mm	40 mm	32 mm	30 mm
20 mm	32 mm	30 mm	25 mm
16 mm	30 mm	25 mm	22 mm

Unless otherwise specified, the maximum as fabricated distance from any edge shall be eight (8) times the thickness of the thinnest outside plate, but shall not exceed 125 millimeters.

The as fabricated distance between centers of fasteners in standard holes shall be as detailed plus or minus five (5) millimeters.

(2) Bolt Holes and Preparation of Holes for Bolting. All holes shall be either punched, drilled, subpunched and reamed, or subdrilled and reamed as per ASTM A 325:

Bolts $\leq$ M24, Bolt hole = Bolt diameter + 2 mm

Bolts > M24, Bolt hole = Bo

The following acceptable substitutes may be used at the Contractor's option:

Requirement	Acceptable Substitute
Reaming with parts assembled	Drilling full size with parts assembled or, if approved by the Engineer, drilling full size without assembly, provided the drilling is done by suitable numerically

	controlled (n/c) drilling equipment, subject to the specific limitations contained in Section 441.5.(2)(c).
Subpunching 5 mm less dia. than that of the finished hole	Subpunching 6 mm less dia. than that of the finished hole.
Subpunching	Subdrilling.
Punching full size	Drilling full size or subpunching and reaming to size with or without all parts assembled.

Holes in vertical load carrying connections and field splices of main members such as trusses, arches, plate girders, continuous beam spans, floor beams, stringers, bents, tower, field bolted diaphragms for curved plate girder units, field bolted diaphragms for railroad structures and rigid frames shall be prepared with parts assembled and either subpunched and reamed or subdrilled and reamed, or drilled full size. Holes for shop fasteners in floor beam end connections and stringer end connections may be subpunched and reamed to a steel template of not less than 25 millimeters thickness or reamed while assembled.

Field connections for secondary members such as diaframs, lateral bracing and sway bracing may be punched full size unless prohibited below.

(a) Punched Holes. Unless prohibited above, members containing not more than five (5) thicknesses of material may be punched full size providing no material is thicker than 20 millimeters for High Yield Carbon (HYC), 16 millimeters for High Strength (HS) or 12 millimeters for Extra High Strength (XHS). The die diameter shall not exceed that of the punch by more than two (2) millimeters. Holes shall be clear cut without torn or ragged edges.

(b) Subpunched or Subdrilled Holes. Holes shall be subpunched or subdrilled five (5) millimeters smaller than the nominal size of the bolt.

(c) Reaming and Drilling Holes. Reamed or drilled holes shall be cylindrical and perpendicular to the member. Reaming and drilling shall be done with twist drills guided by mechanical means unless otherwise approved by the Engineer. Reaming and full-size drilling shall be done using a template, or while the connection is assembled. Full-size drilling may be done using Numerically Controlled (N/C) drilling equipment when approved by the Engineer.

When the reaming or drilling is done while the connection is assembled, the contact surfaces of the connection parts shall be thoroughly cleaned. The connecting parts shall be held securely, without the use of welds, during hole preparation and the pieces shall be matchmarked prior to disassembly. Match marking will be done using low stress stencils. Following matchmarking, assembled pieces shall be taken apart and all burrs or shavings removed. Reaming or drilling through a steel template shall be done after the template has been accurately located as to position and angle and firmly bolted in place. All steel templates shall have hardened steel bushings in holes accurately dimensioned from the centerlines of the connection as inscribed on the template. The centerlines shall be used in accurately locating the template from the milled or scribed ends of the members. Templates used for reaming matching members, or the opposite faces of a single member, shall be exact duplicates. Templates for connections on like parts or members shall be accurately located so that the parts or members are duplicates and require no matchmarking.

When N/C equipment is used, the contractor of bridge structures shall submit to the Engineer for approval the proposed procedures to accomplish the work from initial drilling or punching through check assembly. These procedures shall include the specific members to be N/C drilled or punched, sizes of the holes, location of common index and other reference points, check assemblies, and all other pertinent information. Holes drilled or punched by N/C equipment shall be drilled or punched either through individual pieces, or multiple pieces held tightly together.

(3) Accuracy of Holes. Holes not more than one (1) millimeter larger in diameter than that specified are acceptable. Slotted holes which are produced by flame cutting or a combination of drilling or punching and flame cutting shall not be more than one (1) millimeter greater in width nor two (2) millimeters greater in length than specified. The flame cut surface shall be ground smooth.

Slightly conical holes which naturally result from punching operations are acceptable provided they do not exceed the tolerances specified herein.

(a) Punched and Drilled Holes. All holes punched full-size, subpunched, or subdrilled, shall be so accurately positioned that after assembling (before any reaming is done) a cylindrical pin three (3) millimeters smaller in diameter than the nominal size of the hole may be entered perpendicular to the face of the member, without drifting, in at least 75 percent of the adjoining holes in the same plane. All holes shall pass a **441.6**

pin five (5) millimeters smaller in diameter than the nominal size of the hole. If these requirements are not fulfilled, the misfabricated pieces will be rejected.

(b) Reamed and Drilled Holes. When holes are reamed or drilled, 85 percent of the holes in any adjoining group shall, after reaming and drilling, show no offset greater than one (1) millimeter between adjacent thicknesses of metal.

(c) Misaligned Holes. Correction of misaligned holes may be accomplished by using a tapered reamer in conjunction with a template that is placed and held to force the reaming to the best center of holes for that group.

(4) Preparation and Fit of Members. When shown on the plans, abutting joints shall be finished or milled and brought to an even bearing. Where joints are not finished or milled the openings shall not exceed ten (10) millimeters.

Floor beams and girders with end connection angles shall be built to + one (1) millimeter of the exact length back to back of connection angles. If end connections are faced, the finished thickness of the angles shall be not less than that shown on the shop drawings.

Members to be spliced by high strength bolts shall be in proper alignment. The drifting done during assembling shall be only such as to bring the parts into position and not sufficient to enlarge the holes or distort the metal.

441.6. Fabrication of Welded Structures.

(1) Welding. All groove welded web and flange butt joints of main bridge members, other than rolled beams, shall be welded by the submerged arc process whenever practical.

All submerged arc welding equipment shall have automatic guidance capable of maintaining the position of the arc and controlling the speed of travel; when once set by the operator no further major manipulation is needed. Small adjustments to compensate for acceptable plate waviness, acceptable tilt of flange, etc., will be acceptable. The use of hand held semiautomatic submerged arc welding for welding bridge members will not be allowed unless altered to provide automatic guidance.

Magnetic particle (MT), radiographic (RT) and ultrasonic (UT) nondestructive testing and inspection will be as specified in Welding Code D1.5 for bridge structures and Welding Code D1.1 for all other welding.

Unless otherwise shown on the plans, nondestructive testing required in the shop will be done by the Contractor and at his expense. This will include furnishing all materials, equipment, tools, labor and incidentals necessary to perform the required testing. The Department may require further testing as

necessary in accordance with Article 5.9.

MT, RT, and UT inspection shall be done in the presence of the Engineer or his authorized representative and at locations required by ANSI/AASHTO/AWS D1.5. The Engineer shall examine and interpret all test results of MT and RT inspection. UT inspection shall be performed by a qualified technician approved by the Engineer. The U.T. technician must hold a valid current American Society of Non-Destructive Testing (ASNT) Level II certification in Ultrasonic Inspection and pass a hands on test, which will be administered by the Materials and Tests Division.

Masking (i.e., edge blocks) shall be used at the end of butt welds being subjected to RT inspection.

For shop welds on steel that has a specified yield strength over 450 megapascal, RT inspection shall be made on all flange and web splices. These welds shall be inspected not less than 48 hours after they are completed.

UT inspection shall be made on full penetration corner and tee joints at the same frequency required by D1.5 or at other locations required by the Fracture Control Plan.

Radiographs shall have a density of not less than 2.0 nor more than 3.5 with a density variation of not more than 0.5 and shall be confirmed by the radiographer.

Groove welds requiring repairs shall be retested by RT after repairs are made. All RT inspection and necessary repairs shall be done prior to assembly. All splices shall be RT inspected prior to main member assembly.

RT inspection of designated welds, when shown on the plans, shall be in addition to the RT inspection required in this Item.

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(2) Preparation of Material for Welding. Dimensional tolerances, straightness and flatness of structural shapes and plates shall be in accordance with the appropriate Welding Code, D1.5 or D1.1, and this Item.

Surfaces to be welded shall be smooth, uniform and free from fins, tears and other defects which would adversely affect the quality of the weld. Surfaces to be welded shall be free from loose scale, slag, rust, grease, or other material. Mill scale that withstands vigorous wire brushing or a light film of drying oil or rust inhibitive coating may remain. Finish of bevels of groove welds shall be milled or ground. Oxygen cut bevels without grinding will not be allowed.

Surfaces within 100 millimeters of a groove weld joining main stress carrying members and within 50 millimeters of fillet welds joining diaframs or lateral bracing to stiffeners or gusset plates shall be free from paint and coated with linseed oil.

Sheared plates for webs of built-up members shall be wide enough to allow for trimming of edges where built-in camber is required. Plates with rolled edges used for webs shall be trimmed by oxygen cutting.

Preparation of edges by oxygen cutting shall be in accordance with Subarticle 441.4.(4).

The faying surfaces of the web and flange plates and the adjacent surfaces that are to be fillet welded shall have all mill scale removed by grinding prior to assembly and welding of web to flange.

(3) Assembly of Parts. Extension bars shall be used on all groove welds and fillet welds of main members. Joint preparation and thickness of the extension bars shall be similar to the joint being welded. Minimum lengths of extension bars shall be 25 millimeters for manual and semi- automatic processes and 50 millimeters (longer if required to obtain satisfactory work) for automatic processes.

For painted structures, joints not sealed by welds throughout their length shall fit close enough to exclude water after painting or shall be sealed with paintable silicone sealant prior to painting.

All assemblies to be galvanized shall have all edges of tightly contacting surfaces completely sealed by welding.

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Except for galvanized structures and flange to web welds, fillet welds shall terminate approximately six (6) millimeters from the end of the attachment unless otherwise noted on the contract drawings.

Members to be welded shall be brought into correct alignment and held in position by clamping, welding, or tacking within the joint until the joint has been welded. A method to prevent cupping or warping of flanges must be used to disallow the cupping or warping beyond the tolerance of D1.5. These methods must be designed to not interfere with the operation or guidance of the automatic welding equipment.

Temporary stiffeners used for jigs and/or warpage control shall not be tack welded to the flange material. Tacking to the web is permissible if the welds are at least 1/6 of the web depth away from the flange. The tack weld shall

be removed by grinding flush with the parent metal prior to acceptance.

Suitable allowance shall be made for shrinkage, and the joint shall never be restrained on both sides when welding.

Abutting parts to be joined by groove welds shall be aligned carefully. All shop groove welds in flange plates shall be ground smooth and flush with the base metal on all surfaces. These requirements shall apply to both parts of equal thickness and parts of unequal thickness. The surfaces shall be ground so that the radii at the points of transition will be 100 millimeters minimum.

Groove welds in web plates, except at locations of intersecting welds, need not be ground unless shown on the plans.

Grinding shall be done in the direction of stress, and in a manner that keeps the metal below the blue brittle range (below 175 °C).

When groove welds are used to join materials of different thickness or width, there shall be a smooth transition between offset surfaces with a slope of not greater than one (1) in four (4) in thickness transition, and to the proper radii in the case of width transition (See Figures 1 and 2).

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The member shall meet the combined tilt and warpage tolerances prior to the installation of stiffeners and the stiffeners shall be cut to fit acceptable flange tilt and cupping.

Intermediate stiffeners within 300 millimeters of a splice point shall be shipped tack welded in place. The welding shall be done in the field after the splice is made.

441.7. Shop Assembly.

(1) General Shop Assembly for Bolted and Welded Field Connections. All fabrication, welding, and field splice preparation shall be complete before members are removed from shop assembly. Any deviation from this procedure will require the approval of the Engineer. All shop assemblies shall be in the unrestrained condition, free of external forces.

Field connections of main members of trusses, arches, continuous beams, plate girders, bents, (box girders to girder connections) towers and rigid frames shall be preassembled prior to erection as necessary to verify the geometry of the completed structure or unit and to verify or prepare field splices. Attaining accurate geometry is the responsibility of the Contractor and he shall propose an appropriate method of preassembly for approval by the Engineer. The method and details of preassembly shall be consistent with the erection procedure shown on the erection plans and camber diagrams prepared by the Contractor and approved by the Engineer. As a minimum, the preassembly procedure shall consist of assembling three contiguous panels accurately adjusted for line and camber or span bent to bent. Assemblies consisting of less than three (3) panels shall require the approval of the Engineer. Successive assemblies shall consist of at least one section or panel of the previous assembly (repositioned if necessary and adequately pinned to assure accurate alignment) plus two (2) or more sections or panels added at the advancing end. At the option of the contractor of bridge structures, sequence of assembly may start from any location in the structure and proceed in one or both directions so long as the preceding requirements are satisfied.

All bolted and welded field connections between bent cap girders and plate girders or between plate girders and floor beams shall have their fit verified by shop assembly.

Horizontal curvature and vertical camber shall not be measured for final acceptance until all welding and heating operations are completed and the flanges have cooled to a uniform temperature. Horizontal curvature shall be checked with the girder web in the vertical position by measuring offsets from a string line or wire attached to both flanges or by using other suitable means, prior to final shop assembly. Camber will be checked with the girder web in the horizontal position.

(2) Shop Assembly for Bolted Field Connections. Each shop assembly, including camber, alignment, accuracy of holes, and fit of milled joints, shall be approved by the Engineer before reaming is commenced or before a N/C or template drilled shop assembly is dismantled. All N/C or template drilled connections shall be performed prior to shop assembly and verified during shop assembly. The field connections of main members of trusses, arches, continuous beam spans, bents, towers (each face), plate girders, field connections of floor beams and stringers, field bolted diaphragms for curved plate girder units, and rigid frames shall be assembled in the shop with milled ends of compression members in full bearing, and then shall have all subsize holes reamed to the specified size while the connections are assembled or drilled full size while the connections are assembled.

Parts not completely bolted in the shop shall be secured by temporary bolts to prevent damage in shipment and handling. In no case shall tack welding be used.

Connecting parts in field connections shall be matchmarked (using low-stress stencils), and diagrams showing such marks shall be shown on the erection drawings.

(3) End Preparation and Shop Assembly for Welded Field Connections. Prior to final shop assembly the ends of beams and girders shall be prepared in accordance with Figure 3 and the requirements herein or as shown on the plans. The centerline of the land of opposing web and flange bevels shall not deviate from each other by more than two (2) millimeters.

For Shop Assembly, members shall be brought into abutting contact in accordance with the blocking diagram. Root faces shall not vary in excess of two (2) millimeters from contact. Corrections by additional cutting and/or grinding shall be made to bring the splice within this tolerance.

Finish of bevels for groove welds shall be milled or ground. Oxygen cut bevels without grinding will not be allowed.

Care shall be taken when cutting the bevel adjacent to the web to prevent cutting into the web.

End preparation, backing and tolerances for single V groove welds for framing beams or girders shall conform to Welding Code D1.5 or the details shown on the plans.

Ends of beams or girders to be welded shall be prepared in the shop taking into account their relative positions in the finished structure due to grade, camber and curvature. Each splice shall be completely shop assembled, checked and while assembled, matchmarked with low-stress stencils, and a diagram showing such marks shall be shown on the erection drawings.

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441.8. Fracture Control Plan. Welding and testing of fracture critical members (FCM's) will be in accordance with AASHTO Guide Specifications for Fracture Critical Nonredundant Steel Bridge Members. Shielded Metal Arc Welding (SMAW) and Submerged Arc Welding (SAW) will be the only welding processes allowed for use in the fabrication of FCM designated components.

Welding and testing of FCM's for railroad underpass structures shall be in accordance with the latest A.R.E.A. Specifications, Chapter 15.

441.9. Shop Painting and Cleaning of Bolted Connections. The application of shop paint and the cleaning and coating of machine finished surfaces which are in sliding contact, particularly pins and pinholes, shall be in accordance with Item 446, "Cleaning, Paint and Painting". The inside of all box girders shall be painted with the 742 grey finish coat or a white polyamide cured epoxy. All bearing and faying surfaces of structural steel, including railroad structures, in bolted connections shall be cleaned in accordance with Item 447, "Structural Bolting", prior to shipment.

441.10. Marking and Shipping. All structural members shall be marked in accordance with the erection drawing. The markings shall be over the painted surface. In no case shall shop paint be left off in order to preserve original markings on steel to be painted. Match-marks shall be made with paint in addition to the requirements of Subarticles 441.5(2) and 441.7(2) & (3).

Members weighing more than three (3) megagrams shall have the mass marked thereon. The loading, transporting, unloading and storing of material shall be conducted so the material will be kept clean and free from injury. Bolts of each length and diameter, and loose nuts or washers of each size, shall be packed separately and shipped in boxes, crates, kegs or barrels. A list and description of the contents shall be plainly marked on the outside of each package.

441.11. Field Erection.

(1) Storing Materials. All material shall be handled in a manner that prevents damage. Stored material shall be placed on skids above the ground and kept clean and properly drained. Girders and beams shall be placed upright and shored. Long members, such as columns, shall be supported on skids placed close enough to prevent excessive deflection.

(2) Methods and Equipment. Before starting work, the Contractor shall submit to the Engineer, for approval, detailed erection plans as described in Subarticle 441.3(2). Such approval shall not relieve the Contractor of the responsibility for the safety and adequacy of the methods or equipment used and for performing the work in compliance with the plans and specifications.

Tack welding for the purpose of eliminating field erection bolts or for holding steel parts together while bolting will not be permitted.

The Contractor shall provide the falsework and all tools, machinery and appliances, including drift pins and erection bolts, necessary for the expeditious handling of the work. Drift pins sufficient to fill at least 1/4 of the bolt holes for main field connections shall be provided. Erection bolts shall be of the same nominal diameter as the connection bolts and drift pins shall be one (1) millimeter larger.

All steel beams or girders placed shall be securely tied and/or braced in accordance with the details shown on the plans to prevent overturning immediately after erection, and until diaframs are permanently in place. The methods to be used shall be submitted on the erection drawings. When railroad or roadway traffic must be maintained beneath girders or beams already placed, traffic shall be protected against falling objects during the erection of diaframs and other structural members, during the placing of cast-in-place concrete and during the erection and dismantling of forms. The protection shall consist of nets and/or flooring with openings not larger than 25 millimeters.

(3) Falsework. The falsework shall be designed and constructed for the loads to be supported and shall be properly maintained. The Contractor shall prepare and submit to the Engineer, for approval, falsework plans and design calculations bearing the seal of a Registered Professional Engineer.

(4) Handling and Assembling Material. The parts shall be assembled accurately as shown on the plans. Field welding shall be done in accordance with Item 448, "Structural Field Welding". Field bolts, including high strength erection bolts, shall be installed in accordance with Item 447, "Structural Bolting".

The material shall be handled carefully so that no parts will be bent or otherwise damaged. Hammering which will damage or distort the members shall not be done. All bearing and faying surfaces of structural steel in bolted connections shall be cleaned in accordance with Item 447, "Structural Bolting". The areas of the outside ply under washers, nuts or bolt heads shall be cleaned prior to installation of the bolts.

Temporary welds for transportation or erection will not be allowed unless shown on the Standard Plan Sheet SS-MEBR or approved by the Engineer.

(5) Misfits. Corrections of minor misfits and reaming of not more than ten (10) percent of the bolt holes in a connection will be acceptable if no single hole is three (3) millimeters over the nominal size of the bolt. The method of correction of any misfit which exceeds these limits and prevents the proper assembling of parts shall be submitted immediately to the Engineer for approval.

Straightening of structural members, when approved by the Engineer, shall be in accordance with Subarticle 441.4(7).

All corrections shall be made in the presence of the Engineer. Such work is to be done at the Contractor's expense.

(6) Bearing and Anchorage. Bearing devices such as castings, bearing plates, or shoes shall be placed on properly finished bridge seat bearing areas, and shall have a full and even bearing upon the concrete. When shown on the plans, bearing devices shall be placed on preformed fabric pads manufactured in accordance with Item 434, "Sliding Elastomeric Bearings", except that the thickness tolerance shall not apply. Unless otherwise shown on the plans the required thickness of pads will be six (6) millimeters. Holes in the pad, to allow for installation over anchor bolts, shall be not more than six (6) millimeters larger than the bolt diameter.

When the concrete is placed below grade, the bearing area may be raised to grade by beds of mortar conforming to the requirements of Item 421, "Portland Cement Concrete". The minimum thickness of mortar bed shall be three (3) millimeters and the maximum thickness shall be ten (10) millimeters. When it is necessary to raise the bearing area higher than ten (10) millimeters above the concrete the area shall be built-up in

accordance with Item 420, "Concrete Structures". Adequate curing shall be provided. Steel shims or other approved material may be used in conjunction with one of the specified materials.

Beams and girders shall fit on bearing devices to provide a minimum of 75 percent contact of flange to shoe with no separation greater than one (1) millimeter. Corrections may be made by heat and pressure, in accordance with Subarticle 441.4(7), or the use of galvanized steel shims. Small irregularities may be corrected by grinding.

Care shall be taken to set expansion bearings to accommodate the direction of movement. The rocker plate shall bear on the base plate to provide a minimum of 85 percent line bearing of the contact surfaces.

All foreign matter shall be removed from sliding and machine-finished surfaces immediately prior to placing in the structure.

The location of the slotted holes in the expansion shoes in relation to the anchor bolts shall be varied with the prevailing temperature. The nuts on anchor bolts at the expansion ends of spans shall be adjusted to permit the free movement of the span and either lock nuts shall be provided or the threads of the anchor bolts burred.

Upon completion of welding or bolting all splices, distorted bearing pads and/or expansion bearings shall be restored to an equivalent 21 °C position. This shall be done by an approved method of temporarily relieving the load on the bearing devices.

(7) Grading Deck on Continuous Units. Forms shall not be erected until all welding and/or bolting is complete, the unit positioned, and bearings properly set.

An accurate measurement shall be made of the elevations of girder or beam flanges at all grading control points as shown on the plans. Subsequent grading of forms and placing and finishing of concrete shall be controlled by these measurements taking into account the dead load deflections and vertical alignment shown on the plans.

(8) Paint and Painting. Unless otherwise provided, the application of paint shall conform to the requirements of Item 446, "Cleaning, Paint and Painting".

(9) Field Finish Requirements for Weathering Steel Structures in Unpainted Applications. After all erection, welding and slab concrete placement has been completed, the Contractor shall restore the surfaces of all weathering steel to a uniform appearance by solvent cleaning, hand cleaning, power brush cleaning or blast cleaning, as deemed necessary by the Engineer. All outside surfaces of weathering steel fascia beams, including the underside of the bottom flange, the sides and bottom surfaces of steel bent caps or floor beams and all surfaces of bent caps extending beyond the fascia beams shall receive a Class "B" blast cleaning. No marking will be permitted on the outside face of any fascia beam.

441.12. Measurement and Payment. The work performed, materials furnished and all labor, tools, equipment and incidentals necessary to complete the work under this Item will not be measured or paid for directly, but will be considered subsidiary to the various bid items of the contract.

ITEM 442

METAL FOR STRUCTURES

442.1. Description. This Item shall govern for all structural steel, high strength bolts, forgings, steel castings, iron castings, wrought iron, bronze, steel pipe and tubing, aluminum castings and tubing, and other miscellaneous metals used in structures, except reinforcing steel and metal culvert pipe.

442.2. Process. All ferrous metals furnished for use under these specifications shall be made by one or more of the following processes only:

Open-hearth, basic oxygen, or electric furnace.

Mill test reports, supplemental test documentation and certifications required by this Item shall be furnished to the Engineer.

442.3. Structural Steel.

(1) Steel for Bridge Structures.

The material required for steel bridge structures shall be shown on the plans under the following designations:

(a) Structural Steel-HYC - When shown on the plans and in the proposal as Structural Steel-HYC, the material shall conform to the requirements of ASTM A 709 Grade 250.

(b) Structural Steel-HS - When shown on the plans and in the proposal as Structural Steel-HS, the material shall conform to the requirements of ASTM A 709 Grade 345 or Grade 345W. The use of either Grade 345 or Grade 345W shall be at the Contractor's discretion for painted structures, but Grade 345W must be used when weathering steel is specified.

(c) Structural Steel-XHS - When shown on the plans and in the proposal as Structural Steel-XHS, the material shall conform to the requirements of ASTM A 709 Grade 485W, Grade 690, or Grade 690W. The Grade of material required shall be designated on the plans; if Grade 690 is specified, the use of either Grade 690 or Grade 690W shall be at the Contractor's discretion for painted structures, but Grade 690W must be used when weathering steel is specified.

Unless otherwise shown on the plans, impact testing requirements for all grades of steel shall conform to the supplemental requirements of S83 or S84 of ASTM A 709 for tension components of a bridge member that consist of components of tension members and those portions of a flexural member that are subject to tension stress. The geographical boundaries of Zone 1 consists of all counties in Texas below a line which runs west to east below Deaf Smith and Collingsworth counties. Zone 2 shall include all counties above this line.

(2) Steel for Non-Bridge Structures.

Unless otherwise shown on the plans, structural steels for non-bridge structures listed herein shall conform to the longitudinal Charpy V-notch requirements of Table A for tension components of a member consisting of components of tension members and those portions of a flexural member that are subject to tension stress. Sampling and testing shall be in accordance with ASTM A 673. The (H) frequency of heat testing shall be

used for all material with 250 megapascal and 345 megapascal minimum yield points. The (P) frequency of testing shall be used for all material designated as FCM's and for ASTM A 514 or A 517 steels.

(a) Carbon Steel. When shown on the plans and in the proposal as Structural Steel-HYC, the material shall conform to the requirements of ASTM A 36.

(b) High Strength Steel (HS). High strength steel shall have a minimum required yield point of 345 megapascal, and will be shown on the plans and in the proposal as Structural Steel-HS.

Structural Steel-HS shall conform to one of the following ASTM Steels subject to thickness and physical requirements of the pertinent ASTM Specification:

1. ASTM A 572, High-Strength Low-Alloy Columbium Vanadium Steels of Structural Quality With 345 Megapascal Minimum Yield Point To 100 Millimeters Thickness. Supplemental Requirement S18, for a maximum tensile strength of 655 megapascal, shall be applicable to material used for sign, signal and luminaire supports.

2. ASTM A 588, High-Strength Low-Alloy Structural Steel With 345 Megapascal Minimum Yield Point To 100 Millimeters Thickness.

3. A36MOD345, a special designation for ASTM A 36, Structural Steel modified to 345 megapascal minimum yield point and a minimum elongation of 18 percent (200 millimeters) or 21 percent (50 millimeters) and a tensile strength between 450 megapascal and 655 megapascal. Chemical requirements shall meet ASTM A 36 except that the maximum manganese content shall be 1.35 percent. Alloys containing Columbium (0.035% maximum) and Vanadium (0.06% maximum) are permissible.

TABLE A

LONGITUDINAL CHARPY V-NOTCH REQUIREMENTS

Material	Thickness Millimeters	Group 1 See Notes	Group 2 See Notes
A 36 and A 242	Up to 100	20 N·m at 21 °C	20 N·m at 4 °C
A 572* and A 588*	Up to 100 mechanically fastened	20 N·m at 21 °C	20 N·m at 4 °C
	Up to 50 welded	20 N·m at 21 °C	20 N·m at 4 °C
	Over 50 to 100 welded	27 N·m at 21 °C	27 N·m at 4 °C
A 514 and A 517	Up to 100 mechanically fastened	34 N·m at - 1 °C	34 N·m at - 18 °C
	Up to 64 welded	34 N·m at - 1 °C	34 N·m at - 18 °C
	Over 64 to 100 welded	47 N·m at - 1 °C	47 N·m at - 18 °C

Notes:

Group 1: Minimum Service Temperature - 18 °C and above.

Group 2: Minimum Service Temperature from - 18 °C to - 34 °C.

The geographical boundaries of Group 1 consists of all counties in Texas below a line which runs West to East below Deaf Smith and Collingsworth Counties. Group 2 shall include all counties above this line.

*If the yield point of the material exceeds 450 megapascal, the temperature for the CVN value for acceptability shall be reduced by 8 °C for each increment of 70 megapascal or fraction thereof above 450 megapascal.

(c) Extra High Strength Steel (XHS). Extra high strength steel when shown on the plans shall have a minimum required yield point of 620 megapascal and will be shown on the plans and in the proposal as Structural Steel-XHS. When so specified, the steel shall conform to the following:

1.ASTM A 514, High-Yield Strength, Quenched and Tempered Alloy Steel Plate.

The steel furnished shall be suitable for welding. Structural shapes and seamless tubing, meeting the other requirements of A 514 steels, will be permitted with a maximum tensile strength of 965 megapascal for structural shapes and 1000 megapascal for seamless tubing.

2.ASTM A 517, Pressure Vessel Plates, Alloy Steel, High-Strength, Quenched and Tempered.

The above listed steels are considered weldable. Other steels will require qualification in accordance with ANSI/AASHTO/AWS Bridge Welding Code D1.5 or ANSI/AWS Structural Welding Code D1.1, whichever is applicable, prior to their use.

(3) Miscellaneous Steel.

(a) Unless otherwise shown on the plans, structural steel for members such as shoes, diaframs, stiffeners (including bearing stiffeners), lateral bracing, diagonals, armor joints and finger joints shall conform to ASTM A 36 or A 500, Grade B.

Structural steels used for secondary or nonstress-carrying members will not be subject to impact requirements.

All steels greater than 12 millimeters in thickness used for structural supports for highway signs, luminaries and traffic signals shall conform to the longitudinal Charpy V-notch requirements of Group 1 in accordance with Table A. Charpy V-notch tests will not be required for pipe used in structural supports.

(b) Stud shear connectors, slab anchors and anchors on armor joints and finger joints shall conform to the requirements of ASTM A 108, cold drawn bars, Grades 1010, 1015, 1018 or 1020, either semi- or fully-killed.

Tensile properties as determined by tests of bar stock after drawing or finishing shall conform to the following:

Tensile Strength (Min.)	415 MPa
Yield Strength (Min.)	345 MPa
Elongation (Min.)	20% (50 mm)
Reduction of Area (Min.)	50%

Tensile properties shall be determined in accordance with the applicable section of ASTM A 370.

The manufacturer shall certify that the studs or anchors as delivered conform with the material requirements of this section.

(c) High strength bolts, nuts and washers will be sampled for tests in accordance with Test Method Tex-719-I. High strength bolts shall conform to the requirements of ASTM A 325 or A 490, unless otherwise shown on the plans.

Tests, test reports and supplemental requirements for high strength bolts, nuts and washers shall be in accordance with Item 447, "Structural Bolting".

When high strength bolts are not required, bolts conforming to ASTM A 307 and nuts conforming to ASTM A 563 shall be used.

(d) Steel piling shall conform to the following:

Type	ASTM Designation
Steel H Piling	A 36
Sheet Piling (Rolled)	A 328*
Sheet Piling (Formed)	A 570* Grade 36 (250 MPa, yield)

*A mill certificate shall be furnished by the manufacturer certifying to the results of tests required by the governing specifications.

Sheet piling of a different configuration than that shown on the plans may be used provided the section modulus and mass per meter furnished is equal to or greater than shown on the plans.

(e) Deck Plates. Material for deck plates shall conform to the following:

Corrosive resistant structural steel conforming to ASTM A 242. The material must be of weldable quality, and shall contain alloying elements that furnish corrosion resistance of at least twice that of copper bearing structural steel. The type of material to be used with its trade name, shall be stated on the shop drawings.

(f) Rail Posts. Material for rail posts shall conform to the requirements of ASTM A 36 unless otherwise shown on the plans.

442.4. Steel Forgings. Steel forgings from which pins, rollers, trunnions, or other forged parts are to be fabricated, shall conform to the requirements of the Standard Specifications for Carbon-Steel Forgings for General Industrial Use, ASTM A 668, Class C, D, F or G. The above will govern for all railroad underpass structures. The class of material shall be as shown on the plans.

For other structures, for pins 100 millimeters in diameter or less, material conforming to ASTM A 108, Grades 1016 to 1030 may be used. The material shall have a minimum yield point of 250 megapascal. All forgings shall be thoroughly annealed prior to being machined to form finished parts. Material for pins over 100 millimeters in diameter shall be in accordance with ASTM A 668, Class C, D, F or G. The class of material shall be as shown on the plans.

442.5. Steel Castings. Steel castings shall conform to the specifications for Mild to Medium Strength Carbon Steel Castings for General Application, ASTM A 27, Grade 485-250.

When shown on the plans as Class 70, Class 90, or Class 120, the steel castings shall conform to the specified class of ASTM A 486.

442.6. Iron Castings. All iron castings shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes, and other defects in positions affecting their strength and value for the service intended.

The castings specified shall conform to one of the following ASTM Specifications.

Material	ASTM	Grade
Gray-Iron Castings	A 48	Class 30 (207 MPa, tensile)
Malleable Castings	A 47	24018
Ductile Iron Castings	A 536	60-40-18 (tensile 414, yield 276, elongation 18 in 50 mm)

442.7. Lead. Sheet lead shall conform to the requirements of the Specifications for Pig Lead, ASTM B 29.

442.8. Anchor Bolts. Unless otherwise shown on the plans, plain and threaded bars, headed bolts, medium and high strength bolts, nuts and washers shall conform to Item 449, "Anchor Bolts".

442.9. Steel Pipe. Steel pipe shall conform to the material requirements shown on the plans, or in other applicable specifications.

442.10. Steel Tubing. Steel tubing shall conform to ASTM A 500, Grade B, unless otherwise shown on the plans or herein. Tubing conforming to API Standard 5L, Grade X52, except as noted herein, may be used if produced by a mill recognized as "authorized to produce pipe with the API monogram" and listed as such in the standard API specifications.

The following exceptions to the requirements of API 5L, Grade X52, will be allowed:

Hydrostatic tests will not be required.

In lieu of a mill test report, a certificate from the manufacturer will be required for each lot or shipment, certifying that the tubing meets the requirements stated above.

442.11. Pipe Rail. Pipe shall be construed to include special extruded and bent shapes and shall be of the section shown on the plans. Pipe may be rolled or extruded to the shape shown on the plans or may be cold pressed from a round pipe or flat plate.

If cold pressed, the design of the press and dies shall result in a pipe of uniform section and free from die marks. After the pipe has been formed to the required section, it shall be cut to the lengths required. The end cuts and notches shall be made at such angles with the axis of the pipe as required to produce vertical end faces and plumb posts when required by the plans. Cutting and notching of pipe shall be done with a saw or machine guided torch or other means that will insure a neat and workmanlike finish.

442.12. Steel Deep Beam Rail. The rail element shall be either 3.43 millimeters ± 0.20 millimeters nominal thickness or 2.67 millimeters ± 0.20 millimeters nominal thickness, exclusive of protective coating, as shown on the plans. Rail element shall meet all requirements of AASHTO M-180 except as modified on the plans.

The terminal connector shall be of the same material, but shall not be less than 3.43 millimeters.

Unless otherwise shown on the plans the rail element shall be galvanized in accordance with Item 445, "Galvanizing".

442.13. Aluminum.

(1) Unless otherwise shown on the plans, aluminum materials shall conform to the following:

Castings	ASTM B 108, Alloy A444-T4
Extrusions	ASTM B 221, Alloy 6061-T6
Sheet & Plate	ASTM B 209, Alloy 6061-T6

Test specimens from castings shall be cut from the lower 350 millimeters of the tension flange but not at the junction of the rib or base. The curved surfaces shall be flattened prior to machining. Test specimens shall conform to ASTM E 8, Figure 8.

442.14. Fabrication, Erection, and Painting. Fabrication, welding, and erection of structural metal shall be in accordance with Item 441, "Steel Structures", Item 448, "Structural Field Welding", Item 447, "Structural Bolting", and the ANSI/AASHTO/AWS Bridge Welding Code D1.5 or the ANSI/AWS Structural Welding Code D1.1, whichever is applicable. Paint and painting shall be in accordance with Item 446, "Cleaning, Paint and Painting". Aluminum or galvanized steel members shall not require painting, unless otherwise shown on the plans.

442.15. Galvanizing. Galvanizing of fabricated steel items, steel or iron castings, bolts, nuts, screws, washers and other miscellaneous hardware shall be in accordance with Item 445, "Galvanizing".

Galvanizing will not be required for any material unless specified on the plans or in the specifications.

442.16. Measurement. This Item will be measured by the kilogram of structural metal furnished and placed in a complete structure, exclusive of the mass of erection bolts, paint, or weld metal.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required. The maximum percent variance from the plans quantity will be as follows:

Percent Variance

Quantity	Percent
Over 450 Mg	1/2 %
45 Mg through 450 Mg	1 %
Less than 45 Mg	l-1/2 %

When increases in size or mass of members have been made which were not ordered but were approved by the Engineer, the measurement will be made on the sizes or mass shown on the contract plans.

In determining the mass of structural metal in steel or concrete structures, such items as castings, bearing plates, anchor bolts, drains, deck plates, armor joints, finger joints, and all other metal for which no separate measurement is specified will be included in the total quantity of Structural Steel.

The mass of rolled shapes and plates will be computed on the basis of their nominal mass and dimensions using measurements as shown on the approved shop drawings. The mass of castings will be computed from the dimensions shown on the approved shop drawings. Shoes will be measured by the mass shown on the contract plans, or as specified for castings, if mass are not shown.

Deductions will be made for all cuts, copes, perforations, and all holes except bolt holes.

When computed, the mass of metal will be based on Table B.

Splices will be measured as follows:

(1) No additional mass will be allowed for weld metal in a welded splice.

(2) Where a bolted splice is permitted as an alternate for a welded splice, measurement will be made on the basis of a welded splice.

(3) Where a bolted splice is required, the mass of splice material, bolts, bolt heads, washers, and nuts, with no deduction for holes, will be measured.

TABLE B

	Pay Mass - Kilogram per Cubic Meter				
Material	Steel	Cast Iron	Wrought Iron	Bronze	Lead
Mass	7840	7210	7690	8720	11,310

442.17. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Structural Steel-HYC", "Structural Steel-HS", or for such other classifications of metal as shown on the plans and in the proposal. This price shall be full compensation for furnishing all materials; for all fabrication, shop work, transportation, erection, paint, painting, galvanizing; and for furnishing all equipment, tools, labor and incidentals necessary to complete the work.

ITEM 443

PERMANENT METAL DECK FORMS

443.1. Description. This Item shall govern for the use of permanent metal deck forms when used for the forming of bridge slab concrete in accordance with the plans and the specifications.

443.2. Materials. Permanent metal deck forms, supporting angles, and accessory pieces shall be fabricated from steel conforming to ASTM A 446 (Grades A through E) with a galvanized coating designation Z450 in accordance with ASTM A 525.

443.3. Design. The design of permanent metal deck forms shall be in accordance with the requirements of the plans and of this Item.

Design calculations covering all maximum stress conditions in forms and supports along with typical sketches of the system proposed and materials to be used will be required prior to fabrication. The design calculations shall indicate the acceptable stresses or evidence that the system can support the applied loads. The design span lengths, applied load for forms and supports and cross sectional details shall be clearly indicated and accompany the calculations. Test results submitted as evidence of adequate strength shall be well documented and entirely conclusive that adequate

strength is available. End closures, hangers and connections differing from those shown on the plans will be considered if thoroughly detailed and documented. Two sets of the calculations and sketches, bearing the seal of a Registered Professional Engineer, shall be submitted to the Design Division, Texas Department of Transportation, 125 E. 11th Street, Austin, Texas 78701-2483 for approval.

The permissible form camber shall be limited to the dead load deflection from the slab concrete.

Permanent metal deck forms shall not be used in panels where longitudinal deck construction joints are located between stringers.

443.4. Construction Methods. Erection drawings indicating form details, closures, fasteners, supports, connectors, special conditions, size and location of welds and other pertinent information will be required. Erection drawings shall be submitted for approval in accordance with Item 441, "Steel Structures".

Erection drawings shall clearly show areas of tension flanges for steel beams and provision shall be made for protecting the tension flanges from welding notch effects by inclusion of separating sheet metal or other positive method.

Form sheets shall not be permitted to rest directly on the top of the stringer or floor beam flanges. Sheets shall be securely fastened to form supports and shall have a minimum bearing length of 25 millimeters at each end. Form supports shall be placed in direct contact with the flange of stringer or floor beam.

All attachments shall be made by permissible welds, screws, bolts, clips or other means shown on the approved shop drawings. All sheet metal assembly screws shall be installed with torque-limiting devices to prevent stripping. Only welds or bolts shall be used to support vertical loads.
Welding and welds shall be in accordance with the provisions of Item 448, "Structural Field Welding", pertaining to fillet welds.

All welds shall be made by a qualified welder in accordance with Item 448, "Structural Field Welding".

All permanently exposed form metal, where the galvanized coating has been damaged, shall be thoroughly cleaned and repaired in accordance with Item 445, "Galvanizing". Minor heat discoloration in areas of welds need not be touched up.

Flutes shall line up uniformly across the entire width of the structure where main reinforcing steel is located in the flute.

Construction joints will not be permitted unless shown on the plans. The location of and forming details for any construction joint used shall be shown on the erection drawings. Forms below a construction joint must be removed after curing of the slab.

The direction of concrete placement will be such that the upper layer of the form overlap is loaded first.

A sequence for uniform vibration of concrete shall be approved by the Engineer prior to concrete placement. Attention must be given to prevent damage to the forms, yet provide proper vibration to prevent voids or honeycomb in the flutes and at headers and/or construction joints.

443.5. Measurement and Payment. The work performed, materials furnished and all labor, tools, equipment and incidentals necessary to complete the work under this Item will not be measured or paid for directly, but will be considered subsidiary to the various bid items of the contract.

ITEM 444

BRIDGE PROTECTIVE ASSEMBLY

444.1. Description. This Item shall govern for furnishing and installing Bridge Protective Assemblies or portion thereof, conforming to the requirements of this specification and to the details shown on the plans.

444.2. Materials. All materials shall conform to the pertinent requirements of the following Items:

Item 442, "Metal for Structures"
Item 445, "Galvanizing"

Structural steel for mounting brackets and protective angles shall conform to ASTM A 36 or as specified on the plans. Impact tests will not be required. Signs shall conform to the items and details shown on the plans.

444.3. Construction Methods. Bridge Protective Assemblies, or portions thereof shall be installed as shown on the plans. Unless otherwise shown on the plans all angles, brackets, connectors and other hardware shall be galvanized after fabrication. If sign support brackets and/or protective angle support brackets are to be installed in prestressed concrete beams, the Contractor shall furnish the fabricator with sufficient data so that the required concrete inserts may be properly located in the beams at the time the beams are cast. When beams are being erected in spans over roadways carrying traffic the sign shall be installed as soon as practical, as determined by the Engineer. The vertical clearance to be shown on the sign will be furnished by the Engineer.

444.4. Measurement. The complete bridge protective assembly shall consist of the protective angle with mounting brackets and redwood plank and the clearance sign with mounting brackets and will be measured as each, "Bridge Protective Assembly". Plans may require less than the complete assembly. In this case, measurement will be made as follows:

UNIT	ITEM	DESCRIPTION
Each	"Protective Angle"	Angle, redwood board and angle mounting brackets.
Each	"Protective Angle with Sign Brackets"	Angle, redwood board, angle mounting brackets and sign mounting brackets.
Each	"Sign Bracket"	All brackets necessary to mount one sign.
Each	"Sign and Bracket"	The clearance sign with sign mounting brackets.

444.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Bridge Protective Assembly",

"Protective Angle", "Protective Angle with Sign Bracket", "Sign Bracket" or "Sign and Bracket" in place. This price shall be full compensation for furnishing all materials, including bolts, nuts, washers and anchorage devices, and all labor, tools, equipment and other incidentals required for their installation in accordance with the plans and these specifications.

ITEM 445

GALVANIZING

445.1. Description. This Item shall govern for the galvanizing and galvanizing repair of metal items as designated on the plans and in accordance with this Item.

445.2. Galvanizing. Galvanizing of metal items shall be in accordance with the following:

ITEMS	SPECIFICATION
(1) Fabricated items, rolled, pressed or forged steel shapes, plates, pipes, tubular items and bars	ASTM A 123
(2) Steel or iron castings	ASTM A 153, Class A
(3) Bolts, nuts, screws, washers and other miscellaneous hardware	ASTM A 153, Class C or D or ASTM B 695, Class 50
(4) Miscellaneous fasteners, when permitted by plans or specifications	ASTM B 633, Class Fe/Zn 8
(5) W-Beam elements for guard fence or bridge railing	ASTM A 525, Designation Z600 or AASHTO M-180
(6) Permanent Metal Deck Forms, supporting angles and incidental items	ASTM A 525, Designation Z450

445.3. Construction Methods. Fabricated members or assemblies which are required to be hot-dip galvanized shall provide for proper filling, venting and draining during the cleaning and galvanizing operations. Drain holes or slots may be located as required except where prohibited by the plans. Cleaning and galvanizing processes shall be conducted so as not to produce hydrogen embrittlement.

Tapered members to be assembled by slip-joint splices should be drained to the small end of the individual section.

Material six (6) millimeters or greater in thickness shall have all sharp burrs removed and all edges to be exposed to human activity (e.g. railings, handholes, access holes, etc.) and electrical conductors chamfered approximately two (2) millimeters to prevent injury or damage.

445.4. Inspection. Galvanized coatings shall be inspected as follows:

Red Rust. Evidence of red rust on galvanized items indicates the presence of uncoated areas. Bare spots not greater than three (3) millimeters across may be accepted, unless they are numerous. Larger bare spots shall be repaired in accordance with Article 445.6.

White Rust. A white powdery residue indicates the presence of moisture. Light coatings of white rust may be allowed to remain or be chemically removed when directed by the Engineer. White rust shall be removed from galvanized articles which will be in direct contact with soils. Heavy layers of white rust which have caused pitting of the coating shall be cause for rejection.

Alligator Cracking or Spider Webbing. Apparent dark lines resembling alligator skin are caused by the composition of the base metal. If the coating adhesion is sound, the coating is acceptable. Tapping with a small hammer will demonstrate coating adhesion. Lack of adhesion shall be cause for rejection.

Dull Gray Coating. Dull gray coatings may be caused by many factors but the coating is acceptable if the adhesion to the base metal is sound. Tapping with a small hammer will show if the coating is brittle. Scaling and flaking shall be cause for rejection.

Heavy Runs or Drips. Runs or drips of zinc coating are accept- able if they do not interfere with the intended use of the product. Excessive zinc (runs, lumps or heavy accumulations) may be carefully removed by hand filing.

445.5. Thickness of Coating. The thickness of galvanized coating shall be determined according to Test Method Tex-728-I.

445.6. Repairs. Unless otherwise specified herein, all exposed galvanized surfaces which have been damaged by shipping, handling, welding or other operations shall be repaired as follows:

(1) Materials.

(a) Zinc-Based Solders. Zinc-based solders used for repair shall be of zinc-tin-lead alloys having liquidus temperatures in the range of 230 °C to 260 °C. The solders may be used in rod form or as powders.

(b) Organic Zinc-Rich Paints. Zinc-rich paints based on organic binders, premixed and formulated specifically for use on steel surfaces and which will provide a dried film containing a minimum of 94 percent zinc dust, by mass.

(c) Sprayed Zinc (Metallizing). A zinc coating applied by spraying the surface with droplets of molten metal using wire, ribbon, or powder processes.

(2) Repair Processes.

(a) Surfaces to be repaired with zinc-based solders shall be free of moisture, oil, grease, dirt, corrosion products and welding slag or flux. Surfaces to be repaired shall be cleaned to white metal by wire brushing, light grinding or mild blasting extending into the surrounding undamaged galvanized coating. Preheat the cleaned areas to at least 316 °C, but not more than 400 °C, wire brush while heating and apply an evenly distributed layer of the zinc-solder. When completed, flush the repaired area with water or wipe with a damp cloth to remove the flux residue.

(b) Surfaces to be repaired with zinc-rich paints shall be clean, dry and free of oil, grease, welding slag or flux and corrosion products. The surface

the undamaged galvanized coating to provide a smooth repair. Spray or brush apply the zinc-rich paint to the prepared area in accordance with the paint manufacturer's instructions to attain the required dry-film thickness.

(c) Surfaces to be repaired with sprayed zinc (metallizing) shall be dry, free of oil, grease, corrosion products and any welding slag or flux. The surface shall be cleaned to white metal. Apply the coating by metal-spraying pistols fed with either zinc wire or zinc powder. The sprayed coating shall be of uniform texture, free of lumps, coarse areas or loosely adhering particles.

(3) After completion of the repair process, cooling or curing, the coating thickness in the repaired area shall be measured in accordance with Article 445.5. The minimum coating thickness for repairs shall be the same as that required for the specified galvanizing.

445.7. Measurement and Payment. The work performed, materials furnished and all labor, tools, equipment and incidentals necessary to complete the work under this Item will not be measured or paid for directly, but will be considered subsidiary to the various bid items of the contract.

ITEM 446

CLEANING, PAINT AND PAINTING

446.1. Description. This Item shall govern for the type, source, quality, testing, surface cleaning, surface preparation and application of paint. This Item also includes protection of all traffic, property and/or persons upon, underneath or near the structure and for the protection of all parts of the structure during cleaning and painting operations.

446.2. Materials.

(1) General. Paints for System I and System II and appearance coats for these systems shall be in accordance with Departmental Materials Specification D-9-8100. Information about paint characteristics, thinner requirements, etc., and copies of Specification D-9-8100 are available from the Texas Department of Transportation, Materials and Tests Division, 125 East 11th Street, Austin, Texas 78701-2483.

Paints for System III shall be in accordance with Departmental Materials Specification D-9-8101. Information about paint characteristics, thinner requirement, etc., shall be obtained from the paint supplier. Copies of Specification D-9-8101 are available from the Texas Department of Transportation, Materials and Tests Division, 125 East 11th Street, Austin, Texas 78701-2483.

(2) Condition. Paints to be applied shall be thoroughly mixed and strained. Mixing shall be by mechanical methods and shall be such that the paint is rendered to be a completely homogeneous mixture free of lumps, skins or agglomerates, and shall contain all pigments, vehicle solids and thinners required in the original formulation. Paint containers shall be kept tightly covered and protected from the weather when not in use.

(3) Thinning. Paint may be adjusted to the correct application consistency by the use of properly applied heat not to exceed 66 °C, or by use of suitable thinners. Caution should be exercised since most paints and thinners are flammable. The use of heat to thin epoxy paints may decrease the useful pot life of these paints.

446.3. Paint Systems.

(1) Prime Coat.

(a) Protection System I (800 Prime Coat) requires Class "B" blast cleaning, with a minimum of a 100 micrometer dry film thickness of prime coat paint, applied in a minimum of two coats and a minimum of a 50 micrometer dry film thickness of appearance coat paint.

(b) Protection System II (810 Prime Coat) requires Class "A" blast cleaning, with a minimum of a 90 micrometer dry film thickness and a maximum 250 micrometer dry film thickness of prime coat paint, applied in a minimum of two coats and a minimum of a 50 micrometer dry film thickness of appearance coat paint.

(c) Protection System III (Inorganic Zinc) requires Class "A" blast cleaning, with a minimum of a 75 micrometer dry film thickness of Inorganic Zinc prime coat paint; two (2) coats of System III Epoxy Zinc prime coat paint on the surfaces to be in contact with concrete; a minimum of 50 micrometer dry film thickness of System III Epoxy Intermediate coat paint on all surfaces excluding those to be in contact with concrete, two (2)

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coats of System III Epoxy Intermediate coat paint on surfaces to be in contact with concrete and a minimum of a 50 micrometer dry film thickness of System III Urethane appearance coat paint.

(d) A Special Protection System when specified will require the type of cleaning, the type and thickness of prime coat and other coats, as shown on the plans, or in Special Provisions to this Item.

(2) Appearance Coat. The final appearance coating for Systems I and II shall be aluminum (slow dry or fast dry), green or grey as shown on the plans. Any of these colors may be designated with a particular system. Appearance coats of other colors, when required, will have the type of paint, color and mil coverage shown on the plans.

System III Urethane appearance coat paint shall be concrete grey in color unless shown otherwise on the plans.

(3) System and Color Designation. All structural steel except "Weathering Steel" shall be cleaned and painted in accordance with the paint system and appearance coat shown on the plans or in the specifications. Steel designated as "Weathering Steel" shall not be painted unless otherwise shown on the plans.

When no paint system is specified, the paint system shall consist of Protection System I prime coat and a gray appearance coat. The Contractor may request in writing to substitute System II for a specified System I subject to the approval of the Engineer.

446.4. Source of Supply. All paints required to comply with Departmental Materials Specification D-9-8100 shall be purchased from the Department unless otherwise shown on the plans or in the specifications. All paints required to comply with Departmental Materials Specification D-9-8101 shall be purchased on the Open Market.

Except for quantities of paint of 400 liters or less, the Contractor shall give the Engineer a minimum of 120 days notice as to where the requested quantities of paint will be needed and the required dates. This notification shall be accomplished on a standard Department form supplied by the Engineer.

Paint is stored by the Department in the warehouses located at Seguin, Athens and Post, Texas. Paint will usually be supplied from the warehouse nearest the designation; however, the right is reserved to supply from any warehouse in case of necessity. Shipments will be made direct to the Contractor at the location he designates, with transportation charges to be paid by him. The Contractor may obtain the paint by freight or at a location specified by the Engineer. The Contractor shall place his order for State-stocked paint in accordance with the above, through the Engineer.

All paints purchased from the Department will be charged to the Contractor at prices in accordance with the plans. Reimbursement to the State will be accomplished by making deductions from the Contractor's monthly and/or final estimate for the cost of paints purchased. The Contractor shall not use any of these paints on any work which is not required by or which does not constitute a part of the contract. The Contractor shall return all remaining undamaged and unopened containers of paint to the District Warehouse within 10 days after completion of all painting and credit will be given for the remaining paint based on the Contractor's original purchase price for the paint.

446.5. Responsibility for Hazards. Some paints are harmful to the health. All paints shall be handled according to the information contained on the paint safety data sheet. The Contractor shall be responsible for safety during all cleaning and painting operations.

Unless shown otherwise on the plans, the Contractor, at his expense, shall exercise necessary precautions to contain refuse, dust and paint overspray generated during cleaning and painting operations. Containment shall be such that all falling material is contained and collected for disposal. Noncontainment of airborne particles is permissible provided they are not visible over 30 meters from the actual cleaning or painting operation. A skimmer shall be used when cleaning and painting is over bodies of water. Disposal of collected refuse shall be in accordance with Federal, State and Local rules and regulations.

446.6. Equipment. Equipment used in cleaning and painting shall be of adequate capacity and have sufficient gauges, filters, agitators, regulators and moisture separators to insure delivery of clean dry air at the proper pressure and volume to permit satisfactory performance of the work. All equipment and accessories shall be maintained in good working order.

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All spray equipment shall be adequate for the type of paint being used and shall be equipped with spray heads adequate to provide a smooth, uniform coat of paint. Equipment used for spray painting shall have adequate provisions for separation of moisture from any air stream in contact with the paint. All spray equipment shall evidence good maintenance and be essentially free of old dried coatings on the exterior surfaces. Inside surfaces to which paint is likely to come in contact shall be completely free of any and all dried coatings or other foreign matter. Equipment not in compliance with the above will not be considered suitable.

If airless spray equipment is used, working regulator and air pressure or fluid pressure gauges shall be used. If conventional air spray equipment is used, independent fluid pressure and atomization pressure regulators and gauges shall be used.

Fluid and air hoses for conventional air spray equipment shall be a minimum of 12 millimeters I.D. with a maximum length of 23 meters. Fluid hoses for airless spray equipment shall be a minimum of seven (7) millimeters I.D. and a maximum length of 23 meters. During painting operations, paint pots shall not be more than six (6) meters above or below level of spray application of paint. Fluid hoses shall not be allowed to sag more than three (3) meters below the level of the bottom of the paint pot or actual spraying operations whichever is the lowest point. All hoses shall be serviceable and shall not show cracks or deterioration. Paint pots or other suitable containers from which the paint is dispensed shall be equipped with agitators which shall be in operation at all times that paint is in the pot.

446.7. Construction Methods.

(1) Rigging, Scaffolding, Etc. Contractor shall make available safe and adequate access to all parts of the work for proper inspection.

Rigging, scaffolds, etc., shall not be placed on or hung from previously painted surfaces until the previously applied coating has had a minimum of 48 hours curing time. Previously painted surfaces, to which rigging, scaffolding, etc., will be placed on or hung from, shall be protected with an approved padding to minimize damage to the previously applied coating. All coating damage as a result of rigging and scaffolding shall be repaired as directed by the Engineer.

(2) Cleaning and Preparation of Surfaces. Surfaces to be painted shall be completely free of oil, grease, moisture, dirt, sand, overspray, welding contamination (slag and/or acid residue); loose or flaking mill scale, rust or paint; and be free of any other conditions that will prevent the paint from forming a continuous, uniform, tightly adhering film. All steel splinters (hackles) raised or evident during cleaning shall be removed. When blast cleaning is required, areas from which steel splinters (hackles) are removed shall be reblasted.

All surfaces which are to be painted shall be subjected to the following test to determine if they are contaminated with loose particles.

Press a strip of filament tape onto the surface in question by rubbing with moderate thumb pressure four times. Leave approximately 50 millimeters of one end of the tape free from the surface. Grasp the free end of the tape and remove the tape from the surface with a sharp pull. The surface shall be considered as contaminated if the removed tape exhibits particles clinging to the tape.

Prior to other cleaning operations, grease-like contaminants shall be completely removed with clean petroleum solvents or other methods approved by the Engineer. This requirement shall be applicable to all coats.

All welds deposited using the shielded metal arc welding process, shall be thoroughly flushed with fresh water and allowed to become thoroughly dry before cleaning.

Unless a particular class of cleaning is specified, any effective method for removal of rust, scale and dirt, such as the use of blast cleaning, hand or rotating metal brushes, scrapers, chisels, hammers, flame cleaning or other means will be acceptable.

When blast cleaning is required, all flame-cut edges shall be blasted to produce a noticeable dense anchor pattern over the entire flame cut surface.

On steel items to be painted, all sharp edges forming essentially 90 degree angles shall be rounded to a minimum three (3) millimeters radius or ground to a minimum three (3) millimeters flat surface prior to blast cleaning. This requirement does not apply to punched or drilled holes.

When a class of cleaning is specified, the following requirements shall apply in addition to the above requirements:

(a) Class "A" Blast Cleaning. Class "A" Blast Cleaning is defined as the removal of all visible rust, paint, mill scale and other forms of contamination. The blasted area shall exhibit a uniform surface appearance when viewed with the unaided eye (20-20 vision).

(b) Class "B" Blast Cleaning. Class "B" Blast Cleaning is defined as the removal of all oil, grease, dirt, rust scale, loose mill scale, loose rust and loose paint or coatings. Tight mill scale and tightly-adhered rust, paint and coatings are permitted to remain. Each square millimeter of surface area to be cleaned shall be exposed to the abrasive blast pattern sufficiently to expose several flecks of the underlying metal.

(c) Class "C" Cleaning. Class "C" cleaning is defined as the removal of exposed rust, peeling or flaking paint and oxidized paint. These areas shall be cleaned by hand scraping and/or wire brushing, or any other method approved by the Engineer, so that all loose rust, peeling or flaking paint, and oxidized paint are removed. All edges of coatings surrounding cleaned areas shall be feathered into sound, tightly-adhering coatings.

(3) Painting.

(a) General. Each coat of paint shall be applied to clean, dry, firm surfaces complying with all specification requirements. Each coat shall dry to form a smooth, continuous, tightly adhering film of uniform thickness and appearance, free of sags, runs, pinholes, holidays, and overspray. Care shall be taken to insure that all surfaces to which paint is to be applied are free of all forms of contamination. All coats shall be applied by spray except that any method of application approved by the Engineer may be used to paint inaccessible areas.

When System I or II is specified and the steel and the ambient temperature are both above 16 °C, the required second coat of primer may be applied before the first coat has cured but in no case less than two (2) hours after the application of the first coat. All runs, sags and other defects in a coat shall be repaired before application of any subsequent coat.

Immediately prior to painting, steel surfaces or surfaces of previously applied coats of paint shall be cleaned by blowing with clean **446.7**

compressed air, brushing or a combination of the two (2) in order to remove traces of dust or other foreign particles. When directed by the Engineer, the surfaces of previously applied coatings shall be either washed with clean, fresh water or a mild detergent water followed by a complete and thorough rinse with clean, fresh water.

Paint shall not be applied to any surface containing moisture discernible with the eye or by the following test:

If temperature and humidity conditions are such that moisture is likely to condense upon the surface, a small area thereon shall be moistened with a damp cloth to apply a clearly defined, thin film of water. If this thin film evaporates within fifteen minutes, the surface shall be considered safe to paint.

Paint shall not be applied when the air temperature is below 4 °C; nor when the temperature is expected to drop below 4 °C within two (2) hours after application. No paint shall be applied when impending weather conditions might result in injury to fresh paint.

For all systems the dry film thickness will be measured according to Test Method Tex-728-I.

If in the opinion of the Engineer, there is an objectionable amount of dust in the atmosphere, the Contractor shall, at his own expense, take necessary precautions to prevent dust and dirt from coming in contact with freshly painted surfaces or with surfaces before the paint is applied.

Where paint is likely to be sprayed on traffic, the Contractor, at his own expense, shall provide a shield that will satisfactorily protect the traffic from paint.

Care shall be taken when painting steel that is in contact with concrete to insure full coverage of the steel with a minimal amount of paint onto the concrete surface. In no case shall the paint extend more than 100 millimeters onto the concrete surfaces. When painting is complete, the only visible paint on concrete surface shall be the finish coat. Excessive and/or objectionable paint on concrete surfaces shall be removed, at the Contractor's expense, in a manner approved by the Engineer.

(b) Workmanship. All painting shall be done by skilled painters. Application of modern specialized coatings requires painters knowledgeable about the characteristics of the various coatings, solvents and substrates. The painter also must be capable of adjusting equipment and application techniques as dictated by the type paint, weather conditions, environment, size and shape of surface being painted. Any painter who, in the opinion of the Engineer, does not adjust his equipment so that he can apply the coating in a uniform full wet coat free of runs, sags, holidays or overspray will not be considered a skilled painter.

Spray applications of coatings shall be essentially 90 degrees to the surface and from 0.25 to 0.50 meters from the surface as necessary to apply a full wet coat of paint free of overspray, runs, sags and holidays. Any spray painter who does not consistently spray in this manner and/or extends the spraying stroke such that paint is being applied to the surface at an angle of less than 80 degrees shall not be allowed to spray paint.

(c) Shop Painting. Unless otherwise provided in the contract or approved in writing by the Engineer, the initial cleaning and application of required prime coat paint shall be done by the Fabricator or his designated cleaning and painting contractor prior to shipment of the steel to the job site.

After all fabrication work is completed and has been tentatively accepted, all surfaces to be painted shall be cleaned and painted with the required prime coat. Pieces shall not be loaded for shipment until coatings are thoroughly dry. No painting shall be done after material is loaded for shipment. Erection marks for field identification of members shall be painted upon previously painted surfaces. Surfaces to be in contact after shop or field bolting shall be cleaned but not painted except when System III is specified. When System III is specified, surfaces to be in contact after shop or field bolting shall be cleaned and painted with the inorganic zinc primer only before bolting.

Surfaces within 100 millimeters of a field weld that joins main stress carrying members and within 50 millimeters of fillet welds, including the far side, joining diaframs or lateral bracing to stiffeners or gusset plates shall be free of paint. These unpainted surfaces shall be blast cleaned and coated with raw linseed oil. After welding is completed, the areas shall be cleaned and painted in accordance with the required system. When System

III is specified, inorganic zinc primed surfaces within 100 millimeters of the above mentioned surfaces shall be free of intermediate coating.

Machine-finished surfaces which are in sliding contact in the structure shall be cleaned and coated with a hot mixture of tallow before being shipped. This refers particularly to pins and pinholes. The composition used for coating these machine finished surfaces shall be mixed in the following proportions:

2 kilograms pure tallow
1 kilogram zinc oxide
1 liter pure raw linseed oil

Alternate mixtures may be used in lieu of the above with the written approval of the Director of Materials and Tests.

Unless otherwise shown on the plans or exempted above, the surfaces to be shop painted will include the rolling faces of rockers and base plates, all surfaces of bearing plates, and all surfaces of iron or steel castings, whether or not such surfaces are milled.

Unless otherwise shown on the plans, the top of the top flange of I-beams and/or girders which will be in contact with concrete will require cleaning and painting in accordance with the system specified except as modified below.

For Systems I and II, the minimum and/or maximum dry film thickness of prime coat requirements will apply only to 38 millimeters in from the outside edges of the top of the top flange. The remainder of the top flange shall exhibit a tightly adhering paint film.

For System III, the top of the top flange and other areas to be in contact with concrete shall be painted a minimum of 38 millimeters in from the outside edge of the surface to be in contact with concrete with the inorganic zinc primer. A light coat of inorganic zinc primer is permissible on all surfaces to be in contact with concrete. As the inorganic zinc primer on each fabricated member is approved for thickness and other applied film characteristics, all surfaces of the inorganic zinc primer shall be thoroughly wetted with a fine mist of potable water. When all **446.7**

surfaces are completely dry, the surfaces to be in contact with concrete that exhibits metal oxidation and/or mud-cracking of the inorganic zinc primer shall be recleaned to the specified requirements. Cleaning shall be into the inorganic zinc primer applied to the edges of these surfaces sufficient to ensure removal of all contaminants. Care shall be taken to prevent damage to the inorganic zinc primer applied to other surfaces of the member. After surfaces to be in contact with concrete are cleaned, they shall be coated with two (2) coats of System III epoxy zinc primer applied at 75 to 125 micrometers wet per coat with a minimum of one (1) hours and a maximum of 48 hours between coats. In not less than 24 hours nor more than 96 hours after the application of the second coat of epoxy zinc primer, these same surfaces shall be coated with one (1) coat of System III epoxy intermediate coating, applied at 100 to 150 micrometers wet. The remainder of the inorganic zinc primer surfaces shall be coated with System III epoxy intermediate coating in accordance with the requirements shown elsewhere in this Item.

Shop drawings shall reflect the areas of girders and/or flanges which are not to be painted.

(d) Field Cleaning and Painting. When erection or maintenance work is complete, including all bolting, welding, straightening of material, etc., and all concrete has been placed, and the Engineer has examined and approved the work, all unpainted areas and areas wherein the shop applied prime coat has been damaged or fails to meet specification requirements shall be cleaned in accordance with the method required under the paint system specified. Cleaning shall be sufficiently into the sound shop applied prime coat to ensure removal of all contaminants. Edges of sound paint around cleaned areas shall be feathered.

Cleaned areas shall be painted with the required prime coat. Painting shall overlap onto the surface of the shop applied paint surface sufficient to form a sealed edge. When System III is specified, all unpainted areas shall be painted with the inorganic zinc primer, all spot repair areas shall be painted with the epoxy zinc primer. Prior to application of the intermediate coating to the unpainted area painted with inorganic zinc primer, the inorganic zinc primer surface shall be thoroughly wetted with potable water either by fine spray or clean wet rag.

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The protective coating on machined surfaces and pins, specified in Section 446.7.(3)(c) shall be completely removed as directed by the Engineer for removal of grease and oil.

(e) Appearance Coat. After field painting in accordance with Subarticle (d) is complete and tentatively approved by the Engineer, the required appearance coat may be applied. Previously applied paint film including field touch up requires a minimum cure time as shown in the table below, prior to the application of appearance coat.

Temperature	**Days Cure, Min.**	
	System I & II	System III Intermediate
25 °C and above	2	2
18 °C to 25 °C	3	3
13 °C to 18 °C	4	4
4 °C to 13 °C	5	5

When the cure of previously applied paint is in doubt, the cure can be determined by the following test.

Using moderate to heavy pressure, place thumb on paint surface and apply a twisting motion. If the paint film gives or twists with the thumb, the coating is not thoroughly cured.

Prime coat and intermediate coat surfaces shall be cleaned by any method approved by the Engineer which does not damage the paint to remove all dirt, grease, concrete, overspray and any other substance that may impair adhesion prior to the application of the appearance coat.

At the time of acceptance of the structure, the painted portion thereof shall present an even and uniform appearance throughout.

(f) Paint Improperly Applied. To uncover evidence of improperly applied paint, the Engineer may, at any time during construction, explore underneath the surface of any paint coats already applied. Whenever unsatisfactory conditions are found, the Engineer may require any and all necessary remedial measures as follows:

All paint which has been applied improperly, applied to improperly cleaned surfaces, fails to dry and harden properly,

fails to adhere tightly to underlying metal or other paint film, or does not evidence a normal, workmanlike appearance in conformance with these specifications, shall be repaired or completely removed and replaced at the expense of the Contractor. When the final field coat does not have a uniform color and appearance throughout the structure, it shall be corrected by the use of whatever additional coats or other corrective measures found to be necessary. Freshly applied paint which has not yet set, shall be removed with the use of suitable solvents. Removal of dried paint films shall be either by means of blast cleaning, scraping, or flame torches meeting the approval of the Engineer.

(4) Handling, Storage and Shipping. All blocks, chains, slings, braces, clamps, etc., used in the handling, moving, storing and shipping of painted members shall be padded in such a manner that the paint will not be damaged.

(5) Cleaning and Painting Existing Structures. Unless otherwise shown on the plans, existing steel structures to be cleaned painted shall receive a Protection System I prime coat and a gray appearance coat.

When Class C cleaning is required, all cleaned areas shall be spot primed and appearance coated to the requirements of the paint system shown on the plans.

446.8. Measurement. Unless otherwise shown on the plans, no measurement will be made for the work to be done or the materials to be furnished under this Item, but it shall be considered subsidiary to the various bid items in the contract.

When "Cleaning, Paint and Painting" is specified on the plans to be a pay item, the work and acceptable materials will be paid for by the lump sum for each structure unit as shown on the plans.

446.9. Payment. The work performed and materials furnished as required by this Item will not be paid for directly but will be considered subsidiary to the various bid items of the contract, unless otherwise specified as a pay item in the contract.

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When "Cleaning, Paint and Painting" is specified as a pay item, the work performed and materials furnished in accordance with this Item and

measured as provided under "Measurement" will be paid for at the unit price bid for "Cleaning and Painting Existing Structures", "Cleaning and Painting Existing Railing", or "Cleaning and Painting Existing Steel Piling" for the system specified. This price shall be full compensation for cleaning, spot painting, and painting; for furnishing protection of traffic, scaffolding and paints; for disposal of all refuse; and for all labor, equipment, tools and incidentals necessary to complete the work.

ITEM 447

STRUCTURAL BOLTING

447.1. Description. This Item shall govern for furnishing and installing of high strength fasteners used in structural connections as shown on the plans and in accordance with this Item.

447.2. Materials.

(1) General. Bolts and nuts shall be furnished by the same supplier to ensure proper fit.

Rotational-capacity tests shall be performed on all black or galvanized bolt, nut and washer assemblies by the manufacturer or distributor prior to shipping. Each combination of bolt production lot, nut lot and washer lot shall be tested as an assembly and a rotational-capacity lot number assigned to each combination of the lots tested. The manufacturer or distributor shall furnish, to the Engineer, a manufacturer's certified test report (MCTR) or a distributor's certified test report (DCTR) for each rotational-capacity lot furnished. The MCTR or DCTR shall include the results of all tests; location of where bolt assembly components were manufactured; the date and location of the tests; results of the R-C tests and a statement that the materials represented by the test report conform to the specifications.

(2) Bolts. Bolts from M16 to M36 inclusive shall conform to the requirements of ASTM A 325 or A 490 except as provided herein.

Bolts shall conform to the requirements for heavy hexagon structural bolts as specified in ANSI B18.2.1. The length of the bolt shall **447.2**

be such that the point of the bolt will be flush with or outside the face of the nut when completely installed.

Unless otherwise specified, bolts shall conform to the dimensions for heavy hex structural bolts specified in ANSI B 18.2.3.7M.

Threads shall be the metric coarse thread series as specified in ANSI B1.13M, and shall have class 6g tolerances.

Bolts for painted structures shall be Type 1, 2, or 3 in accordance with ASTM A 325 or A 490. When weathering steel is specified, bolts shall be Type 3.

Galvanized bolts shall be either ASTM A 325 Type 1 or Type 2. Galvanizing shall be in accordance with ASTM A 325 except that the maximum Rockwell hardness of these bolts shall be limited to 33 Rc.

(3) Nuts. Nuts shall conform to the requirements of ASTM A 325 or A 490 except as provided herein.

Unless otherwise specified, threads in nuts shall be the metric coarse thread series as specified in ANSI B1.13M, and shall have grade 6H tolerances.

Nuts for painted structures shall be grades 2, C, D, or C3 with a minimum Rockwell hardness of 89HRB (Brinell hardness 180HB) or heat treated grades 2H, DH, or DH3. Weathering steel nuts shall be grade C3 or DH3. Nuts to be galvanized shall be heat treated grade 2H, DH, or DH3.

Nuts that are to be galvanized shall be tapped oversize the minimum amount required for proper assembly. The amount of overtap in the nut shall be such that the nut will assemble freely on the bolt in the coated condition and shall meet the mechanical requirements of ASTM A 563 and the rotational-capacity test.

Galvanized nuts shall be lubricated with a lubricant containing a dye of any color that contrasts with the color of the galvanizing.

(4) Washers. Circular, beveled and clipped washers shall conform to the requirements of ASTM F 436.

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(5) Alternate Fasteners. When shown on the plans or approved by the Engineer, high-strength steel lock-pin and collar fasteners may be used as an alternate for high-strength bolts. The shank and head of the high-strength steel lock-pin and collar fasteners shall meet the chemical composition and mechanical property requirements of ASTM A 325 or A 490. The fasteners shall provide a solid shank body of sufficient diameter to provide tensile and shear strength equivalent to or greater than the bolt specified; shall have a cold forged head on one end, of the type and dimensions as approved by the

Engineer; and shall have a shank length suitable for the material thickness fastened, locking grooves, breakneck groove and pull groove (annular grooves) on the opposite end. Each fastener shall provide a steel locking collar of proper size for the shank diameter used which, by means of suitable installation tools, is cold sweged into the locking grooves forming a head for the grooved end of the fastener after the pull groove section has been removed. The steel locking collar shall be a standard product of an established manufacturer of lock-pin and collar fasteners. Flat washers will not be required when lock-pin and collar fasteners are used unless slotted or oversized holes are specified.

447.3. Sampling and Testing. Sampling of high-strength bolts, nuts and washers will be in accordance with Test Method Tex-719-I.

Testing of high strength bolts, nuts and washers shall be in accordance with the applicable ASTM specification. Wherever final bolting is performed, Rotational Capacity tests shall be performed by the Contractor and witnessed by the Engineer in accordance with Test Method Tex-452-A.

447.4. Identification and Dimensions. ASTM A 325 and A 490 for bolts and the specification referenced therein for nuts require that bolts and nuts be identified by specific markings on the top of the bolt head and on one (1) face of the nut.

Bolts manufactured in accordance with ASTM A 325 or A 490 shall have head markings identifying the strength grade by the symbol "A325" or "A490", the manufacturer and the type, if Type 2 or 3. Nut markings shall identify the strength grade, the manufacturer and the type, if Type 3.

Washers for use when weathering steel is specified shall be marked on one (1) face near the outer edge with the numeral "3", or other distinguishing marks indicating that the washer is of a weathering type.

447.5. Construction Methods.

(1) General. All material within the grip of the bolt shall be steel. There shall be no compressible material such as gaskets or insulation within the grip.

The slope of the surfaces of parts in contact with the bolt head or nut shall not exceed 1:20 with respect to a plane normal to the bolt axis.

All joint surfaces, including those adjacent to the bolt heads, nuts or washers, shall be free of dirt, loose rust, loose scale, burrs and other matter that

will prevent solid seating of the parts.

Unless otherwise shown on the plans, faying surfaces of all nongalvanized joints, including splice plates, shall be given a Class "A" Blast Cleaning, in accordance with Item 446, "Cleaning, Paint, and Painting", prior to final bolting in the shop or field. Faying surfaces shall be free of loose rust prior to final bolting in the shop or field. Loose rust shall be removed by blast cleaning.

Galvanized faying surfaces shall be roughened by hand wire brushing.

When shown on the plans, faying surfaces shall be blast cleaned and coated with a paint that provides the specified mean slip coefficient as determined by the "Test Method to Determine the Slip Coefficient for Coatings Used in Bolted Joints" as adopted by the Research Council on Structural Connections. Coated joints shall not be assembled before the coatings have cured for the minimum time used in the qualifying test.

Bolts and nuts shall be protected from dirt and moisture at the job site. Only as many fasteners as are anticipated to be installed and tightened during a work day shall be taken from protected storage. Fasteners not used shall be returned to protected storage at the end of the day. Fasteners shall not be cleaned of lubricant that is present in the as-delivered condition. Fasteners that show signs of rust or dirt shall be cleaned and relubricated prior to installation. Any additional lubrication required must be applied prior to installing bolts in the holes.

Bolts shall be installed with a hardened washer under either the nut or bolt head, whichever is turned during tightening. When the outer plies being fastened have a yield strength of less than 275 megapascal, a hardened washer shall be installed under both the head and nut when A 490 bolts are used.

All fasteners shall be tightened to provide the minimum bolt tension values shown in Table 1.

The following procedures shall apply for bolt installation of a complete connection, regardless of the method of tightening:

(a)A minimum number of the holes, as determined by the Engineer, at a bolted connection shall be filled with erection pins to "fair-up" all holes.

(b)Install and tighten in a well distributed pattern a minimum of 25 percent of the final number of bolts, following a pattern of progression from the center or most rigid part of the joint toward the free edges, making sure that all plies of the connection are properly fitted and in contact. The tightness of fit-up bolts need not be inspected; however, overtightening of fit-up bolts shall not be permitted. Mark these bolts as fit-up bolts.

(c)Install and tighten all remaining bolts by the required amount. Remove the erection pins and fill the remaining holes with bolts. Loosen all A 325 bolts used for fit-up, and replace all A 490 bolts used for fit-up. Tighten these bolts by the required amount.

(d)The bolting crew shall mark finished work with an identifying symbol and the Inspector will mark accepted work.

A 490 bolts and galvanized A 325 bolts shall not be reused. Other A 325 bolts may be reused one time, if approved by the Engineer. Retightening previously tightened bolts which may have been loosened by the tightening of adjacent bolts will not be considered as reuse.

(2) Tightening Methods. Unless otherwise shown on the plans, tightening shall be by one or more of the following methods.

(a)Turn-of-Nut Tightening. A representative sample of not less than three bolt and nut assemblies of each diameter, length and grade to be used in

the work shall be checked at the start of work in a device capable of indicating bolt tension (Skidmore-Wilhelm Bolt Calibrator or equal). The test shall demonstrate that the method for estimating the "snug tight" condition and controlling the turns from snug tight develops a tension not less than five (5) percent greater than the tension specified in Table 1.

Bolts shall be installed in the sequence described in subsection (1) and brought to a "snug tight" condition. "Snug tight" is defined as the tightness that exists when the plies of the joint are in firm contact. This may be attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Snug tightening shall progress systematically from the most rigid part of the connection toward the free edges. Then the bolts of the connection shall be retightened in a similar systematic manner until all bolts are simultaneously snug tight and the connection is fully compacted. Nuts and the protruding bolt ends shall be match marked before final tightening, to allow the inspector visual means of determining actual rotation. Match marks shall be made by the bolting crew with a spot of paint after the bolts have been brought up to snug tight. Following this initial operation, all bolts in the connection shall be tightened further by the applicable amount of rotation specified in Table 2. Tightening shall progress systematically from the most rigid part of the joint to its free edges. During the tightening operation there shall be no rotation of the element not turned by the wrench.

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TABLE 1
Fastener Tension

Nominal Bolt Size,	Minimum Tension* in Kilonewtons

	A 325 Bolts	A 490 Bolts
M16	91	114
M20	142	179
M22	176	221
M24	205	257
M27	267	334
M30	326	408
M36	475	595

*Equal to 70 percent of specified minimum tensile strengths of bolts rounded to nearest kilonewton.

TABLE 2
Nut Rotation from Snug Tight Condition *,**

	Disposition of Outer Face of Bolted Parts		
Bolt length (Under side of head to end of bolt)	Both faces normal to bolt axis	One face normal to bolt axis and other face sloped not more than 1:20 (beveled washer not used)	Both faces sloped not more than 1:20 from normal to the bolt axis (beveled washer not used)
Up to and including 4 diameters	1/3 turn	1/2 turn	2/3 turn
Over 4 diameters but not exceeding 8 dia.	1/2 turn	2/3 turn	5/6 turn
Over 8 diameters but not exceeding 12 dia.***	2/3 turn	5/6 turn	1 turn

* Nut rotation is relative to both regardless of the element (nut or bolt) being turned. For bolts installed by 1/2 turn and less, the tolerance should be plus or minus 30 degrees; for bolts installed by 2/3 turn or more, the tolerance should be plus or minus 45 degrees.

** Applicable only to connections in which all material within the grip of the bolt is steel.

*** No research has been performed to establish the turn-of-nut procedure for bolt lengths exceeding 12 diameters. Therefore, the required rotation must be determined by actual test in a suitable tension measuring device which simulated conditions of solidly fitted steel.

(b)Alternate Fastener Installation. When fasteners which incorporate a design feature intended to indirectly indicate the bolt tension or automatically provide the bolt tension specified in Table 1 are to be installed, a representative sample of not less than three (3) fasteners of each diameter, length and grade shall be checked at the start of work in a device capable of

indicating bolt tension (Skidmore-Wilhelm Bolt Calibrator or equal). The test assembly shall include flat hardened washers, if required in the actual connection, arranged as in the actual connections to be tensioned. The calibration test shall demonstrate that each fastener develops a tension not less than five (5) percent greater than the tension specified in Table 1. The Manufacturer's installation procedure shall be followed for installation of fasteners in the calibration device and in all connections.

When alternate design fasteners are used, they shall be installed by a procedure submitted by the Contractor and approved by the Engineer. The procedure shall incorporate the concept of erection pins and fit-up bolts as described in subsection (1). If these fasteners are used as fit-up bolts and the control or indicator element is twisted off during the fit-up stage, then the bolt must be replaced prior to final acceptance of the work. All fasteners shall then be further tightened, progressing systematically from the most rigid part of the connection to the free edges in a manner that will minimize relaxation of previously tightened fasteners. In some cases, proper tensioning of the bolts may require more than a single cycle of systematic partial tightening prior to final twist-off of the control or indicator element of individual fasteners.

(c)Lock-Pin and Collar Fastener Installation. The installation of lock-pin and collar fasteners shall be by methods and procedures submitted by the Contractor and approved by the Engineer. This method shall incorporate the concept of erection pins and fit-up bolts as described in subsection (1).

447.6. Measurement and Payment. No direct compensation will be made for the installation of bolts or fasteners. Payment will be subsidiary to the pertinent items requiring the use of high-strength bolts.

Measurement and payment for the bolts, nuts and washers required for structural steel connections will be in accordance with Item 442, "Metal for Structures".

ITEM 448

STRUCTURAL FIELD WELDING

448.1. Description. This Item shall govern for the field welding of structural steel, reinforcing steel, and miscellaneous steel items as shown on the plans and in accordance with this Item.

Provisions are made herein for the welding of the types of steel listed in Table 1, using the manual shielded metal arc process and flux cored arc welding processes.

Shop fabrication and welding shall be in accordance with Item 441, "Steel Structures".

448.2. Welder Qualification. All welders shall be certified before working on any material which is to be incorporated into a Department project, except for miscellaneous welds as defined below. Each welder must have certification papers showing the type of work for which he is certified in accordance with Construction Bulletin C-6 and will not be permitted to do any type of work not covered by such papers.

Miscellaneous welds of the following types may be made by a welder who is certified for structural or reinforcing steel, or a qualified welder:

Armor joints and their supports, screed rail and form hanger supports where permitted on steel units, reinforcing steel to R-bars for lateral stability between prestressed beams, spirals or bands to reinforcing bars in drilled shaft cages, permanent metal deck forms, additional steel added in railing when slip form construction is used and other similar miscellaneous members that have no load carrying capacity in the completed structure.

A qualified welder is an experienced welder who is capable of making welds of sound quality, but does not have certification papers. Prior to welding operations, the Resident Engineer's personnel shall check the welder's ability by a job site Miscellaneous Weld Qualification Test. The Contractor shall furnish all of the material and equipment necessary for this test.

448.2

The Miscellaneous Weld Qualification Test shall consist of the following:

The welder shall make a single pass fillet weld in the vertical position six (6) millimeters maximum size approximately 50 millimeters long on 13 millimeters plate using four (4) millimeters low hydrogen electrodes in the location shown in Figure 1. The welder shall stop and start again within the 50 millimeters length of fillet weld.

The specimen shall be visually examined and the fillet weld shall present a reasonably uniform appearance free of cracks, overlap and undercut (See Figure 3). There shall be no porosity visible on the surface of the weld.

The specimen shall be ruptured as shown in Figure 2 by the application of a force or by striking with a hammer.

The fractured surface of the weld shall show complete penetration into the root of the joint and shall exhibit no incomplete fusion to the base metal nor any inclusion or porosity larger than two (2) millimeters in its greatest dimension.

448.2

If a welder fails to meet the requirements of this test, a retest may be allowed under the following conditions:

(1) An immediate retest may be made consisting of two (2) test welds, as described above, and both test specimens shall meet all of the requirements specified.

(2) A retest may be made after 30 days, provided there is evidence that the welder has had further training or practice. In this case the test shall be a single specimen.

Qualification by the test herein specified for miscellaneous welding shall be effective immediately upon satisfactory completion thereof and shall remain in effect for the duration of the project.

Tests for certification of welders for manual shielded metal arc welding shall be as prescribed by Construction Bulletin C-6. Tests shall be given by an approved laboratory. For field welding, certification by an approved laboratory will be accepted for a period of one (1) month from the time of certification. During this period, the welder will be permitted to work on Department projects provided his work is satisfactory. If his work is satisfactory during this period, the Department will issue him certification papers which will permit the welder to work on Department projects as long as he continues to do satisfactory work.

A welder shall pass the Basic Qualification Test for Structural Welding in the vertical (3G) and overhead position (4G) in accordance with Construction Bulletin C-6 prior to welding on any load carrying members. Also, he must demonstrate to a Department welding inspector a thorough knowledge of the required welding procedures together with his ability and desire to follow them and make welds of sound quality and good appearance. Quality of the welds will be checked by radiography.

To work on field splices of beams and girders, a welder must be certified for and be capable of making groove welds in both the vertical and overhead position when using the manual shielded metal arc process.

For flux cored arc welding, welder qualification tests for certification shall qualify using an approved procedure in accordance with ANSI/AASHTO/AWS D1.5 and tested in accordance with Construction Bulletin C-6 as follows:

(1) Basic Test-Certification for groove welds for unlimited thickness material will also qualify a welder for any equal or lower strength steel or for fillet welding in the position in which he is certified using the same electrode and combination of shielding used for the test.

(2) Welders shall be certified in the vertical and overhead position to work on field splices of beams or girders.

(3) Tests for certification shall be given by an approved laboratory. Certification papers for flux cored arc welding issued by an approved laboratory will be handled in a manner similar to that used for the manual shielded metal arc process.

(4) Welders shall be qualified for each process to be used.

(5) Qualification for welding with any grade electrode will automatically qualify a welder for the use of lower grades of electrodes using the same process.

The certification papers issued by the Department are the property of the Department and may be cancelled at any time.

Radiographic inspection shall be made of all qualification test plates of groove welds for the "Basic Qualification Test". If this inspection indicates any lack of fusion, incomplete penetration, and defects 1.5 millimeters or larger in greatest dimension, or if the sum of the greatest dimensions of defects less than 1.5 millimeters in greatest dimension exceeds ten (10) millimeters in any 25 millimeters of weld, the weld shall be considered as failing the soundness test. This radiographic inspection shall apply only to that portion of the welds between the discard strips of the specimens as indicated in Figures 13 and 14 of Appendix B of Construction Bulletin C-6. The specimen plates shall be wide enough to provide a minimum of 150 millimeters of effective weld length for radiographic testing. Mechanical testing will be in accordance with Construction Bulletin C-6.

448.3. General. All welds (except miscellaneous welds), including tack welds to be incorporated therein, shall be made by a certified welder. Tack welds shall be cleaned and fused thoroughly with the final weld. Defective, cracked or broken tack welds shall be removed.

Certification for welders shall be in conformance with the requirements of Construction Bulletin C-6. Miscellaneous welds may be made by a welder qualified in accordance with Article 448.2.

Welds shall be as required by the contract or erection drawings. The location or size shall not be changed without approval of the Engineer.

The welder shall place his identification mark with crayon or paint near the groove welds made by him.

No welding will be allowed when the air temperature is lower than - 6 °C, when surfaces are wet or exposed to rain, snow, or wind, or when operators are exposed to inclement conditions that will hamper good workmanship.

Any moisture present at the point of welding shall be driven off in accordance with Table 2, before welding commences. Wind breaks shall be required for the protection of all welding operations.

There shall be no temporary welds for transportation, erection or other purposes on main members except as shown on SS-MEBR Plan Sheet or as approved by the Engineer.

All groove welds, except when produced with the aid of backing, shall have the root of the initial weld gouged, chipped or otherwise removed to sound metal before welding is started from the second side, except that back gouging will not be required when welding steel piling or armor joints. The back side shall be thoroughly cleaned before placing the back-up pass.

Groove welds made with the use of steel backing shall have the weld metal thoroughly fused with the backing. Steel backing shall be continuous for the full length of each weld made with backing. A continuous length of backing may be made by welding shorter sections together under the following conditions:

(1) All welds shall be complete joint penetration groove welds made with the same controls as similar joint penetration groove welds in the structure.

(2) Radiographic tests as described in Article 448.9 shall be used to assure weld soundness.

(3) All welding and testing of the backing shall be complete before the backing is used to make the structural weld.

Before welding over previously deposited metal, all slag shall be removed, and the weld and adjacent base metal shall be cleaned. This requirement shall apply equally to successive layers, successive beads and the crater area.

Arc strikes outside the area of permanent welds must be avoided on all steels. Where they do occur, resulting cracks and blemishes shall be ground out to a smooth contour and checked to insure soundness.

Stringer bead technique shall be used where possible for groove welds on all types of steel.

In all welding processes, the progression for all passes in vertical welding shall be upward using a back step sequence.

Groove welds shall begin and terminate at the ends of a joint on extension bars. Edge preparation and thickness of extension bars shall be the same as that of the member being welded and shall extend a minimum of 20 millimeters beyond the joint. Extension bars shall be removed with a cutting torch or arc-air gouging upon completion and cooling of the weld, and the flange edges shall be ground smooth.

Any defects exposed by the grinding shall be cleaned, filled with weld metal, and reground to a uniform finish. All grinding shall be parallel to the flange. Excess grinding of the parent metal shall be avoided.

448.4. Filler Metal. Electrodes for manual shielded metal arc welding shall conform to the requirements of the latest edition of "Specifications for Mild Steel Covered Arc Welding Electrodes", ANSI/AWS A5.1, or to the requirements of the latest edition of "Specifications for Low Alloy Steel Covered Arc Welding Electrodes", ANSI/AWS A5.5.

Electrodes for flux cored arc welding shall conform to the requirements of the latest edition of "Specification for Carbon Steel Electrodes for Flux Cored Arc Welding", ANSI/AWS A5.20, or "Specification for Low Alloy Steel Electrodes for Flux Cored Arc Welding", ANSI/AWS A5.29.

All electrodes and flux-electrode combinations used on Department projects shall be on the approved lists maintained by the Director of Materials and Tests. For approval of electrodes or flux-electrode combinations, the

Contractor or electrode manufacturer shall submit to the Materials and Tests Division, 125 East 11th Street, Austin, Texas, 78701-2483, certified copies of all tests required by the pertinent AWS specifications. Electrode and flux-electrode combinations for bridge structures shall be in accordance with ANSI/AASHTO/AWS D1.5 Bridge Welding Code and, for reinforcing steel, shall be in accordance with ANSI/AWS D1.4 Structural Welding Code for Reinforcing Steel. Tests shall be made on electrodes of the same class, size, and brand which were manufactured by the same process and with the same materials as the electrodes to be furnished. Tests must be made and approval renewed every 12 months.

Class of electrodes required will be as shown in Table 1. Electrodes shall be used with the type of current, the polarity and in the positions permitted by AWS A5.1 and A5.5 for manual shielded metal arc welding (SMAW). AWS A5.20 and A5.29 specifications shall govern for flux cored arc welding (FCAW).

Table 1
Classifications of Electrodes Permitted

Type of Steel	Electrode Specification	Process	Filler Metal Requirements
Steel Piling	AWS A5.1 or A5.5	SMAW	E60XX E70XX or E70XX-X
Armor Jts. A500 A501	AWS A5.20	FCAW	E6XTX-X E7XTX-X (except -2, -3 -10, -GS)

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Type of Steel	Electrode Specification	Process	Filler Metal Requirements
A 36 A 572, Grade 345 A36MOD345 A 588 A 242	AWS A5.1 or A5.5	SMAW	E7016 E7018 E7028
	AWS A5.20	FCAW	E7XT-1 E7XT-5 E7XT-6 E7XT-8
Weathering Steel A 588 A 242	AWS A5.5	SMAW	E7018-W E8018-W E8016-C3 E8018-C3 E8016-C1 E8018-C1 E8016-C2 E8018-C2
	AWS 5.29	FCAW	E8XT1-W E8XTX-Ni1 E8XTX-Ni2 E8XTX-Ni3
Reinforcing Steel Grade 275	AWS A5.1 or A5.5	SMAW	E70XX
Reinforcing Steel Grade 400	AWS A5.5	SMAW	E90XX
Permanent Metal Deck Forms	AWS A5.1 or A5.5	SMAW	E6010 E6011 E6013 E7018

(1) In joints involving base metals of different yield points or strengths, low hydrogen electrodes applicable to the lower strength base metal may be used.

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Before use, all electrodes with low hydrogen coverings conforming to AWS A5.1 shall be dried for not less than two (2) hours between 230 °C and 260 °C and electrodes with low hydrogen coverings conforming to AWS A5.5 for not less than one (1) hour at a temperature between 370 °C and 430 °C.

Immediately after drying, electrodes shall be stored in ovens held at a temperature of at least 120 °C. E70 electrodes not used within four (4) hours, E80 within two (2) hours, E90 within one (1) hour, after removal from the storage oven, shall be redried before use. Electrodes with flux which has been wet, cracked or otherwise damaged, shall not be used. Electrodes may be redried only once.

Suitable facilities for drying and storage of electrodes shall be furnished at the job site, along with thermometers for checking and controlling the oven temperature.

In humid atmospheres, the times allowed for use without redrying may be reduced.

When a gas or gas mixture is used for flux cored arc welding, it shall be of a welding grade having a dew point of - 40 °C or lower. The gas manufacturer shall furnish certification to the Engineer that the gas or gas mixture is suitable for the intended application and will meet the dew point requirements.

Welding wire coils removed from the original package shall be protected or stored to keep their characteristics or welding properties intact. Rusty coils, or portions of coils that are rusty, shall not be used.

Any deviation from the above electrode designation, shall be approved by the Engineer.

448.5. Assembly and Fit-Up. For any welding process, the parts to be joined by fillet welds shall be brought into as close contact as possible and shall not be separated more than five (5) millimeters. If the separation is 1.5 millimeters or greater, the leg of the fillet weld shall be increased by the amount of the separation. The separation between faying surfaces of lap joints and of butt joints landing on backing strips shall not exceed 1.5 millimeters.

Splices of beams and girders joined by groove welds shall be carefully aligned with the center of gravity of both members coinciding or

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each flange vertically offset equally. Beams and girders with offset webs shall be fit with the webs aligned and the flanges offset laterally.

When flanges are offset, or abutting parts differ in thickness or width by more than three (3) millimeters, the joint shall be made with the slope of the weld metal to each surface, with a transition not exceeding one (1) in four (4).

Suitable allowance shall be made for shrinkage and the joint shall never be restrained on both sides in any welding process.

All butt splices shall be made before welding of diaframs or sway bracing in a particular section of a unit. Diaframs and sway bracing may be welded in a unit behind the splice welding to provide stability except where such welding interferes with butt splice adjustments, such as at a drop-in segment of a continuous unit. All splices shall be made before welding of beams or girders to shoes.

For manual shielded metal arc welding, the fit-up procedure listed below shall be used for manual shielded metal arc welding of groove welds for butt joints:

Members shall be spaced to provide a five (5) millimeters root opening at the nearest point. When, at other points of the joint, the spacing provides up to and including a 11 millimeters opening, correction may be made by buildup not exceeding three (3) millimeters on each bevel nose. Openings exceeding 11 millimeters shall require rebeveling of the joint to bring it within the maximum buildup limits prescribed above. Buildups must be allowed to cool before proceeding with the welding.

All members shall be brought into correct alignment and held in position by acceptable clamps while being welded.

Deviations from the above fit-up procedures shall be approved by the Engineer.

448.6. Procedure. Shrinkage and distortion shall be controlled through the use of an approved procedure. Passes shall be made symmetrically and shall alternate between both sides of the joint.

For manual shielded metal arc welding, beam and girder splices shall be made using the sequences shown in Figure 4, except that some members will require fewer or more passes than shown. Welds shall be alternated from side to side to prevent heat buildups on one flange edge. The passes must be arranged between the top and bottom flange to maintain balance and symmetry.

The sequence used in welding of splices in all I-beams shall be to first place four (4) tacks (38 to 50 millimeters) in the web.

For I-beam or for built-up girders, place passes one (1), two (2) and three

(3) in the top flange, followed by passes four (4), five (5) and six (6) in the bottom flange (See Figure 4).

Gouge out and replace passes one (1) and four (4), which always are placed in the overhead position, before welding on the web. Next, place passes seven (7) and eight (8) in the web after aligning girder webs with short tacks at approximately 200 millimeters on centers. (I-beam web is already tacked at this stage.)

Welding procedures for any special connections shall be approved by the Design Division.

When welding the root passes of beam and girder splices, E7010 electrodes may be used, provided the work is preheated in accordance with Table 2A, Note (b). After the root passes are backed up, the E7010 electrode pass shall be completely removed by arc-air gouging and replaced using low hydrogen electrode.

When this procedure is used, it shall be a continuous operation and back gouging and rewelding shall be completed on each splice before starting on another one.

Deviation from the above sequence of weld passes shall be approved by the Engineer.

Welding procedures for any special connections shall be approved by the Design Division.

Procedures for flux cored arc welding shall be submitted to the Engineer for approval and shall be qualified prior to any field welding.

Flux cored arc welding procedures shall be qualified in accordance with ANSI/AASHTO/AWS D1.5. For each joint to be used in construction, the joint details, electrode classification or grade, electrode diameter, voltage, amperage, travel speed, order and relative position of passes, number and thickness of layers, gas flow, dew point of gas, back gouging, method of cleaning and other pertinent information shall be clearly presented in the Procedure Specification.

The classification and size of electrode, arc length, voltage and amperage shall be suitable for the thickness of the material, type of groove, welding positions and other circumstances attending the work.

(1) Manual shielded metal arc welding process.

(a) The maximum size of electrode shall be as follows provided the welder has been certified for its use by the Department:

1. Six (6) millimeters for all welds made in the flat position except root passes.

2. Six (6) millimeters for horizontal fillet welds.

3. Six (6) millimeters for root passes of fillet welds made in the flat position and of groove welds made in the flat position with backing and with a root opening of six (6) millimeters or more.

4. Four (4) millimeters for welds made with EXX14 and low hydrogen electrodes in the vertical and overhead positions.

5. Five (5) millimeters for root passes of groove welds and for all other welds not included under 1, 2, 3 and 4 above.

(b) The root pass size shall be large enough to prevent cracking. The maximum thickness of layers subsequent to the root pass in fillet welds and of all layers in groove welds shall be as follows:

1. Six (6) millimeters for root passes of groove welds.

2. Three (3) millimeters for subsequent layers of welds made in the flat position.

3. Five (5) millimeters for subsequent layers of welds made in the vertical, overhead and horizontal positions.

(c) The maximum size fillet weld which may be made in one (1) pass shall be as follows:

1. Ten (10) millimeters in the flat position.

2. Eight (8) millimeters in horizontal or overhead positions.

3. Thirteen (13) millimeters in the vertical position.

(2) Flux cored arc welding process.

(a) The maximum size electrode used shall be as follows:

1. Four (4) millimeters for the flat and horizontal positions.

2. Three (3) millimeters for the vertical position.

3. Two (2) millimeters for the overhead positions.

(b) The thickness of weld layers, except root and surface layers, shall not exceed six (6) millimeters. When the root opening of a groove weld is 13 millimeters or greater, a multiple pass split-layer technique shall be used. The split-layer technique shall be used in making all multiple pass welds when the width of the layer exceeds 16 millimeters for flux cored arc welding.

(c) The welding current, arc voltage, gas flow, mode of metal transfer and speed of travel shall be such that each pass will have complete fusion with adjacent base metal and weld metal, and there will be no overlap, excessive porosity or undercutting.

(d) Flux cored arc welding with external gas shielding shall not be done in a draft or wind. An approved shelter of a material and shape capable of reducing the wind velocity in the vicinity of the welding to a maximum of eight (8) kilometers per hour shall be furnished by the Contractor.

(e) The maximum size of a fillet weld made in one (1) pass shall be as follows:

1. Thirteen (13) millimeters for the flat and vertical position.

2. Ten (10) millimeters for the horizontal position.

3. Eight (8) millimeters for the overhead position.

(3) Preheat.

Preheat ahead of welding both groove and fillet welds (including tack welding) will be required as shown in Table 2.

Preheat and interpass temperatures must be sufficient to prevent crack formation. The preheat temperatures shown in Table 2 are minimums and higher preheats may be necessary in highly restrained welds.

When the base metal is below the required temperature, it shall be preheated so the parts being welded are not less than the specified temperature within 75 millimeters of the point of welding.

For all groove welds, preheat temperature shall be measured on the side opposite to which the heat is applied at points approximately 75 millimeters away from the joint.

Preheating equipment shall be adequate to maintain the entire joint at or above the specified temperature. When possible, a joint shall be completely welded before it is allowed to cool below the specified temperature but shall always be welded sufficiently to prevent cracking before cooling is permitted.

Usually preheat and interpass temperatures shall not exceed 200 °C for thickness up to 38 millimeters and 230 °C for greater thickness.

The welder shall have and use approved equipment for checking preheat and interpass temperatures at all times while welding is in progress.

Table 2
Minimum Preheat and Interpass Temperature for Manual Shielded Metal Arc Welding or Flux Cored Arc Welding

Thickness of Thickest Part at Point of Welding	Flux Cored Arc Welding or Manual Shielded Metal Arc Welding With Low Hydrogen Electrodes
To 19 mm, incl.	10 °C
Over 19 mm to 38 mm, incl.	20 °C
Over 38 mm to 64 mm, incl.	65 °C
Over 64 mm	110 °C

(1) Preheat and interpass temperatures shall be sufficient to prevent crack formation and welding shall be carried continuously to completion or to a point that will assure freedom from cracking before the joint is allowed to cool below the minimum specified preheat and interpass temperature. Temperatures above those shown may be required for highly restrained welds.

(2) When E7010 electrodes are permitted for tacking or temporary root pass, the material shall be preheated according to the following:

Table 2A

Thickness of Thickest Part	Preheat for Tacking or Temporary Root Pass
13 mm and Less	65 °C
14 mm through 19 mm	90 °C
20 mm through 38 mm	150 °C
Over 38 mm	200 °C

(3) When joining steels of different thickness with groove welds, the preheat and interpass temperatures for the average plate thickness shall be used. For fillet welds, the preheat shall be used for the thickest plate being welded.

(4) When the base metal temperature is below 0 °C, preheat to at least 20 °C and maintain this minimum temperature during welding.

(5) When moisture is present on the base metal it shall be preheated to 95 °C before welding is started.

448.7. Quality of Welds. Weld metal shall be sound throughout.

There shall be no cracks in any weld or weld pass.

There shall be complete fusion between the weld metal and the base metal and between successive passes throughout the joint.

Welds shall be free from overlap and the base metal free from undercut more than 0.25 millimeter deep when its direction is transverse to the primary stress in the part that is undercut. Undercut shall not be more than 0.8 millimeter deep when its direction is parallel to the primary stress in the part that is undercut.

All craters shall be filled to the full cross section of the welds.

448.8. Corrections. When welding is unsatisfactory or indicates inferior workmanship, the following corrective measures will be required by the Engineer whose specific approval shall be obtained for making each correction.

When requirements prescribe the removal of part of the weld or a portion of the base metal, removal shall be by oxygen gouging or arc-air gouging.

Oxygen gouging shall not be used on A588 weathering steel.

Backgouging of splices in beams and girders or cutouts of defective welds shall be done by arc-air gouging by a welder qualified to make beam and girder splices.

Where corrections require the deposition of additional weld metal, the sides of the area to be welded shall have sufficient slope to permit depositing new metal.

Defective or unsound welds shall be corrected either by removing and replacing the entire weld, or as follows:

Excessive convexity. Reduce to size by grinding off the excess weld metal.

Shrinkage cracks. Cracks in base metal, craters and excessive porosity. Remove defective portions of base and weld metal down to sound metal and replace with additional sound weld metal.

Undercutting, undersize, and excessive concavity. Clean and deposit additional weld metal.

Overlapping and incomplete fusion. Remove and replace the defective portion

of weld.

Slag inclusions. Remove the parts of the weld containing slag and replace with sound weld metal.

Removal of adjacent base metal during welding. Clean and form full size by depositing additional weld metal.

Where corrections require the deposition of additional weld metal, the electrode used shall be smaller than that used for making the original weld. Surfaces shall be cleaned thoroughly before rewelding.

A cracked weld shall be removed throughout its length, unless the extent of the crack can be ascertained to be limited, in which case the weld metal shall be removed 50 millimeters beyond each end of the crack and repairs made.

Where work performed after the making of a deficient weld has made the weld inaccessible or has caused new conditions making the correction of the deficiency dangerous or ineffectual, the original conditions shall be restored by removal of welds or members, or both, before making the necessary corrections, or else the deficiency shall be compensated by additional work according to a revised design approved by the Engineer.

Improperly fitted and misaligned parts shall be cut apart and rewelded.

Members distorted by the heat of welding shall be straightened by mechanical means or by the carefully supervised application of a limited amount of localized heat. Heated areas shall not exceed 650 °C as measured by temperature indicating crayons or other approved methods for steel up to 450 megapascal yield strength. Parts to be heat straightened shall be substantially free of stress from external forces, except when mechanical means are used in conjunction with the application of heat. Prior to straightening, a straightening procedure shall be submitted to the Engineer for approval.

448.9. Radiographic Inspection. Radiographic testing required in the field shall be done at the expense of the Contractor by an agency or individual registered and licensed to perform industrial radiography.

Radiographic operations and equipment shall meet all applicable rules and regulations. The testing shall include furnishing all materials, equipment, tools, labor and incidentals necessary to perform the required testing. The Department may require further tests as necessary in accordance with Article 5.9, and may perform additional testing, including other types.

Radiographic equipment, procedures, resulting radiographs, identification marks, penetrameters, examination, reports and weld surface preparation shall be in accordance with ANSI/AASHTO/AWS D1.5. The Engineer will examine and interpret the resulting radiographs.

Initial radiography of beam or girder splices and the radiography of weld repairs may begin immediately after the completed weld or weld repair has cooled to ambient temperature.

For field welds of splices in beams or girders, radiographic inspection will be made of the full flange width of 100 percent of all flange splices and of the top and bottom 1/6 of the web at each splice. Welds requiring repairs shall be retested by radiography after repairs are made. Necessary repairs shall be made prior to any further work being done.

All radiography required because of unacceptable welding shall be performed at the Contractor's expense.

When radiographic inspection of particular welds is required by the plans, this shall be in addition to the radiographic inspection required herein.

All resulting radiographs shall become the property of the Department and remain with the Engineer.

All groove welds designed to carry primary stresses shall be subject to radiographic inspection. When subjected to such inspections, the presence of any of the following defects in excess of the limits indicated will result in rejection of the defective weld until corrected:

(1) Sections of welds shown to have any cracking, regardless of length or location, incomplete fusion, overlapping, or inadequate penetration shall be judged unacceptable.

(2) Inclusions less than 1.5 millimeters in greatest dimension, including slag, porosity and other deleterious material, shall be permitted if well dispersed so that the sum of the greatest dimensions of the inclusions in any 25 millimeters of welded joint shall not exceed ten (10) millimeters.

(3) Inclusions 1.5 millimeters or larger in greatest dimension shall be permitted provided such defects do not exceed the limits shown on Figure 5 or in

paragraph two (2) above.

(4) There shall be no inclusion greater than 1.5 millimeters within 25 millimeters of the edge of part or member at the joint or point of restraint.

NOTES:

(1) The distance from the edge of an inclusion to the edge of a plate or to any intersecting weld shall be equal to or greater than the clearance between inclusions.

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(2) Inclusions with any dimension greater than 13 millimeters are not acceptable.

(3) For joint thickness greater than 38 millimeters, the minimum allowable dimension and spacing of inclusions shall be the same as for 38 millimeters joints.

(4) Values of (B) obtained by projecting horizontally from (A) are maximum values. Any value of (B) smaller than the maximum is satisfactory.

(5) Values of (C) obtained by projecting vertically from (B) are minimum values. Any value of (C) larger than the minimum is satisfactory.

Definitions:

Porosity signifies gas pockets or any similar generally globular type voids.

Fusion-type defect signifies slag inclusions and similar elongated defects.

448.10. Reinforcing Steel. Provisions are made herein for the welding of reinforcing steel by the manual shielded metal arc process.

Splicing of reinforcing steel by welding shall be done only at locations shown on the plans.

(1) Base Metal. Reinforcing steel to be welded shall conform to the requirements of Item 440, "Reinforcing Steel".

(2) Filler Metal. Electrodes as specified in Table 1 will be required for all welding of reinforcing steel. Drying of electrodes shall be as specified in Article 448.4.

(3) Preheat and Interpass Temperature. Minimum preheat and interpass temperatures shall be as shown in Table 3.

Table 3
Minimum Preheat and Interpass Temperature
for Reinforcing Steel 1,2

Carbon Equivalency Range, %	Size of Reinforcing Bar, No.	Temperature
Up to and including 0.40	Up to 35M inclusive 45M and 55M	none 10 °C
0.41 - 0.45 inclusive	Up to 35M inclusive 45M and 55M	none 40 °C
0.46 - 0.55 inclusive	Up to 20M inclusive 25M to 35M inclusive 45M and 55M	none 10 °C 95 °C
Unknown	Up to 55M inclusive	10 °C

Notes:

(a) When the reinforcing steel is below the temperature listed for the size and carbon equivalency range of the bar being welded, it shall be preheated in such a manner that the cross section of the bar for not less than 150 millimeters on each side of the joint shall be at or above the specified minimum temperature.

(b) After welding is complete, bars shall be allowed to cool naturally to ambient temperature. Accelerated cooling is prohibited.

For widening projects, the preheat and interpass temperatures shall be based on the existing reinforcing steel and the requirements of Table 3 shall apply.

(4) Joint Types. For all bars 25M and larger, butt splices will be required. For 20M bars and smaller, lap splices will be required.

Fillet welds in lap splices shall be a minimum of 100 millimeters in length and shall be welded on each side of the lap joint. For bars 15M and smaller, welding from one (1) side of the lap will be permitted by the Engineer when it is impractical to weld from both sides of the joint, but in this case the weld shall be a minimum of 150 millimeters in length.

Lap welds shall meet the requirements specified in Table 4.

Where possible, all butt splices shall be made in the flat position. All welds for butt splices, except horizontal welds on vertical bars, shall be as shown in Figure 6. The back-up strip will be required when access to the splice is from the top only. When bars may be rotated or access to the splice is available from two (2) sides, the double bevel splice may be made, and this type weld requires gouging out the root pass similar to a flange splice on structural steel. The root pass may be made using E7010 electrodes for all double beveled splices, and the root pass shall be completely removed prior to welding the opposite side. The steel shall be preheated to 205 °C if E7010 electrodes are used. Horizontal splices, on vertical bars, shall be as shown in Figure 7.

Table 4
Required Dimensions for Lap Splices

Bar Size	"a"	"b" (Max.)	"t" (Min.)	"c" (Max.)	Electrode Size*
10M	1.0 mm	3 mm	2.0 mm	1.5 mm	1/8 in.
15M	1.5 mm	3 mm	5.0 mm	1.5 mm	5/32 in.
20M	1.5 mm	3 mm	6.0 mm	1.5 mm	5/32 in.

* Electrode sizes will continue to be in inches until changes are made by the American Welding Society (AWS).

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(5) Widening Projects. In general, the new reinforcing steel shall be either lap or butt spliced directly to the bar to be extended. When the reinforcement in the old portion of a structure is found to be of the wrong spacing, dowel bars long enough to develop the welded lap or butt splice and also develop the bar in bond, as required in Item 440, "Reinforcing Steel", shall be welded to the old steel, and the new reinforcement placed at the correct spacing without welding to the old steel. No measurement or payment will be made for the dowels but will be subsidiary to the other items in the contract.

Both old and new reinforcement shall be cleaned thoroughly prior to the preparation of the joint.

(6) Radiographic Inspection. When so designated on the plans, welded butt splices shall be radiographed. Radiographic testing required in the field shall be done in accordance with Article 448.9. Weld quality shall be as follows: There shall be no cracks and the sum of the greatest dimensions of porosity and fusion-type defects shall not exceed 1/10 of the nominal bar diameter in millimeters.

The Engineer will examine and interpret the resulting radiographs, which shall become the property of the Department and remain with the Engineer.

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448.11. Measurement and Payment. The work performed, materials furnished and all labor, tools, equipment and incidentals necessary to complete the work under this Item will not be measured or paid for directly, but will be considered subsidiary to the various bid items of the contract.

ITEM 449

ANCHOR BOLTS

449.1. Description. This Item shall govern for the fabrication and installation of anchor bolts, embedded in or otherwise attached to concrete, of the types and sizes as shown on the plans and in accordance with the requirements of this Item.

449.2. Mild Steel Anchor Bolts. Anchor bolts shown on the plans with no specific material or strength requirements shall conform to the requirements of ASTM A 307 Grade A or ASTM A 36. Nuts for mild steel anchor bolts shall conform to the requirements of ASTM A 563.

A mill test report or manufacturer's certification will be required indicating that the material conforms to these requirements.

449.3. Medium-Strength, Mild Steel Anchor Bolts. Anchor bolts shown on the plans as A36MOD380 may be fabricated in diameters up to 75 millimeters. A36MOD380 is a special designation for a modified ASTM A 36 or ASTM A 572 material with a higher specified yield strength and having other additional requirements as described herein. Nuts for medium-strength, mild steel anchor bolts shall conform to the requirements of ASTM A 194 Grade 2H or ASTM A 563 Grade D or better.

Medium-strength, mild steel anchor bolts shall conform to all the bolt requirements of ASTM A 307 and the material requirements of ASTM A 572 or ASTM A 36, except as modified herein. Standard mill test reports shall be furnished to the Engineer showing the chemical and mechanical properties of each heat of steel used in the manufacture of the bolts.

(1) A36MOD380 bolts manufactured from ASTM A 36 steel shall meet the chemical and mechanical properties of ASTM A 36, except that the maximum manganese content shall be 1.35 percent. The alloying elements Columbium (0.035 percent maximum) and Vanadium (0.06

percent maximum) are permissible. The minimum yield strength shall be 380 megapascals, the tensile strength shall be between 450 and 655 megapascals, and

the minimum elongation shall be 18 percent in 200 millimeters or 21 percent in 50 millimeters.

(2) A36MOD380 bolts manufactured from ASTM A 572 steel shall meet the chemical and mechanical requirements of A 572 Grade 345 steel, except that the maximum carbon content shall be 0.26 percent, the minimum yield strength shall be 380 megapascal, and the maximum tensile strength shall be 655 megapascal.

449.4. High Strength Steel Anchor Bolts. Anchor bolts shown on the plans as high strength anchor bolts shall conform to the requirements of ASTM A 325 or ASTM A 321 threaded rod. Nuts for high strength anchor bolts shall conform to ASTM A 194 or ASTM A 563, heavy hex.

A mill test report or manufacturer's certification will be required indicating that the material conforms to these requirements.

449.5. Alloy Steel Anchor Bolts. Anchor bolts shown on the plans as A 193 B7 shall conform to the requirements of ASTM A 193 Grade B7 or ASTM A 687. Nuts for alloy steel anchor bolts shall conform to ASTM A 194 Grade 2H or ASTM A 563, heavy hex, Class 12.

Mill test reports or manufacturer's certifications and a test report or certification relative to the heat treating process will be required to verify the acceptability of alloy steel anchor bolts.

449.6. Washers. Washers installed with anchor bolts of any type shall conform to the requirements of ASTM F 436 and shall have the same finish or coating as the bolt and nut.

449.7. Threads. Threads for anchor bolts shall be rolled or cut threads of 8 pitch or unified coarse thread series in accordance with ANSI B1.1. For rolled threads, the diameter of the unthreaded portion shall not be less than the minimum pitch diameter nor more than the maximum major diameter of the threads.

All threads for bolts shall have a Class 2a tolerance and nuts shall have a Class 2b tolerance in accordance with ANSI B1.1.

449.8 to 449.9

When nuts are to be galvanized, the untapped blanks shall be galvanized prior to cutting the threads.

449.8. Fabrication. Welded splicing of rod material for anchor bolts will not be permitted.

Each anchor bolt shall have an anchorage device, consisting of either a standard bolt head, a threaded bolt with nut, or if shown on the plans, a 90 degree bend. The inside bend diameter shall be approximately two (2) times the anchor bolt diameter, but at no point along the bend shall it be greater than three (3) times the bolt diameter. Hot bending is permissible provided the temperature does not exceed 595 °C.

When embedded templates are not used, nuts welded to the end of threaded rods to create anchorage devices shall be welded only to the unstressed ends of the rods. Care must be taken to ensure that no welding, arc, or other potential notch producing effect occurs in the stressed portion of the bolt.

If the anchor bolts are shown to be installed in a template embedded in concrete, the anchorage nuts are to be tack welded to the template in the shop. This welding shall be done with appropriate jigs so as to ensure that the anchor bolt is perpendicular to the template.

Top and/or bottom templates, washers, lock washers, nuts, lock nuts, and other devices used for installing anchor bolts, as shown on the plans, shall be considered part of the anchor bolt assembly.

Shipping of the anchor bolt cage in its assembled condition is not required.

449.9. Finish. When shown on the plans, anchor bolts to be embedded in concrete shall have the exposed end plus a minimum of 150 millimeters galvanized or coated with two (2) coats of a zinc-rich coating. Anchor bolts which are to extend through the concrete attachment shall have their complete length galvanized or coated. Exposed nuts shall be galvanized or coated with a zinc-rich coating if the anchor bolts are not galvanized. Galvanizing and zinc-rich coating shall be in accordance with Item 445, "Galvanizing".

449.10. Installation. The anchor bolt and template assembly shall be rigidly held in position during concrete placement. Anchor bolts not requiring steel templates shall have wood templates or other positive means to ensure correct positioning of the bolts. Positioning devices may be tack welded to the steel templates but not to any portion of the anchor bolts.

Threads of anchor bolts shall be coated with pipe joint compound prior to installation of the nut(s). Exposed threads of painted bolts shall be cleaned and an additional coating of zinc-rich paint applied to seal the bolt thread-nut joint.

449.11. Measurement and Payment. The work performed, materials furnished, and all labor, tools, equipment, and incidentals necessary to complete the work under this Item will not be measured or paid for directly, but will be considered subsidiary to the various bid items of the contract.

ITEM 450

RAILING

450.1. Description. This Item shall govern for the construction of concrete, steel, or aluminum railing, or a combination of these materials on bridges, culverts, walls, or other structures as shown on the plans.

In general, railing shall include that portion of the structure erected on and above the roadway or along the edges of walks, curbs, or slabs for the protection of traffic and pedestrians, and shall include any anchor bolts or reinforcing steel required for anchorage to the structure, and any tie-in anchorage to approach railing or guard fence.

Railing, including the necessary anchorages, shall be in accordance with these specifications and the details shown on the plans.

450.2. Materials. All materials shall conform to the pertinent requirements of following items:

Item 420, "Concrete Structures"
Item 421, "Portland Cement Concrete"
Item 440, "Reinforcing Steel"

450.3

Item 442, "Metal for Structures"
Item 445, "Galvanizing"

450.3. Construction.

(1) General. Railing shall be of the classification and type specified conforming with the requirements of this item and shall be constructed in accordance with details, alignment, and grade designated on the plans. Unless otherwise provided, railing shall not be placed until falsework, if any, for the span has been released. During construction, care shall be exercised to insure proper functioning of expansion joints.

If the plans include details of both steel and aluminum designs for the same type of railing, the Contractor has the option of furnishing either type. The option chosen (steel or aluminum) shall be furnished for all railing of that type in the entire contract.

(2) Metal Railing. Fabrication and erection of metal railing shall conform to the pertinent provisions of Item 441, "Steel Structures", and to the requirements of this Item.

Splicing of members will be permitted only as provided by the plans. All splice locations and details shall be shown on the shop or erection drawings.

For metal railings, shop or erection drawings when required by the plans shall be prepared and forwarded for approval in accordance with the requirements of Item 441, "Steel Structures".

Shop welding shall be in accordance with Item 441, "Steel Structures". Field welding, when required, shall be in accordance with Item 448, "Structural Field Welding".

Railing materials shall be stored above the ground on platforms, skids, or other supports and kept free from grease, dirt and contact with dissimilar metals. Care shall be taken at all times to avoid scratching, marring, denting, discoloring, or otherwise damaging the railing.

To facilitate bending or straightening, aluminum materials other than castings may be heated not to exceed 200 °C for a period not exceeding 30 minutes.

Welding of aluminum materials shall be done by an inert gas shielded,

electric arc welding process using no welding flux. Torch or flame cutting of aluminum will not be permitted.

Metal railing and posts which are shop fabricated into panels shall be mounted in a jig clamped in their true relative position, accurately spaced with respect to each other, and while assembled shall be completely welded or bolted, as the case may be. When required by the plans, as each railing section is completely assembled and connected, the adjacent section shall be set in its proper relative position with the ends engaged and remain in this position until completely connected. Each pair of sections shall be matchmarked so they may be erected in the same position in which they were fabricated.

Fabricated W-Beam elements included as part of a railing system shall conform to the dimensions and cross section shown on the plans. Maximum deviation from straightness of either edge shall be six (6) millimeters per three (3) meters. W-Beam elements shall be jointed and connected to the rail posts as shown on the plans. Lapped elements shall have the lap in the direction of traffic in the adjacent lane. Unless otherwise shown on the plans, bolts and nuts for W-Beam railing shall conform to ASTM A 307 and shall be galvanized in accordance with Item 445, "Galvanizing".

Castings shall be permanent mold castings true to pattern in form and dimensions, shall be of the metal specified and of uniform quality and condition, free from cracks and defects such as blowholes, porosity, hardspots or shrinkage effects which affect their suitability for use. Minor defects in aluminum castings may be repaired by an approved inert gas welding process. The finished castings shall be free of all burrs, fins, discoloration and mold marks and shall have a uniform appearance and texture.

Castings shall be produced under radiographic control to establish and verify a product free from harmful internal defects. Radiographic examination of production castings shall be made, as necessary, to insure satisfactory quality. When heat treating is required the entire lot of castings shall be heat treated to the specified temper.

All castings shall be permanently marked on the web or top of the base with the heat or lot number. Mill test reports shall be furnished showing the heat or lot number, chemical composition, tensile strength, elongation, and number of pieces for each casting heat or lot.

For aluminum castings, a heat or lot shall consist of not more than 450 kilograms of trimmed castings when produced from batch type furnaces, or 900 kilograms when produced from a continuous furnace during a period not exceeding eight (8) consecutive hours. The entire number of acceptable posts cast from each heat or lot shall be furnished to the project, except where a portion of a lot is required to complete the shipment.

(3) Concrete Railing. The concrete portions of railing shall conform to provisions of Item 420, "Concrete Structures", and to the requirements of this Item. Provisions shall be made in constructing forms to provide for checking and correction of railing lines and grades after concrete has been placed but before initial set. The finish floating of the railing tops shall not disturb the form alignment after the final check. Particular care shall be exercised in other construction operations to avoid disturbing or vibrating the span with the newly placed railing. Precast members shall conform to Item 424, "Precast Concrete Structures (Fabrication)".

Reinforcing steel for railing shall conform to the pertinent provisions of Item 440, "Reinforcing Steel".

Concrete railing may be constructed using slip-form equipment approved by the Engineer. Sensor control for both line and grade must be provided.

450.4. Tests. One post from each cast aluminum post lot shall be selected by the Engineer for test purposes and shall meet the requirements of Item 442, "Metal for Structures".

For W-Beam elements, a sample of the rail may be taken from each project or from each shipment to a project. Samples of bolts and nuts may also be required. Physical tests shall be performed in accordance with the

Department's Manual of Testing Procedures and tests for galvanized coatings shall be in accordance with ASTM A 90. Field testing of galvanized coating thicknesses shall be in accordance with Test Method Tex-728-I.

450.5. Protective Coating. Unless otherwise noted on the plans, all portions of steel railing shall be galvanized. When painting is specified on the plans, the type and coating thickness shall be in accordance with the paint system shown on the plans and conforming with Item 446, "Cleaning, Paint and Painting".

Galvanized railing shall be hot dip galvanized after fabrication. Any damaged galvanizing shall be repaired after erection. Galvanizing and repairs shall be done in accordance with Item 445, "Galvanizing".

Aluminum railing and galvanized steel railing shall not require field painting. Prior to final acceptance, extrusion marks, grease, and dirt shall be cleaned from the railing.

450.6. Measurement. This Item will be measured by the meter in accordance with the dimensions and details as shown on the plans.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

450.7. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Railing" of the classification and type specified. This price shall be full compensation for furnishing, preparing and placing of all concrete, expansion joint material, reinforcing steel, structural steel, aluminum, cast steel, pipe, anchor bolts, anchorage devices for attaching Metal Beam Guard Fence, and all other materials required in the finished railing, and for all labor, tools, hardware, equipment, paint and painting, galvanizing and incidentals necessary to complete the work.

Payment for revised quantities due to a change in design will be paid for at the unit price bid per meter measured as provided in Article 450.6. Adjustments of quantities will be subject to the provisions of Article 4.2.

ITEM 452

REMOVING RAILING

452.1. Description. This Item shall govern for the removal and disposal of railing which is not to be reused on the structure, but is to be completely replaced with other railing. The removal may be on one side only, or on both sides of the structure.

452.2. Construction Methods. The existing railing shall be removed to the lines and grades as shown on the plans by the use of air driven equipment or other suitable means. The use of explosives will not be permitted. Care shall be taken to avoid damage to that portion of the concrete that is to remain in place. Any concrete removed beyond the neat lines, or lines established by the Engineer, shall be replaced at the Contractor's expense.

Existing reinforcing steel in concrete posts, not to be used as dowels, shall be cut off a minimum of 25 millimeters below the finished surface of the concrete. The concrete removed in making the cut-off shall be replaced in a manner satisfactory to the Engineer.

The top of the concrete where railing is removed shall be refinished in such a manner as to leave a neat surface.

All material which the Engineer deems as salvable for reuse shall be carefully dismantled and, unless otherwise shown on the plans, placed in neat piles along the right-of-way at convenient loading points approved by the Engineer.

Portions of railing, which are not deemed salvable by the Engineer, shall become the property of the Contractor and shall be removed to suitable disposal sites off the right-of-way arranged for by the Contractor, or otherwise disposed of in a manner satisfactory to the Engineer.

Work performed under this specification shall be performed at such time and prosecuted in such manner that will cause a minimum of inconvenience to traffic.

452.3. Measurement. This Item will be measured by the meter in its original position, except that concrete railing to be removed on the side of the structures to be widened will not be measured under this Item, but will be considered subsidiary to Item 430, "Extending Concrete Structures".

452.4. Payment. The work performed in accordance with this Item and measured as provided under "Measurement", will be paid for at the unit price bid for "Removing Railing", of the type specified. This price shall be full compensation for removing all materials, loading, hauling, unloading and satisfactorily disposing of the material, for cutting back old post reinforcing bars, for refinishing the top and roadway face of the old curb and for all labor, tools, equipment, manipulations and incidentals necessary to complete the work.

ITEM 453

TEMPORARY RAILING

453.1. Description. This Item shall govern for the installation of temporary railing, at the locations shown on the plans, in conformity with plan details and the requirements of this Item.

453.2. Material. Temporary railing shall be constructed of materials and to details specified on the plans.

Steel shapes, plates and deep-beam members shall be in satisfactory condition for the use intended. Portions of permanent railing to be used later on the permanent structures may be used subject to the requirements of this Item.

Paint for portions of the temporary railing which are to be later used in the permanent railing shall conform to Item 446, "Cleaning, Paint and Painting".

When a portion of the temporary railing is to be furnished by the Department, such portions to be furnished will be shown on the plans.

453.3. Construction. The temporary railing shall be erected on that side of the existing structure where widening operations are to begin prior to the removal of the existing railing, curb and portion of the slab. The rail and posts shall be constructed in accordance with the details shown on the plans.

After erection, all steel parts not galvanized shall be thoroughly cleaned and painted. Portions of the railing which are to become a part of the permanent rail shall receive paint in accordance with the paint system shown on the plans for the permanent rail. Other portions of the rail shall be painted with one (1) coat of commercial grade aluminum paint unless otherwise specified on the plans.

After completion of the widening on one side of bridges to be widened on both sides, the temporary railing shall be moved to the other side and erected, prior to the removal of the existing railing and curb.

Any railing material furnished by the State will be delivered by State Forces to the bridge site or stored at a site designated on the plans.

The Contractor shall maintain the temporary railing in a condition acceptable to the Engineer until all work on the structure has been completed.

All holes left in concrete from erection of temporary railing shall be filled with mortar and finished in a manner acceptable to the Engineer.

Upon removal of the railing, materials furnished by the State shall be stored near the bridge site as directed by the Engineer for subsequent removal by State Forces.

Prior to installation on the structure, the portion of permanent railing which was used as temporary railing, shall be reworked, if necessary, to provide railing for the new structure as intended by the plans and specifications. Portions damaged beyond repair shall be replaced at the Contractor's expense.

453.4. Measurement. Temporary railing, constructed complete in place, moved as required by the plans, maintained and finally removed will be measured as one lump sum for all railing furnished under this Item.

453.5. Payment. The work performed in accordance with this Item and measured as provided under "Measurement", will be paid for at the lump sum contract price bid for "Temporary Railing". This price shall be full

compensation for furnishing all materials except those designated on the plans to be furnished by others, for all preparation, hauling and erection, painting, maintaining, moving the railing as required, for removing the railing, stockpiling the rail material on the right-of-way when required, and for all labor, tools, equipment, and incidentals necessary to complete the work.

ITEM 454

SEALED EXPANSION JOINTS

454.1. Description. This Item shall govern for furnishing and installing sealed expansion joints for bridges or other structures in accordance with the locations and details shown on the plans.

454.2. Materials. The joint shall conform to the design shown on the plans. Materials for standard design joints shall conform to Item 442, "Metal for Structures" and Item 435, "Elastomeric Materials".

The Contractor shall choose the type of joint to be installed. The joint shall extend, with the seal unbroken, the full length shown on the plans, including that portion into the parapet wall, when required.

454.3. Working Drawings. Complete fabrication and erection drawings for each joint shall be submitted for approval, prior to fabrication, to the Director of Design, Texas Department of Transportation, 125 East 11th Street, Austin, Texas 78701-2483. Submission of drawings shall be as required by Item 441, "Steel Structures".

454.4. Construction Methods. The joints shall be installed to the opening shown on the plans for 20 °C temperature, adjusted for the temperature at the time of installation, and in accordance with the manufacturer's instructions. The joints shall be mounted on armor angles, cast-in-place with the deck, when shown on the plans.

454.5. Measurement. Sealed expansion joints will be measured by the meter of the size (minimum total movement capacity) shown on the plans. Measurement will be along the centerline of the joint at the surface of the roadway and the parapet, if required.

454.6 to 458.2

454.6. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Sealed Expansion Joints" of the size specified. This price will be full compensation for furnishing and installing the joints including armor angles, when required, and for all materials, tools, equipment,

labor and all incidentals necessary to complete the work.

Armor angles required by the plans are considered part of the sealed expansion joint for payment.

ITEM 458

WATERPROOFING FOR STRUCTURES

458.1. Description. This Item shall govern for the furnishing and placing of waterproofing on concrete and steel bridge decks of railroad structures and on other structures as shown on the plans and in accordance with this Item.

458.2. Types. The type of waterproofing will be shown on the plans or in the contract proposal and shall be one of the following:

(1) Type 1. Type 1 waterproofing shall consist of a butyl rubber membrane applied to a surface with a proper adhesive, without protective planking, and in accordance with the details shown on the plans. Unless otherwise specified, the thickness shall be 1.5 millimeters.

(2) Type 2. Type 2 waterproofing shall consist of one (1) asphaltic primer coat and one (1) mopping of asphalt.

(3) Type 3. Type 3 waterproofing shall consist of one (1) asphaltic primer coat and two (2) moppings of asphalt. When shown on the plans, waterproofing at construction joints of foundation structures shall be supplemented by two (2) layers of treated cotton fabric with a third mopping of asphalt placed over the outer layer of fabric.

(4) Type 4. Type 4 waterproofing shall consist of a self-adhering polyethylene with a rubberized asphalt mastic material.

(5) Type 5. Type 5 waterproofing shall consist of a single component, coal tar modified, urethane coating.

(6) Type 6. Type 6 waterproofing shall consist of a self-adhering, built-up membrane of rubberized asphalt formed on a preformed board, with cold applied asphaltic primer.

(7) Type 10. When Type 10 waterproofing is shown on the plans, the Contractor may furnish either Type 1, Type 4, Type 5 or Type 6.

(8) Type RR-1. Type RR-1 waterproofing shall consist of a butyl rubber membrane with a protective course of asphalt plank or asphalt mat of the specified thickness.

(9) Type RR-2. Type RR-2 waterproofing shall consist of a self-adhering membrane of rubberized asphalt formed on plastic film, with cold applied asphaltic primer, and protected with two (2) layers of ten (10) millimeters thick asphaltic panels.

(10) Type RR-3. Type RR-3 waterproofing shall consist of a self-adhering built-up membrane of rubberized asphalt formed on a preformed board, with cold applied asphaltic primer.

(11) Type RR-10. When Type RR-10 waterproofing is shown on the plans, the Contractor may furnish either Type RR-1, Type RR-2 or Type RR-3.

458.3. Materials. The waterproofing materials listed below shall conform to Departmental Material Specification D-9-6300.

(1) Butyl rubber membrane
(2) Asphalt for mopping above ground
(3) Asphalt for mopping below ground
(4) Asphaltic primer
(5) Treated cotton fabric
(6) Self-adhering polyethylene
(7) Coal tar modified urethane
(8) Rubberized asphalt with preformed board membrane
(9) Asphalt plank
(10) Asphalt mat
(11) Rubberized asphalt with plastic film

(12) Asphaltic panels
(13) Plastic cement
(14) Cold asphalt base emulsion

Materials for waterproofing shall not be used until approved by the Engineer. Materials requiring sampling and testing shall be delivered to the work site a minimum of three (3) weeks prior to use to allow for sampling and testing. Materials for waterproofing may be tested and approved prior to delivery to the work site, when authorized by the Engineer.

458.4. Construction Methods.

(1) General. Waterproofing material shall be stored in a manner to prevent damage. The material shall be kept dry at all times and shall be stored in a warm area prior to use in cold weather and out of direct sunlight in hot weather.

Asphalt planks, asphalt mats and asphaltic panels shall be stored so as to prevent warping and breaking.

Concrete decks and other unformed concrete surfaces to be waterproofed shall have a wood float finish. All concrete surfaces to be waterproofed shall cure for not less than seven (7) days before waterproofing application.

Steel or concrete deck surfaces to be waterproofed shall be clean, dry, smooth and free of fins, sharp edges, and loose material. Grinders shall be used, if necessary, to remove protrusions that would puncture waterproofing membrane. The surfaces shall be free of such contaminants as form release agents, wax base curing compounds, oil and grease; if these contaminants are present, they shall be removed by abrasive blast cleaning. There shall be no depressions or pockets in horizontal surfaces of finished waterproofing.

Unless otherwise required, expansion joints and other grooves shall be filled with plastic cement conforming to these specifications. Joints shall be dry and clean when filled. They shall be overfilled slightly to allow for shrinkage in drying.

The area to be waterproofed shall be thoroughly swept, vacuumed or air blown to remove all dust, dirt and loose foreign material. After the

deck is clean, it shall be maintained in a clean condition until completion of

waterproofing.

After the deck waterproofing work has started, no vehicular or equipment traffic shall be allowed on the bridge until after the work is complete and an adequate ballast cushion has been placed on the deck. The waterproofing shall be protected against damage from any source.

When asphalt waterproofing is shown on the plans as a protection for back of abutments, retaining walls or footings, asphalt for mopping below ground shall be used unless otherwise specified. Asphalt waterproofing on bridge decks shall be asphalt for mopping above ground.

(2) Type 1. Type 1 waterproofing shall not be applied in wet weather, or when the ambient temperature is below 10 °C. The rubber membrane shall be free from punctures, pockets or folds.

The membrane shall be turned into drainage holes and castings without break. Special care shall be taken to make the waterproofing effective along the sides and ends of members to be waterproofed.

Expansion joints and other grooves shall be filled with plastic cement conforming to these specifications. Joints and grooves shall be dried and cleaned immediately before filling and shall be overfilled slightly to allow for shrinkage in drying.

The butyl membrane shall be installed by first applying the adhesive as recommended by the butyl rubber membrane manufacturer to the surface to be waterproofed and at necessary splices in a solid area extending from the edges back about one (1) meter. Apply the butyl rubber membrane. Press the membrane firmly and uniformly in place against the previously applied adhesive. Avoid wrinkles and buckles. All splices, laps and flashing shall be made in accordance with the butyl rubber manufacturer's recommended procedures.

(3) Type 2. When Type 2 waterproofing is specified, the asphalt primer shall be in place at least 24 hours and shall be dry prior to the asphalt mopping. The primer shall be well worked in to give a uniform coating. To provide uniform coating, the asphalt for mopping shall be heated in kettles equipped with armored thermometers, but shall not be heated above 175 °C. While being heated the asphalt shall be stirred

frequently. The mop coating shall require not less than 1.6 liters per square meter of surface. If imperfections appear in the coating additional coatings shall be applied until the imperfections are corrected.

(4) Type 3. When Type 3 waterproofing is specified, the asphalt primer shall be in place at least 24 hours and shall be dry prior to the first asphalt mopping. The primer shall be well worked in to give a uniform coating. To provide uniform coating, the asphalt for mopping shall be heated in kettles equipped with armored thermometers, but shall not be heated above 175 °C. While being heated the asphalt shall be stirred frequently. Minimum coverage for each mop coating shall be 1.6 liters per square meter of surface. If imperfections appear in the coating, additional coatings shall be applied until the imperfections are corrected.

At construction joints, the surfaces to be waterproofed shall be mopped in sections. While the first mopping of asphalt is still hot, a strip of cotton fabric 375 millimeters wide shall be laid on the mopping and pressed into place. Each mopping thereafter shall be so applied that it will completely cover and seal the cotton fabric. End laps of the cotton fabric shall be not less than 300 millimeters.

(5) Type 4. Type 4 waterproofing shall be applied in the following manner:

Unwrap the roll and press the adhesive surface into contact with the concrete, horizontally, secure the free end, then unroll slowly, using hand pressure to smooth the membrane in place and help make a tight bond with the concrete. Adjacent strips shall be overlapped a minimum of 25 millimeters over the previously laid strip. Backfilling may be started as soon as the initial horizontal strip has been applied.

(6) Type 5. Type 5 waterproofing shall be applied in two (2) coats to produce a minimum cured film thickness of 1.5 millimeters. Unless otherwise shown on the plans, the application may be made using a roller, squeegee, brush or spray equipment. Application of the second coat shall be made within 16 hours after the initial coat. The manufacturer's instructions shall be followed with regard to the maximum time allowed between coats and any treatment of the initial coat required if this maximum time should be exceeded. Ambient temperature at the time of application of the waterproofing shall be not less than 5 °C.

458.4

Backfilling shall not commence until the second coat of waterproofing has cured sufficiently to prevent damage by the backfilling operation.

(7) Type 6. Type 6 waterproofing shall be applied by first applying the

primer at a rate of 0.4 liter per square meter of surface, or at the rate recommended by the manufacturer, and allowing it to dry to a tacky surface before placing the waterproofing membrane.

The primer and waterproofing membrane board panels shall be applied only when the substrate temperatures are above 10 °C.

All joints shall be sealed by centering the 150 millimeters gusset tape over the joint and pressing firmly into position. The panels and jointing tape must be rolled in with sufficient pressure to assure maximum adhesion, conformance to substrate and elimination of air bubbles. The manufacturer's recommendations for installation shall also be considered.

Backfilling should begin as soon as the application of Type 6 waterproofing is completed and accomplished within 48 hours after the material is applied to a nonhorizontal surface.

(8) Type RR-1. Type RR-1 waterproofing shall be applied to dry surfaces and when the ambient temperature is above 10 °C. The rubber membrane shall be free from punctures, pockets or folds.

The membrane shall be turned into drainage castings without break. Special care shall be taken to make the waterproofing effective along the sides and ends of girders and at stiffeners, gussets, etc. Grooves shall be filled with plastic cement.

The butyl membrane shall be installed by first applying the adhesive as recommended by the butyl rubber membrane manufacturer to ballast retainers, ends of deck and at necessary splices in a solid area extending from the edges back about one (1) meter. Apply the butyl rubber membrane. Press the membrane firmly and uniformly in place against the previously applied adhesive. Avoid wrinkles and buckles. All splices, laps and flashing shall be made in accordance with the butyl rubber manufacturer's recommended procedures.

As soon as practicable after membrane placement, its protective cover shall be placed. The membrane surface shall be cleaned of all dirt and other foreign material just prior to placing the cover material. A coating of cold asphalt emulsion shall be applied over the butyl rubber membrane at the minimum rate of 1.6 liters per square meter of surface and the asphalt plank or mat placed thereon.

The minimum thickness of protection shall be 25 millimeters and shall consist of asphalt plank or asphalt mat laid as provided hereafter. As successive planks are laid, the edges and ends of adjacent planks already laid shall be coated heavily with cold asphalt emulsion. The planks shall be laid tight against those previously laid so that the emulsion will completely fill the joints and be squeezed out the top. After all planks have been laid, any joints not completely full shall be filled with emulsion. When two (2) layers of planks are used to obtain the required 25 millimeters cover thickness, the vertical joints of the second layer shall be offset not less than 100 millimeters transversely and 300 millimeters longitudinally from the joints in the lower layer.

Asphalt mat protection shall be applied in the same manner, except that the longitudinal butt joints in a single layer shall be staggered approximately 600 millimeters. When more than one (1) thickness of asphalt mat is required, the same procedure shall be followed with all vertical joints offset at least 300 millimeters. A follow-up coating of asphalt emulsion approximately 150 millimeters in width shall be placed over all joints of the top layer.

Where deck waterproofing is carried over the back wall and down the back of the abutment for only several feet for the purpose of providing a proper flashing for the deck waterproofing, "Above Ground" moppings of asphalt as defined in Departmental Material Specification D-9-6300 shall be used.

(9) Type RR-2. Type RR-2 waterproofing shall not be done when ambient, substrate or material temperatures are below 5 °C or above 40 °C; or when wet or damp surfaces will restrict the full bonding of materials.

Primer shall be applied to concrete decks with a brush or roller at a rate of one (1) liter per 6.25 to 8.5 square meters of surface until the surface is completely coated. Primer shall dry one (1) hour or more, until

tack-free, prior to application of membrane. If not covered with membranes within 36 hours, the surface shall be reprimed.

Steel decks shall not be primed.

Construction and control joints shall be covered by 1.6 millimeters thick galvanized sheet metal, of the width shown on the plans, centered on the joint. Joints in sheet metal shall be lapped 50 millimeters and corners of sheet metal shall be rounded to a 13 millimeters radius.

An inverted strip of membrane (plastic side down), 150 millimeters wider than the sheet metal, shall be centered over the sheet metal and the joint. This shall then be covered with a full width of membrane placed rubberized-asphalt side down and centered on the joint prior to placing membrane over the entire deck surface.

Inside corners shall be filled with a 13 millimeters fillet of mastic.

All inside and outside corners shall receive an initial 300 millimeters wide strip of membrane placed rubberized-asphalt side down and centered along the axis of the corner.

Membrane shall be laid with laps parallel to the long direction of the deck. If there is a deck slope normal to the laps, membrane shall be laid from the low point to the high point across the fall line so that the laps shed water as do shingles on a roof. Membrane shall be rolled onto the surface using care to eliminate any wrinkles or air spaces so that a smooth surface results. Succeeding strips of membrane shall be laid with a minimum 65 millimeters side and end overlap.

The 65 millimeters overlap shall be rolled down firmly and completely using a rubberized wheel-type roller weighing approximately 45 kilograms.

Membrane applied to sloping or vertical surfaces shall be rolled down firmly over the entire areas covered.

The outside edges of membrane shall be rolled as specified above and shall be finished with a trowelled bead of mastic.

Areas within 150 millimeters of drains and protrusions shall receive a double layer of membrane. Mastic shall be liberally applied to the seams and the contact area between the membrane and drain or protrusion.

A careful inspection of the membrane shall be made and any holes, tears, misaligned or wrinkled seams or other discontinuities shall be patched with a piece of membrane extending at least 65 millimeters beyond the imperfection.

Membrane protection shall be placed as soon as possible after completion of the membrane application, but not more than five (5) days later.

Semi-mastic shall be used to bond asphaltic panels together and to the membrane. The bond coat shall be applied with a brush at a rate of 0.8 liter per square meter to completely coat the surface. Asphaltic panels shall be placed while the bond coat is still tacky.

The first layer of asphaltic panels on the horizontal surface shall be laid on the bond coat with joints staggered not less than 450 millimeters, another bond coat, as specified in the preceding paragraph, shall be applied filling all joints in the asphaltic panels, and a second layer of asphaltic panels shall be laid with joints staggered not less than 450 millimeters from the joints in the first layer. Following application of the bond coat, one (1) layer of asphaltic panels shall then be placed and rolled firmly on any sloping or vertical surfaces. All joints in asphaltic panels shall be laid tight and shall be completely sealed with semi-mastic at the completion of the work.

Asphaltic weathercoating shall be flowed on the exterior top surface of the protection course. This coating shall be rivuleted in surface, shall be of sufficient thickness to provide complete dimensional stability to the material when stored outdoors in direct sunlight. A suitable bond breaking film or coating shall be applied, to function as a release sheet. During installation, the asphalt-saturated felt side shall be placed against the membrane waterproofing; the side with the bond breaking film or coating shall be exposed to the ballast rock.

(10) Type RR-3. Type RR-3 waterproofing shall not be placed when ambient, substrate or material temperatures are below 5 °C or when wet or damp surfaces will restrict the full bonding of materials.

Primer shall be applied to concrete decks with a brush or roller at a rate

of 0.4 liter per square meter until the surface is completely coated. Primer shall dry one (1) hour or more, until tack-free, prior to application of membrane. If not covered with membrane within 36 hours, the surface shall be reprimed.

Steel decks shall not be primed.

Construction, expansion and control joints of the deck shall be covered by galvanized sheet metal having a nominal thickness of 1.6 millimeters, of the width shown on the plans, centered on the joint. Joints in sheet metal shall be lapped 50 millimeters and corners of sheet metal shall be rounded to a 13 millimeters radius.

An inverted strip of membrane (board side down), 150 millimeters wider than the sheet metal, shall be centered over the sheet metal and the joint. This shall then be covered with a full width of membrane, placed rubberized-asphalt side down, centered on the joint prior to placing membrane over the entire deck surface.

Inside corners shall be filled with a 13 millimeters fillet of mastic.

All inside and outside corners shall receive an initial 300 millimeter wide strip of membrane placed rubberized-asphalt side down and centered along the axis of the corner.

Strips of membrane shall be butt-jointed parallel to the long direction of deck, with 150 millimeter gusset tape provided by the membrane manufacturer, applied directly over the joint.

Membrane and gusset-taped joints shall be rolled down firmly onto the surface over the entire area covered, including any sloping or vertical surfaces. Care in the rolling shall be used to eliminate any wrinkles or air spaces so that a smooth surface results.

Rolling shall be accomplished using a rubberized wheel-type roller weighing approximately 45 kilograms.

Outside edges of membrane shall be rolled and shall be finished with a trowelled bead of mastic including the contact area between the membrane and a drain or protrusion.

458.5 to 460.1

A careful inspection of the membrane shall be made and any holes, tears, misaligned or wrinkled seams or other discontinuities shall be patched with a piece of membrane extending at least 65 millimeters beyond the imperfection.

458.5. Measurement. When shown on the plans to be a pay item, this Item will be measured by the square meter of waterproofing, complete in place.

458.6. Payment. The work performed, materials furnished and all labor, tools, equipment and incidentals necessary to complete the work under this Item will not be paid for directly, but will be considered subsidiary to the various bid items of the contract, unless this Item is specified as a pay item in the contract.

When waterproofing is specified as a pay item, the work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Waterproofing", of the type specified. This price shall be full compensation for furnishing all materials, labor, tools, equipment and incidentals necessary to complete the work.

Waterproofing for retaining walls will not be paid for directly but will be considered subsidiary to Item 423, "Retaining Wall".

ITEM 460

CORRUGATED METAL PIPE

460.1. Description. This Item shall govern for the furnishing and installing of all corrugated metal pipe and/or materials for constructing corrugated metal pipe culverts or corrugated metal sewer mains, laterals, stubs and inlet leads. The pipes shall be of the sizes, types, design and dimensions shown on the plans and shall include all connections and joints to new or existing pipes, sewer, manholes, inlets, headwalls and other appurtenances as may be required to complete the work.

460.2. Materials. Unless otherwise specified on the plans or herein, corrugated metal pipe may be galvanized steel, aluminized steel, aluminum or precoated galvanized steel conforming to the following:

Galvanized Steel	AASHTO M218
Aluminized Steel	AASHTO M274
Aluminum	AASHTO M197
Precoated Galvanized Steel	AASHTO M246

Corrugated metal pipe for sewers shall be Type IA and the smooth liner shall be polymer coated with a minimum thickness of 250 micrometers on each side. The outer liner shall be galvanized, unless otherwise shown on the plans.

Where reference is made to thickness of metal, the reference is to U. S. Standard Gage for uncoated sheets. Tables in AASHTO M218 and AASHTO M274 list thicknesses for coated sheets in millimeters. Tables in AASHTO M197 list thicknesses in millimeters for clad aluminum sheets.

Sampling and testing of metal sheets and coils used for corrugated metal pipe shall be in accordance with Test Method Tex-708-I.

Damaged galvanized coating shall be repaired in accordance with Item 445, "Galvanizing".

Damaged aluminized and/or polymer coating shall be repaired in accordance with the manufacturer's recommendations.

460.3. Fabrication. Corrugated metal pipe of all types may be fabricated with annular corrugations, lap joint construction with riveted seams or may be fabricated with helical lock seams. Steel corrugated metal pipe may also be fabricated with resistance spot welded seams or helical continuous welded seams. All corrugated metal pipe shall be Type I (circular), Type IA (circular, smooth-lined) or Type II (arch) as specified on the plans.

(1) Steel Pipe. Galvanized or aluminized steel pipe shall conform to the requirements of AASHTO M36.

(2) Aluminum Pipe. Aluminum pipe shall conform to the requirements of AASHTO M196.

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(3) Precoated Galvanized Steel Pipe. Precoated galvanized steel pipe shall conform to the requirements of AASHTO M245. Unless otherwise noted on the plans, both the inside and outside coating shall be a minimum thickness of 250 micrometers.

460.4. Selection of Thicknesses. The plans will provide a summary indicating the location and length for all pipe. For full circle pipe, the diameter, permissible corrugations and required thickness will be shown. Pipe arch design size and permissible corrugations will be shown on the plans. The shape and minimum thickness for pipe arch shall be as designated in Tables A, B or C for the specified design size and corrugation for steel pipe, and in Table D for aluminum pipe.

All dimensions are measured from the inside crests of the corrugations. A tolerance of plus or minus 25 millimeters or two (2) percent of the equivalent circular diameter, whichever is greater, will be permissible in span and rise.

Table A
STEEL PIPE ARCH
68 MILLIMETERS BY 13 MILLIMETERS CORRUGATIONS
H-20 LOADING

Design Size	Span mm	Rise mm	Minimum Cover mm*	Minimum Wall Thickness Required mm	Coated Thickness mm	Equivalent Diameter Full Circle Pipe mm
1	425	325	300	1.6	1.6	375
2	525	375	300	1.6	1.6	450
3	700	500	300	1.6	1.6	600
4	875	600	300	1.6	1.6	750
5	1050	725	300	2.0	2.0	900
6	1225	825	300	2.0	2.0	1050
7	1425	950	300	2.8	2.8	1200
8	1600	1075	300	2.8	2.8	1350
9	1775	1175	300	3.5	3.5	1500

* The fill heights for all sizes of pipe arch are limited to a maximum of two (2) meters.

460.4

Table B
STEEL PIPE ARCH
75 MILLIMETERS BY 25 MILLIMETERS CORRUGATIONS

H-20 LOADING

Design Size	Span mm	Rise mm	Minimum Cover mm*	Minimum Wall Thickness Required mm	Coated Thickness mm	Equivalent Diameter Full Circle Pipe mm
7	1325	1025	300	2.0	2.0	1200
8	1500	1150	300	2.0	2.0	1350
9	1650	1275	300	2.0	2.0	1500
10	1825	1375	300	2.0	2.0	1650
11	2025	1475	300	2.0	2.0	1800
12	2175	1575	300	2.0	2.0	1950
13	2375	1675	300	2.8	2.8	2100
14	2575	1775	450	2.8	2.8	2250
15	2800	1875	450	2.8	2.8	2400
16	2925	1975	450	2.8	2.8	2550
17	3200	2075	600	3.5	3.5	2700
18	3425	2175	600	3.5	3.5	2850
19	3550	2275	600	3.5	3.5	3000

* The fill heights for all sizes of pipe arch are limited to a maximum of three (3) meters.

Table C
STEEL PIPE ARCH
125 MILLIMETERS BY 25 MILLIMETERS CORRUGATIONS
H-20 LOADING

Design Size	Span mm	Rise mm	Minimum Cover mm*	Minimum Wall Thickness Required mm	Coated Thickness mm	Equivalent Diameter Full Circle Pipe mm
11	2025	1475	300	2.8	2.8	1800
12	2175	1575	300	2.8	2.8	1950
13	2375	1675	300	2.8	2.8	2100
14	2575	1775	450	2.8	2.8	2250
15	2800	1875	450	2.8	2.8	2400
16	2925	1975	450	2.8	2.8	2550
17	3200	2075	600	3.5	3.5	2700
18	3425	2175	600	3.5	3.5	2850
19	3550	2275	600	3.5	3.5	3000

* The fill heights for all sizes of pipe arch are limited to a maximum of three (3) meters.

Table D
ALUMINUM PIPE ARCH
68 MILLIMETERS BY 13 MILLIMETERS CORRUGATIONS
H-20 LOADING

Design Size	Span mm	Rise mm	Minimum Cover mm*	Minimum Wall Thickness Required mm	Sheet Thickness mm	Equivalent Diameter Full Circle Pipe mm
1	425	325	300	1.6	1.5	375
2	525	375	300	1.6	1.5	450
3	700	500	300	2.0	1.9	600
4	875	600	300	2.0	1.9	750
5	1050	725	450	2.8	2.7	900
6	1225	825	450	2.8	2.7	1050
7	1425	950	450	3.5	3.4	1200
8	1600	1075	450	3.5	3.4	1350
9	1775	1175	450	4.3	4.2	1500

* The fill heights for all sizes of pipe arch are limited to a maximum of two (2) meters.

460.5. Coupling Bands. Except as otherwise required herein, coupling bands and other hardware for galvanized or aluminized steel pipe shall conform to the requirements of AASHTO M36 for steel pipe and AASHTO M196 for aluminum pipe. Field joints for each type of corrugated metal pipe shall maintain pipe alignment during construction and prevent infiltration of side material during the life of the installation.

Coupling bands shall be not more than three nominal sheet thicknesses lighter than the thickness of the pipe to be connected and in no case lighter than 1.32 millimeters for steel or 1.22 millimeters for aluminum.

Coupling bands shall be made of the same base metal and coating as the pipe.

Coupling bands shall lap equally on each of the pipes being connected to form a tightly closed joint after installation.

Coupling bands with annular corrugations shall be used only with pipe with annular corrugations, or helical pipe in which the ends have been rerolled to form annular corrugations. The corrugations in the band shall have the same dimensions as the corrugations in the pipe end, or may be of a special design to engage only the first or second corrugation from the end of each pipe. The band may also include a U-shaped channel to accommodate upturned flanges on the pipe.

Helical pipe without annular end corrugations will be permitted only when it is necessary to join a new pipe to an existing pipe having helical end corrugations. Pipe furnished with helical end corrugations shall be field joined with either helically corrugated bands or with bands with projections (dimples).

Coupling bands with projections (dimples) may be used with pipe having either annular or helical corrugations. The bands shall be formed with the projections in annular rows with one projection for each corrugation of helical pipe. Bands 265 or 300 millimeters wide shall have two (2) annular rows of projections and bands 415 or 560 millimeters wide shall have four (4) annular rows of projections.

The coupling band width shall not be less than as shown in Table E. The bands shall be connected in a manner approved by the Engineer with suitable galvanized devices such as angles, integrally or separately formed and attached flanges, bolted with galvanized bolts and nuts; bars and straps; wedge lock and straps or lugs. Other types of coupling systems designated in AASHTO M36 may be used, when authorized by the Engineer.

Table E
COUPLING BAND WIDTH REQUIREMENTS

Nominal	Nominal	Coupling Band Width, millimeters, min.		
Corrugation Size* Millimeters	Pipe Inside Diameter** (Millimeters)	Annular Corrugated Bands	Helically Corrugated Bands	Bands With Projections
68 by 13	300 to 900	180	300	265
	1000 to 1800	265	300	265
	2000 to 2200***	265	300	415
75 by 25	900 to 1800	300	350	265
	2000 to 3000	300	350	415
125 by 25	900 to 1800	500	560	300
	2000 to 3000	500	560	560

*For helically corrugated pipe with rerolled ends, the nominal size refers to the dimensions of the end corrugations in the pipe.

**Equivalent circular diameter for Type II pipe.

***Diameter through 3000 millimeters for annular corrugated bands used on rerolled ends of helically corrugated pipe.

The minimum diameter of bolts for coupling bands shall be M10 bolt for pipe diameters 450 millimeters and less and M12 bolt for pipe diameters 500 millimeters and greater. Bands 300 millimeters wide or less will have a minimum of two (2) bolts, and bands greater than 300 millimeters wide shall have a minimum of three (3) bolts.

Galvanized bolts, nuts, washers, angles and other hardware shall be galvanized in accordance with Item 445, "Galvanizing".

460.6. Designation of Type. The types of pipe will be indicated on the plans by the following descriptions:

Pipe Type: CMP or CMP ARCH

Type of Material: (Galvanized Steel, Aluminum Coated or Aluminum)

Pipe Coating: (Bituminous Coated or Polymer Coated)

Special Requirements: (Paved Invert or Smooth Lining)

Pipe Size: (Diameter or Design No.)

When designated as Corrugated Metal Pipe without a type or coating designation, the Contractor may furnish any of the above types.

460.7. Protective Coating.

(1) Bituminous Coated. Bituminous coated pipe or pipe arch shall conform to this specification both as to base metal and fabrication, and shall be coated inside and out with a bituminous coating meeting the requirements herein and in AASHTO M190. The pipe shall be uniformly coated inside and out to a minimum thickness of 1.3 millimeters, measured on the crests of the corrugations.

When specified as smooth lining, the pipe shall receive additional bituminous material applied to the full inner circumference, to form a smooth inside lining, with a minimum thickness of five (5) millimeters above the crest of the corrugations.

The bituminous coating shall tightly adhere to the metal; shall not chip off in handling; and shall protect the pipe from deterioration as evidenced by samples prepared from the coating material successfully meeting the Shock Test and Flow Test in accordance with Test Method Tex-522-C.

(2) Paved Invert. When a paved invert is specified, the pipe or pipe arch, in addition to the fully coated treatment described above, shall receive additional bituminous material, of the same specification as above, applied to the bottom quarter of the interior surface to form a smooth pavement with a minimum thickness of five (5) millimeters above the interior crests of the corrugations.

460.8. Construction Methods. The location of private driveway and side road pipe shall be constructed at locations shown on the plans or as directed by the Engineer.

Corrugated metal pipe shall be installed in accordance with the plans and requirements herein.

(1) Excavation. All excavation shall be in accordance with the requirements of Item 400, "Excavation and Backfill for Structures", except where tunneling or jacking methods are shown on the plans or permitted by the Engineer.

(2) Shaping and Bedding. All shaping and bedding shall be in accordance with Item 400, "Excavation and Backfill for Structures".

Cement stabilized materials for bedding or backfill will not be permitted to come into contact with any uncoated aluminum or aluminized pipe surface.

(3) Laying Pipe. Unless otherwise authorized by the Engineer, the laying of pipes on the bedding shall be started at the outlet end, the separate sections firmly joined together, outside laps of annular joints pointing upstream and longitudinal laps on the sides. Any metal in joints which is not protected by galvanizing or aluminizing shall be coated with a suitable asphaltum paint. Proper facilities shall be provided for hoisting and lowering the sections of pipe into the trench without damaging the pipe or disturbing the bedding and the sides of the trench. Any pipe which is not in alignment or which shows any undue settlement after laying shall be taken up and relaid without extra compensation.

Multiple installation of corrugated metal pipe and pipe arches shall be laid with the center lines of individual barrels parallel. Unless otherwise indicated on the plans, the following clear distances between outer surfaces of adjacent pipes shall be maintained:

Diameter of Pipe	Clear Distance Between Pipes Full Circle and Pipe Arch	Pipe Arch Design No.
450 mm	360 mm	2
600 mm	430 mm	3
750 mm	510 mm	4
900 mm	580 mm	5
1050 mm	660 mm	6
1200 mm	740 mm	7
1350 mm	860 mm	8
1500 mm - 2100 mm	970 mm	9
2250 mm - 3000 mm	1040 mm	10 & over

(4) Culvert Connections. Where new structures are constructed as extensions to structures in place or are joined to existing structures, the construction shall include all work necessary to provide a proper connection between the new structure and the existing structure as indicated on the plans, including coating of the connection with bituminous material when required.

(5) Reuse of Existing Appurtenances. When existing appurtenances are specified on the plans for reuse, the portion to be reused shall be severed from the existing culvert and moved to the new position previously prepared, by approved methods.

Connections shall conform to the requirements for joining sections of pipes as indicated herein or as shown on the plans. Any headwalls and any aprons or pipe attached to the headwall that are damaged during moving operations shall be restored to their original condition at the Contractor's expense. The Contractor, if he so desires, may remove and dispose of the existing headwalls and aprons and construct new headwalls at his own expense, in accordance with the pertinent specifications and design indicated on the plans or as furnished by the Engineer.

(6) Sewer Connections and Stub Ends. Connections of pipe sewer to existing sewers or sewer appurtenances shall be as shown on the plans or as directed by the Engineer. Portions of aluminum pipe that are to be in contact with concrete or metal other than aluminum shall be insulated from these materials by a coating of bituminous material meeting the performance requirements set forth in Article 460.7. The coating applied to the pipe or pipe arch to provide an insulation between the aluminum and other material shall extend a minimum distance of 0.3 meter beyond the area of contact. The bottom of the existing structure shall be mortared or concreted if necessary, to eliminate any drainage pockets created by the new connection. Where the sewer is connected into existing structures which are to remain in service, any damage to the existing structure resulting from making the connection shall be restored by the Contractor to the satisfaction of the Engineer. Stub ends, for connections to future work not shown on the plans, shall be sealed by installing watertight plugs into the free end of the pipe.

(7) Backfilling. Backfilling for the metal pipe structure is a critical phase of the construction and shall be in accordance with Item 400, "Excavation and Backfill for Structures". Special emphasis is placed upon the need for obtaining uniform backfill material and uniform compacted density throughout the length of the structure so that equal pressure will be provided. Care is to be taken to insure proper backfill under the structure.

(8) Protection of Pipe. Unless otherwise shown on the plans or permitted in writing by the Engineer, no heavy earth moving equipment will be permitted to haul over the structure until a minimum of 1.2 meters of compacted fill (permanent or temporary) has been placed over the top of the structure.

Prior to adding each new layer of loose backfill material, until a minimum of 300 millimeters of cover is obtained, an inspection will be made of the inside periphery of the structure for local or unequal deformation caused by improper construction methods. Evidence of such will be reason for such corrective measures as may be directed by the Engineer.

Pipe damaged by the Contractor shall be removed and replaced by the Contractor at no additional cost to the State.

460.9. Measurement. This Item will be measured by the meter. Such measurements will be made between the ends of the barrel along its flow line, exclusive of safety end treatments. Safety end treatments shall be measured in accordance with Item 467, "Safety End Treatment". Where spurs, branches or connections to existing pipe lines are involved, measurement of the spur or new connecting pipe will be made from the intersection of its flow line with the outside surface of the pipe into which it connects. Where inlets, headwalls, catch basins, manholes, junction chambers, or other structures are included in lines of pipe, that length of pipe tying into the structure wall will be included for measurement but no other portion of the structure length or width will be so included.

For multiple pipes, the measured length will be the sum of the lengths of the barrels, measured as prescribed above.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

460.10. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Corrugated Metal Pipe", "Corrugated Metal Pipe Arch", "Corrugated Metal Pipe (Sewer)" or "Corrugated Metal Pipe Arch (Sewer)" of the type, size and coating specified. This price shall be full compensation for furnishing, hauling, placing and joining of pipes; for all connections to new or existing structures; for moving and reusing headwalls where required; for removing and disposing of portions of existing structures as required; for cutting of pipe ends on skew or slope; and for all labor, tools, equipment and incidentals necessary to complete the work.

Excavation, bedding and backfill will be paid for in accordance with Item 400, "Excavation and Backfill for Structures".

ITEM 461

STRUCTURAL PLATE STRUCTURES

461.1. Description. This Item shall govern for the furnishing and installing of structural plate pipes, pipe arches, arches, underpasses, box culverts and special shapes conforming to these specifications, of the sizes, dimensions and materials shown on the plans, at the locations shown on the plans or designated by the Engineer and in conformance with established lines and grades.

461.2. Materials. All materials shall conform to the pertinent requirements of the following items:

Item 420, "Concrete Structures"
Item 421, "Portland Cement Concrete"
Item 432, "Riprap"
Item 440, "Reinforcing Steel"
Item 442, "Metal for Structures"
Item 445, "Galvanizing"
Item 447, "Structural Bolting"

Galvanized steel plates shall conform to AASHTO M167 and aluminum plates shall conform to AASHTO M219.

Unless otherwise shown on the plans, Class A concrete shall be used for footings and headwalls and Class B concrete shall be used for riprap slope protection and invert paving, when required.

461.3. Design.

(1) Minimum Thickness and Corrugations for Structural Plate. Minimum thickness and permissible corrugations of metal plates to be furnished for each structure will be shown on the plans.

(2) Skewed Structures. The end skew shall not exceed 45 degrees. When the skew of arches is more than 15 degrees, the length of the structure shall be such that no portion of the live load will be carried by the cut portion of the arch end. Where right of way or other conditions do not permit the required length, the cut end shall be supported by a rigid headwall designed to meet the conditions. When the skew angle of a structure exceeds 20 degrees, and the structure has the ends cut to fit a slope, the ends shall be reinforced with concrete riprap or other suitable end **461.4**

treatment as shown on the plans or as directed by the Engineer. If headwalls are required, the plates shall be anchored to the headwall with not less than M20 bolt

by 150 millimeters minimum length bolts, at not over 480 millimeter centers. If structures are to have skewed ends, bevels, step-bevels or other special end treatment, this information will be shown on the plans.

(3) Multiple Structures Installed in Parallel Lines. Where multiple lines of pipes, pipe arches or box culverts greater than 1200 millimeters in diameter or span are used, they shall be spaced so that adjacent sides of the structure shall be at least one-half diameter or one (1) meter apart, whichever is less, to permit adequate compaction of backfill material. For diameters up to and including 1200 millimeters, the minimum spacing shall be not less than 600 millimeters.

(4) Substructure for Arches. The substructure for structural plate arches shall be as shown on the plans.

461.4. Fabrication.

(1) Plates. The plates and fasteners used for construction of structural plate pipes, pipe arches, arches, underpasses, box culverts and special shapes shall conform to AASHTO M167 for galvanized corrugated steel structures, and to AASHTO M219 for aluminum alloy structures.

Steel plates shall consist of structural units of corrugated galvanized metal. Single plates shall be furnished in standard sizes to permit structure length increments of 0.6 meter. Plates will have approximately a 50 millimeters lip beyond each end crest, which results in the actual length of a given structure being approximately 100 millimeters longer than the nominal length, except when skewed or beveled. Footings for arches shall be designed and constructed to accommodate this additional length.

Aluminum plates shall consist of structural units of corrugated aluminum alloy. For aluminum alloy structures, cut plates shall be furnished on structure ends to permit structure length increments of 0.3 meter.

Plates shall be formed to provide bolted lap joints. The bolt holes shall be punched so that all plates having like dimensions, curvature, and the same number of bolts per 0.3 meter of seam shall be interchangeable. Each plate shall be curved to the proper radius so that the cross-sectional dimensions of the finished structure shall be as shown on the plans. Joints **461.5**

shall be staggered so that not more than three (3) plates are jointed at any one point. Unless otherwise specified, bolt holes along those edges of the plates that will form longitudinal seams in the finished structure shall be (a) staggered in

rows 50 millimeters apart, with one row in the valley and one in the crest of the corrugations and not less than 12 bolts per meter for galvanized steel structures or (b) in rows 45 millimeters apart with two (2) bolts in each valley and on each crest and not less than 16 bolts per meter
for aluminum alloy structures. Bolt holes along those edges of the plates that will form circumferential seams in the finished structure shall provide for a bolt spacing of not more than 300 millimeters. The minimum distance from center of hole to edge of plate shall be not less than 1-3/4 times the diameter of the bolt. The diameter of the bolt holes in the longitudinal seams shall not exceed the diameter of the bolt by more than five (5) millimeters. Plates for forming skewed or sloped ends shall be cut so as to give the angle of skew or slope specified. Burned edges shall be free from oxide and burrs and shall present a finish satisfactory to the Engineer. Legible identification numerals shall be placed on each plate to designate its proper position in the finished structure.

(2) Metal Headwalls. Metal headwalls shall comply with the details shown on the plans.

(3) Miscellaneous Aluminum. When required, aluminum alloy inverts, toe walls, footings and closure plates shall be fabricated in accordance with the requirements for aluminum structural plate structures.

(4) Certifications. The Contractor shall furnish an itemized statement of the number and size of plates in each shipment and erection drawings showing the position of the plates in the structure. The fabricator shall furnish copies of mill test reports stating physical and chemical properties of the base metal and, if galvanized, a Galvanizing Certificate indicating compliance with this Item. When deemed necessary by the Engineer, samples of the plates may be taken in accordance with Test Method Tex-708-I.

461.5. Designation of Type. The type(s) of structure will be indicated on the plans by the following descriptions:

Structure Type: Structural Plate Pipe, Structural Plate Pipe Arch, Structural Plate Arch, Structural Plate Underpass or Structural Plate Box Culvert.

Type of Material: (Galvanized Steel or Aluminum)
Structure Size: (Diameter or Horizontal and Vertical Dimensions)

When designated as one of the above structure types without the type of material being specified, the Contractor may furnish the structure in either galvanized steel or aluminum.

461.6. Construction Methods. Structural plate structures shall be constructed in accordance with the plans and to the requirements herein.

(1) Excavation. Unless otherwise required herein, all excavation shall be in accordance with the requirements of Item 400, "Excavation and Backfill for Structures".

(2) Bedding, Structural Plate Structures with Metal Inverts. Bedding for structural plate structures shall be in accordance with Item 400, "Excavation and Backfill for Structures".

(3) Foundations, Structural Plate Structures with Reinforced Concrete Footings. Footings for these structures shall be formed and finished to true lines and grades as established by the Engineer. Anchors or slots (for box culverts) shall be set to true line and grade when placing concrete for each substructure unit. The work of placing substructure units shall conform to the requirements of Item 420, "Concrete Structures" and Item 440, "Reinforcing Steel".

Footings shall be placed entirely on either (a) rock, shale or similarly hard material, or (b) firm soil or compacted soil cushion. When part of the founding area is rock, it shall be undercut and replaced with a minimum 300 millimeters thick compacted soil cushion. When a thin layer of soil is partially covering rock within the bearing area and when practical to do so, the soil shall be removed and the footings placed directly on rock in accordance with details shown on the plans.

(4) Erection. Structural plate structures shall be installed in accordance with the plans, the erection drawings and this Item.

Any steel in joints which is not protected by galvanizing shall be coated with suitable asphaltum paint.

Pipes and/or plates shall be handled carefully to avoid damage to any protective coating. Damaged coatings shall be repaired.

Anchor bolts used for anchoring plates to headwalls or other concrete end treatment shall be M20 diameter by 150 millimeters minimum length on not more than 480 millimeter centers.

No plates for arch structures shall be placed until the substructure has cured for a minimum of three (3) days.

When all plates are in position, all bolts not already in place shall be inserted and all nuts tightened progressively and uniformly, beginning at one end of the structure. All nuts shall be tightened a second time to a torque of not less than 205 newton meter nor more than 405 newton meter for steel bolts and not less than 135 newton meter nor more than 205 newton meter for aluminum bolts. If an impact wrench is used, sufficient number of bolts will be checked with a torque wrench. All service bolts used in drawing the plates together shall be replaced with standard bolts.

(5) Workmanship. Structural plates on which the galvanized coating has been damaged, or which show defective workmanship, will be rejected, except that damaged areas of galvanized coating deemed by the Engineer to be of a minor nature may be repaired in accordance with Item 445, "Galvanizing". This requirement applies not only to the individual plates but to the shipment as a whole. The presence of any of the following defects may be cause for rejection:

(a) Uneven laps
(b) Elliptical shaping (unless specified)
(c) Variation from a straight center line
(d) Ragged edges
(e) Loose, uneven lined or spaced bolts
(f) Illegible brand
(g) Bruised, scaled or broken galvanized coating
(h) Dents or bends in the metal

(6) Shape Control. The Contractor shall furnish acceptable devices for monitoring the horizontal and vertical shape of the structure(s). The shape shall be kept within two percent of design measurements (span or rise, whichever is greater), or 125 millimeters whichever is less during erection and backfilling.

(7) Backfilling. Backfilling and/or construction of the embankment around and over the structural plate structure is a critical phase of the construction and shall be performed in accordance with Item 400, "Excavation and Backfill for Structures", except as modified herein. The structure shall be backfilled so that when backfill is complete the inside dimensions shall be within the tolerances set forth above in "Shape Control". In the case of arches (does not apply to pipe arches) when backfilling is completed before headwalls are placed, the first material shall be placed midway between the ends of the arch, forming as narrow a ramp as possible until the top of the arch is reached. The ramp shall be constructed evenly from both sides, and the backfilling material shall be thoroughly compacted as it is placed. After the two ramps have been constructed to the top of the arch, the remainder of the backfill shall be deposited from the top of the arch both ways from the center, to the ends and as evenly as possible on both sides of the arch. If the headwalls are built before the arch is backfilled, the fill material shall be placed first adjacent to one headwall until the top of the arch has been reached, after which the fill shall be dumped from the top of the arch toward the other headwall, with care being taken to deposit the material evenly on both sides of the arch.

For multiple structures the same backfill phases will be performed for all structures more or less simultaneously. Backfilling between the barrels will usually require that the material be placed with a crane and bucket or other suitable equipment. Backfill material shall not be dropped from a height, or concentrated in such an amount prior to distribution over the top arc, that damage to the flexible structure will result. Compaction of this backfill shall be with hand operated tamps or other acceptable equipment.

(8) Slope Protection and Invert Paving. Slope protection and invert paving shall be in accordance with details shown on the plans and Item 432, "Riprap".

(9) Protection of Structure. Within vertical planes 0.6 meter beyond the horizontal limits of the structure and until a minimum of 0.6 meter of cover has been compacted over the structure, only hand operated, mechanical tamping equipment will be permitted.

Unless otherwise shown on the plans or permitted in writing by the Engineer, no heavy earth moving equipment will be permitted to haul over

the structure until a minimum of 1.2 meter of permanent or temporary, compacted fill has been placed thereon. Plates or structures damaged by the Contractor's equipment or backfilling operation shall be removed and replaced by the Contractor at his expense.

Prior to adding each new layer of loose backfill material, until a minimum 0.6 meter of cover is obtained, the Contractor shall check the inside periphery of the structure to determine any local or unequal deformation caused by improper construction methods.

461.7. Measurement. Structural plate pipes, pipe arches, arches, underpasses or box culverts will be measured by the meter. Such measurements will be made between the ends of the barrel along its flow line, exclusive of safety end treatments. Safety end treatments will be measured in accordance with Item 467, "Safety End Treatment".

For multiple structures, the measured length will be the sum of the lengths of the barrels, measured as prescribed above.

Aluminum alloy inverts, toe walls, footings, closure plates and stiffeners, when required, will be considered a part of the requirements of the structure, and will not be measured for payment.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

461.8. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the price bid for "Structural Plate Pipes", "Structural Plate Pipe Arches", "Structural Plate Underpasses" and "Structural Plate Box Culverts", of the size, minimum thickness, and material specified. This price will be full compensation for furnishing, transporting and erecting the structural plate structures; for all bolts, nuts, washers, anchor bolts and anchor channels or angles; for furnishing aluminum alloy inverts, toe walls, footings, closure plates and stiffeners, when required, and for all labor, tools, equipment and incidentals necessary to complete the work.

Excavation, bedding and backfill required in the construction of structural plate structures will be paid for in accordance with Item 400, "Excavation and Backfill for Structures".

ITEM 462

CONCRETE BOX CULVERTS AND SEWERS

462.1. Description. This Item shall govern for the materials furnished, and for constructing, furnishing and placing concrete box culverts and sewers at the locations shown, and in accordance with the details on the plans and this Item. Unless otherwise shown on the plans, the Contractor shall have the option of furnishing cast-in-place, precast (formed) or precast (machine-made) box culverts or sewers.

462.2. Materials. All materials shall conform to the pertinent requirements of the following items:

Item 420, "Concrete Structures"
Item 421, "Portland Cement Concrete"
Item 440, "Reinforcing Steel"
Item 464, "Reinforced Concrete Pipe"

Concrete for precast (machine-made) concrete boxes shall conform to ASTM C 789 or C 850.

When precast (machine-made) boxes are furnished and portland cement is partially replaced, blended or otherwise modified by a pozzolan, the pozzolan shall be fly ash conforming to the Departmental Materials Specification D-9-8900, "Fly Ash". Copies of Departmental Materials Specifications are available from the Texas Department of Transportation, Materials and Tests Division, 125 East 11th Street, Austin, Texas 78701-2483.

462.3. Types.

Cast-in-place concrete boxes shall conform to the details shown on the plans and to the requirements of Item 420, "Concrete Structures".

Precast (formed) concrete boxes shall conform to the details shown on the plans and the requirements of Item 424, "Precast Concrete Structures (Fabrication)".

Precast (machine-made) concrete boxes shall conform to the requirements of ASTM C 789, C 850, C 789 M or C 850 M whichever is applicable. Forms fabricated after October 1, 1996, shall conform to the requirements of ASTM C 789 M or C 850 M.

462.4. Fabrication.

(1) General. All fabrication of concrete boxes including forming, casting and curing shall conform to the following requirements:

(a) Cast-in-place concrete boxes shall be produced in accordance with Item 420, "Concrete Structures".

(b) Precast (formed) concrete boxes shall be produced in accordance with Item 424, "Precast Concrete Structures (Fabrication)".

(c) Precast (machine-made) concrete boxes shall be produced by a process which will provide for uniform placement of the concrete in the forms and compaction by mechanical devices which will assure dense concrete. Concrete shall be mixed in a central batch plant or other approved batching facility from which the quality and uniformity of the concrete can be assured. Ready-mix concrete will not be acceptable for use in precast (machine-made) concrete boxes. Curing shall be in accordance with ASTM C 789 or C 850, whichever is applicable.

(2) Testing. Test specimens for testing of cast-in-place concrete boxes sections shall be in accordance with Item 421, "Portland Cement Concrete". Test specimens for precast (formed) concrete box sections shall be in accordance with Test Method Tex 704-I. Test specimens for precast (machine-made) shall be test cylinders made at the same time and in the same manner as the box sections they represent.

For precast concrete boxes (machine-made), a minimum of four (4) test cylinders shall be made for each day's production run of each size and class of box section. Test cylinders for machine-made concrete boxes shall be cured in the same manner and for the same time as the boxes they represent.

Equipment required for testing concrete boxes produced in a precasting plant shall be furnished by the producer.

(3) Lifting Holes. For precast concrete boxes, not more than four (4) lifting holes may be provided in each section to facilitate handling. Lifting holes may be cast, cut into the fresh concrete after form removal, or drilled. Lifting holes shall be so sized as to provide for adequate lifting devices based on the size and mass of the box sections but shall not be larger than 75 millimeters in diameter. Spalled areas around the holes shall be repaired.

(4) Marking. Precast concrete boxes produced in a precasting plant shall bear the following markings:

(a) The name or trademark of the producer.

(b) The date of manufacture.

(c) The box size and height of fill.

(d) When lifting holes are not provided, one end of each box section shall be clearly marked on the inside and outside walls to indicate the top or bottom as it will be installed.

(e) When required under "Fabricating Tolerances", matchmarks shall be used for proper installation.

Markings shall be indented into the box section or may be painted thereon with waterproof paint.

(5) Fabricating Tolerances. Tolerances for precast sections of either type shall conform to the following:

The inside vertical and horizontal dimensions shall be according to ASTM C 789, C 850, C 789 M, C850 M or as shown on the plans.

The horizontal or vertical plane at each end of the box section shall not vary from perpendicular by more than 13 millimeters measured on the inside faces of the section.

The sides of a section at each end shall not vary from being perpendicular to the top and bottom by more than 13 millimeters when measured diagonally between opposite interior corners of the end section.

The thickness of walls and slabs shall not be less than that shown on the plans, except that an occasional deficiency not greater than six (6) millimeters will be acceptable. If proper jointing is not affected, thicknesses in excess of plan requirements are acceptable.

The straightness of the tongue and groove, at the mating surface shall not vary by more than six (6) millimeters.

Deviations from the above tolerances will be acceptable if the sections can be fitted at the plant or job site and it is demonstrated that an acceptable joint can be made. For this condition an acceptable joint is:

When two sections are fitted together on a flat surface, in proper alignment and in the position the sections will be installed, the joint opening at any point shall not exceed 25 millimeters. Sections fitted together at the plant and accepted in this manner shall be matchmarked for installation.

(6) Defects and Repair. Fine cracks on the surface of the member which do not extend to the plane of the nearest reinforcement will not be cause for rejection unless the cracks are numerous and extensive. Cracks which extend into the plane of the reinforcing steel shall be repaired in an approved manner.

Small damaged or honeycombed areas which are purely surface in nature shall be repaired to the satisfaction of the Engineer. Excessive damage, honeycomb or cracking will be subject to structural review. Repairs shall be sound, properly finished and cured in conformance with the pertinent specifications. When fine cracks on the surface indicate poor curing practices, further production of precast sections shall be discontinued until corrections are made and proper curing provided.

(7) Storage and Shipment. Precast sections shall be stored on level blocking in a manner acceptable to the Engineer. No load shall be placed upon the sections until design strength is reached and curing completed. Shipment of sections may be made when the design strength and curing requirements have been met.

462.5. Construction Methods. Excavation, bedding and backfill shall be in accordance with the requirements of Item 400, "Excavation and Backfill for Structures", except where tunneling or jacking methods are required or permitted by the plans.

Unless otherwise shown on the plans, the Contractor may use any of the jointing materials in accordance with the jointing requirements specified in Item 464, "Reinforced Concrete Pipe".

When precast box culverts are used to form multiple barrel structures, the box sections shall be placed in conformance with the details shown on the plans. Material to be used between barrels shall be as shown on the plans.

Connections of precast sections to cast-in-place culverts or to any required headwalls, wingwalls, riprap or other structure shall conform to the details shown on the plans.

Lifting holes shall be filled with mortar or concrete and cured to the satisfaction of the Engineer. Precast concrete or mortar plugs may be used when approved by the Engineer.

462.6. Measurement. This Item will be measured by the meter. Such measurement will be made between the ends of the culvert or sewer along the flow line, exclusive of safety end treatments. Safety end treatments shall be measured in accordance with Item 467, "Safety End Treatment". Where spurs or branches, or connections to existing structures are involved, measurement of the spur or new connection box sections will be made from the intersection of the flow line with the outside surface of the structure into which it connects. Where inlets, headwalls, catch basins, manholes, junction chambers, or other structures are included in lines of culverts or sewers that length of box section tying into the structure wall will be included for measurement but no other portion of the structure length or width will be so included.

For multiple barrel structures, the measured length will be the sum of the lengths of the barrels measured as prescribed above.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contact plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

462.7. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Concrete Box Culvert" or "Concrete Box Sewer" of the size and type specified. This price shall be full compensation for constructing, furnishing and transporting sections; for preparing and shaping of the bed; for jointing of sections; for cutting of sections on skew or slope; for connections to existing structures; for concrete, reinforcing steel and all materials, labor and equipment, tools and incidentals necessary to complete the work.

Excavation, bedding, and backfill for box culverts and sewers will be paid for in accordance with Item 400, "Excavation and Backfill for Structures".

ITEM 464

REINFORCED CONCRETE PIPE

464.1. Description. This Item shall govern for furnishing and installing all concrete pipe and materials and for constructing precast concrete pipe culverts or precast concrete sewer mains, laterals, stubs and inlet leads. The pipes shall be of the sizes, strengths and dimensions shown on the plans and shall include all connections to new or existing pipes, sewers, manholes, inlets, headwalls and other appurtenances and jointing materials as may be required to complete the work.

464.2. Materials.

(1) General. Except as modified herein, precast reinforced concrete pipe shall conform to the design shown on the plans and to ASTM C 76 or C 655 for circular pipe; ASTM C 506 for arch pipe or ASTM C 507 for horizontal elliptical pipe.

All precast concrete pipe shall be machine made or cast by a process which will provide for uniform placement of the concrete in the form and compaction by mechanical devices which will assure a dense concrete. Concrete shall be mixed in a central batch plant or other approved batching facility from which the quality and uniformity of the concrete can be assured. Transit mixed concrete will not be acceptable for use in precast concrete pipe.

Unless otherwise shown on the plans, not more than two (2) holes may be placed in the top section of precast pipe for lifting and placing. The holes may be cast, cut, or drilled in the wall of the pipe. The holes shall not exceed 75 millimeters in diameter at the inside surface of the pipe wall. Not more than one (1) longitudinal wire or two (2) circumferential wires may be cut per layer of reinforcing steel when locating lift holes in the pipe
wall. After the pipe is in place, lift holes shall be filled with concrete or mortar or precast concrete plugs to the satisfaction of the Engineer.

The Contractor has the option of using portland cement or portland cement plus fly ash. When fly ash is used, then "cement" shall also be defined as "cement plus fly ash". "Cement plus fly ash" shall be composed of portland cement of the type specified and 20 to 35 percent fly ash by absolute volume. Type B fly ash shall not be used when Type II cement is shown on the plans. When portland cement is partially replaced, blended or otherwise modified by a pozzolan, the pozzolan is defined and limited to fly ash conforming to Department Materials Specification D-9-8900, "Fly Ash".

Copies of Departmental Materials Specifications are available from the Texas Department of Transportation, Materials and Tests Division, 125 East 11th St., Austin, Texas 78701-2483.

(2) Design. Circular pipe shall be of the class or D-load shown on the plans. Regardless of the design shown, the Contractor may furnish pipe to either ASTM C 76 or ASTM C 655 specifications. Table C outlines the class and D-load equivalents. For concrete pipe arch or elliptical pipe, the minimum design shall conform to Table A or B.

TABLE A *

Arch Pipe

Design Size	Equiv. Dia. mm	Rise mm	Span mm
1	450	345	560
2	525	395	660
3	600	460	725
4	750	570	920
5	900	675	1110
6	1050	795	1300
7	1200	915	1485
8	1350	1015	1650
9	1500	1145	1855
10	1800	1370	2235

TABLE B *

Horizontal Elliptical Pipe

Design Size	Equiv. Dia. mm	Rise mm	Span mm
1	450	365	575
2	600	490	770
3	675	550	865
4	750	610	960
5	825	670	1055
6	900	730	1150
7	975	795	1250
8	1050	855	1345
9	1200	975	1535
10	1350	1095	1730

*Minimum height of cover required is 0.3 meter.
*Maximum height of cover is 2.4 meters.

TABLE C
CIRCULAR PIPE
(CLASS, D-LOAD EQUIVALENTS)

C76	C655
CLASS I	800D-LOAD
CLASS II	1000D-LOAD
CLASS III	1350D-LOAD
CLASS IV	2000D-LOAD
CLASS V	3000D-LOAD

Reinforced concrete pipe for jacking, boring or tunneling shall meet the requirements of the pertinent ASTM specification with the following additional requirements:

The pipe shall have circular reinforcement and for 750 millimeters and larger diameters shall have an additional layer of Class III reinforcement, 300 millimeters long, extending into both the tongue and groove of the joint to within 19 millimeters of the end of the tongue and the groove. The minimum wall thickness shall be wall "B" for the diameter specified, unless special designs are required. The minimum concrete compressive strength for jacking and boring pipe shall be 34 megapascal. Variations in the laying length of opposite sides shall not exceed ten (10) millimeters for pipe diameters 600 millimeters through 1500 millimeters and 13 millimeters for pipe diameters 1650 millimeters and larger. The maximum joint taper shall be seven (7) degrees for tongue and groove pipe and two (2) degrees for O-ring gasket pipe. Pipe manufactured to these additional requirements shall be marked to identify pipe for jacking and boring.

The plans will provide a summary indicating the locations and length for all pipe. In addition, the diameter, required D-load and/or class for full circle pipe, and/or the design size for pipe arch or elliptical pipe will also be shown.

(3) Physical Test Requirements. The acceptability of the pipe shall be determined by the results of the physical tests outlined herein; by appropriate material tests required in ASTM C 76, C 506, C 507, or C 655; by absorption tests on selected samples from the wall of the pipe; and by inspection of the finished pipe to determine its conformance with the required design and its freedom from defects. Three-Edge Bearing tests shall be performed on one (1) pipe for each 100 pipe or fraction thereof of each design or shape, size, class or D-load for the load to produce a 0.3 millimeter crack and, at the discretion of the Engineer, the pipe may be tested to ultimate load.

As an alternate to the Three-Edge Bearing test, concrete pipe 1500 millimeters in diameter and larger may be accepted on the basis of compressive strength of cores cut from the wall of the pipe. The manufacturer shall furnish facilities and personnel for taking the cores and determining the compressive strength of the samples. Three-Edge Bearing tests and core tests shall be in accordance with ASTM C 497.

The manufacturer shall plug and seal core holes in the pipe wall, after testing, in a manner satisfactory to the Engineer.

(4) **Marking.** The following information shall be clearly marked on each section of pipe:

(a) The class or D-load of pipe.

(b) The date of manufacture.

(c) The name or trademark of the manufacturer.

(d) One end of each section of pipe with elliptical reinforcement shall be clearly marked during the process of manufacture or immediately thereafter on the inside and the outside of opposite walls to show the location of the "top" or "bottom" of the pipe as it should be installed, unless the external shape of the pipe is such that the correct position of the top and bottom is obvious. Marking shall be indented on the pipe section or painted thereon with waterproof paint.

(e) Pipe for jacking and boring shall be identified for the intended use.

(5) **Inspection.** The quality of materials, the process of manufacture, and the finished pipe shall be subject to inspection and approval by the Engineer at the pipe manufacturing plant. In addition, the finished pipe shall be subject to further inspection by the Engineer at the project site prior to and during installation.

(6) **Causes for Rejection.** Pipe shall be subject to rejection for failure to conform to any of the specification requirements. Individual sections of pipe may be rejected because of any of the following:

(a) Fractures or cracks passing through the shell, except for a single end crack that does not exceed the depth of the joint.

(b) Defects that indicate imperfect proportioning, mixing and molding.

(c) Surface defects indicating honeycombed or open texture.

(d) Damaged ends, where such damage would prevent making a satisfactory joint.

(e) Any continuous crack having a surface width of 0.3 millimeter or more and extending for a length of 300 millimeters or more, regardless of position in the wall of the pipe.

(7) Repairs. Pipe may be repaired if necessary, because of occasional imperfections in manufacture or accidental injury during handling and will be acceptable if, in the opinion of the Engineer, the repairs are sound, properly finished and cured, and the repaired pipe conforms to the requirements of the specifications.

(8) Rejections. All rejected pipe will be plainly marked by the Engineer by painting colored spots over the Materials and Tests Division monogram on the inside wall of the pipe and on the top outside wall of the pipe. The painted spots shall be sufficient to identify the rejected pipe but no larger than 100 millimeters in diameter. Rejected pipe shall not be defaced in any other manner. The Contractor shall remove the rejected pipe from the project and replace with pipe meeting the requirements of this Item.

(9) Jointing Materials. Unless otherwise specified on the plans the Contractor shall have the option of making the joints using any of the materials described herein. For all jointing materials except mortar, the Contractor shall furnish the Engineer the Manufacturer's Certificate of Compliance.

(a) Mortar. Mortar for joints shall be in accordance with the section, "Jointing", of this Item.

(b) Cold Applied, Plastic Asphalt Sewer Joint Compound. This material shall consist of natural and/or processed asphalt base, suitable volatile solvents and inert filler. The consistency is to be such that the ends of the pipe can be coated with a layer of the compound up to 13 millimeters thick by means of a trowel. The joint compound shall cure to a firm, stiff plastic condition after application. The material shall be of a uniform mixture and any small separation occurring in the container shall be stirred to a uniform mix before use.

This material shall meet the following requirements when tested in accordance with Test Method Tex-526-C:

Asphalt Base, 100% - % Volatites - % Ash, % by mass	28-45
Volatiles, 100 °C Evaporation, 24 h, % by mass	10-26
Mineral Matter, determined as Ash, % by mass	30-55
Consistency, Cone Penetration, 150 q, 5 s, 25 °C	150-275

(c) Rubber Gaskets. These gaskets shall conform to ASTM C 361 or C443. The design of the joints and permissible variations in dimensions shall be in accordance with ASTM C 443. The Contractor shall furnish the Engineer the Manufacturer's Certificate of Analysis.

(d) Cold Applied Preformed Plastic Gaskets. Preformed plastic gaskets shall be suitable for sealing joints of tongue and groove concrete pipe. The gasket sealing the joint shall be produced from blends of refined hydrocarbon resins and plasticizing compounds reinforced with inert mineral filler and shall contain no solvents, irritating fumes or obnoxious odors. The gasket joint sealer shall not depend on oxidizing, evaporating, or chemical action for its adhesive or cohesive strength, and shall be supplied in extruded rope-form of suitable cross-section. The size of the plastic gasket joint sealer shall be in accordance with the manufacturer's recommendations and be of sufficient size to properly seal the joint. The plastic gasket joint sealer shall be so constructed as to provide evidence of proper installation either by means of "squeeze-out" of the gasket material on the inside or outside around the complete pipe joint circumference or by means of tabs, projections or other such indicators placed at established intervals around the circumference of the pipe joint. Plastic gasket joint sealers shall be Type 1 or Type 2. Type 1 gaskets shall meet the "squeeze-out" requirements and Type 2 gaskets shall meet the requirements for tabs, projections or other indicators. The gasket joint sealer shall be protected by a suitable wrapper designed that when removed, the jointing material maintains integrity.

The chemical composition of the gasket joint sealing compound for Type 1 and 2, as shipped, shall meet the following requirements:

COMPOSITION	TEST METHOD	ANALYSIS
Bitumen, Petroleum Plastic Content, % by mass	ASTM D 4	50-70
Ash-Inert Mineral Matter, % by mass	Tex-526-C	30-50
Volatile Matter, 163 °C, % by mass	Tex-506-C	2.0 max.

The gasket joint sealing compound when immersed for 30 days at ambient room temperature separately in five (5) percent solution of caustic potash; a five (5) percent solution of hydrochloric acid; a five (5) percent solution of sulfuric acid; and a saturated H_2S solution, shall show no visible deterioration.

The physical properties of the gasket joint sealing compound as shipped shall meet the following requirements:

PROPERTY	TEST METHOD	REQUIREMENT Type 1	REQUIREMENT Type 2
Ductility @ 25 °C (mm), min.	Tex-503-C	50.0	50.0
Softening Point, °C	Tex-505-C	135	135
Penetration			
0 °C (300 g) 60 s, min.	Tex-502-C	--	65
25 °C (150 g) 5 s	Tex-502-C	50-120	50-120
46 °C (150 g) 5 s, max.	Tex-502-C	--	150

464.3. Construction Methods. The location of private driveway and side road pipe shall be constructed at locations shown on the plans or as directed by the Engineer.

Reinforced concrete pipe culverts and sewers shall be constructed in accordance with the plans and requirements of this Item.

(1) Excavation. All excavation shall be in accordance with the requirements of Item 400, "Excavation and Backfill for Structures", except where tunneling or jacking methods are shown on the plans or permitted by the Engineer.

(2) Shaping and Bedding. Shaping and bedding shall be in accordance with Item 400, "Excavation and Backfill for Structures".

(3) Laying Pipe. Unless otherwise authorized by the Engineer, the laying of pipe on the bedding shall be started at the outlet end with the spigot or tongue end pointing downstream and shall proceed toward the inlet end with the abutting sections properly matched, true to the established lines and grades. Where bell and spigot pipe are used, cross trenches shall be cut in the foundation to allow the barrel of the pipe to rest firmly upon the bedding. These cross trenches shall be not more than 50 millimeters larger than the bell ends of the pipe. Proper equipment shall be provided for hoisting and lowering the sections of pipe into the trench without disturbing the bedding and the sides of the trench. The ends of the pipe shall be carefully cleaned before the pipe is placed. As each length of pipe is laid, the mouth of the pipe shall be protected to prevent the entrance of earth or bedding material. The pipe shall be fitted and matched so that when laid in the bed the pipe shall form a smooth, uniform conduit. When elliptical pipe with circular reinforcing or circular pipe with elliptical reinforcing is used, the pipe shall be laid in the trench in such position that the markings "Top" or "Bottom", shall not be more than five (5) degrees from the vertical plane through the longitudinal axis of the pipe.

Multiple installations of reinforced concrete pipe shall be laid with the center lines of individual barrels parallel. Unless otherwise shown on the plans, the following clear distances between outer surfaces of adjacent pipes shall be used.

Diameter in Millimeters	450	600	750	900	1050	1200	1350	1500 to 2100
Clear Distance Between Pipes (Millimeters)	225	275	325	375	425	475	575	600

(4) Jointing.

(a) Joints sealed with portland cement mortar shall be made as follows:

Mortar shall consist of one (1) part cement, two (2) parts sand and sufficient water to make a plastic mix. The pipe ends shall be cleaned and wetted before making the joint. The lower half of the bell or groove and the upper half of the tongue or spigot shall be plastered with mortar. After the pipes are tightly jointed, mortar shall be packed into the joint from both

inside and outside the pipe. The inside shall be finished smooth and flush with adjacent joints of pipe. Over the joint outside the pipe, a bead shall be formed at least 25 millimeters on either side of the joint and of semicircular cross section for tongue and groove joints, but for bell and spigot joints, the mortar shall form a 45° fillet between the outer edge of the bell and the spigot. Mortar joints shall be cured by keeping the joints wet for at least 48 hours or until the backfill has been completed, whichever comes first. No jointing shall be done when the atmospheric temperature is at or below 5 °C. Mortared joints shall be protected against freezing by backfilling or other approved methods for at least 24 hours.

No mortar banding on the outside of pipe will be required for driveway culverts.

At the Contractor's option, and with the approval of the Engineer, pipes which are large enough for a man to enter may be furnished with the groove not less than 13 millimeters and not more than 19 millimeters longer than the tongue. Such pipe may be laid and backfilled without mortar joints. Care shall be exercised to avoid displacing the joints during the backfilling operations. After the backfilling has been completed, the space between the end of the tongue and the groove on the interior of the pipe shall be cleaned of all foreign material, thoroughly wetted and filled with mortar around the entire circumference of the pipe and finished flush.

The Contractor shall make available for the use of the Engineer, an appropriate rolling device similar to an automobile mechanic's "Creeper" for conveyance through small size pipe structures.

Mortar joints will be required for irrigation wells, vents and similar vertical structures.

(b) Joints using Cold Applied, Plastic Asphalt Sewer Joint Compound shall be made as follows:

Both ends of the pipes shall be clean and dry. A 13 millimeter thick layer of the compound shall be troweled or otherwise placed in the groove end of the pipe covering not less than two-thirds of the joint face around the entire circumference. Next, the tongue end of the next pipe shall be shoved home with sufficient pressure to make a tight joint. After the joint is made

any excess mastic projecting into the pipe shall be removed. Backfilling of pipe laid with asphalt mastic joints may proceed as soon as the joint has been inspected and approved by the Engineer. Special precautions shall be taken in placing and compacting backfill to avoid damage to the joints.

(c) Joints using Rubber Gaskets shall be made as follows:

Where rubber gasket pipe joints are required by the plans the joint assembly shall be made according to the recommendations of the gasket manufacturer. Water tight joints will be required when using rubber gaskets. Backfilling may begin when approved by the Engineer.

(d) Joints using Cold Applied Preformed Plastic Gaskets shall be made as follows:

Before laying the pipe in the trench, the plastic gasket shall be attached around the tongue or groove near the shoulder or hub of each joint in accordance with the gasket manufacturer's recommendations. The protective wrapper shall be removed and the gasket pressed firmly to the clean, dry surface of the pipe, as recommended by the manufacturer. The joint sealer must be placed in such a manner that no dirt or other deleterious materials will come in contact with the joint sealing material.

After the tongue is correctly aligned with the flare of the groove, the wrapper or wrappers on the gasket shall be removed and the pipe shall be pulled or pushed home with sufficient force to properly seal the joint. Any joint material pushed out into the interior of the pipe that would tend to obstruct the flow shall be removed. (Pipe shall be pulled home in a straight line with all parts of the pipe on line and grade at all times.) Backfilling of pipe laid with plastic gasket joints may proceed as soon as the joint has been inspected and approved by the Engineer. Special precautions shall be taken in placing and compacting backfill to avoid damage to the joints.

When the atmospheric temperature is below 15 °C, plastic joint seal gaskets shall either be stored in an area warmed to above 20 °C, or artificially warmed to this temperature in a manner satisfactory to the Engineer. Gaskets shall then be applied to pipe joints immediately prior to placing pipe in trench, followed by connection to previously laid pipe.

(5) Connections and Stub Ends. Connections of concrete pipe to existing pipes, pipe sewers or sewer appurtenances shall be as shown on the plan.

The bottom of existing structures shall be mortared or concreted if necessary to eliminate any drainage pockets created by the connections. Any damage to the existing structure resulting from making the connection shall be repaired by the Contractor, to the satisfaction of the Engineer, at the Contractor's expense.

When concrete pipe is to be joined with existing aluminum pipe, portions of the aluminum pipe that are to be in contact with the concrete pipe, shall be insulated with a coating of bituminous material meeting the requirements of Article 460.7. The coating shall extend to a minimum distance of 0.3 meter beyond the area of contact.

Unless otherwise shown in the plans, connections between concrete pipe and corrugated metal pipe shall be made with a suitable concrete collar having minimum thickness of 100 millimeters.

Stub ends, for connections to future work not shown on the plans, shall be finished by installing watertight plugs into the free end of the pipe.

(6) Backfilling. After the pipe has been placed, bedded and jointed as specified, filling and/or backfilling shall be done in accordance with the applicable requirements of Item 400, "Excavation and Backfill for Structures". When mortar joints are specified, no fill or backfill shall be placed until the jointing material has been cured for at least six hours. Special precautions shall be taken in placing and compacting the backfill to avoid any movement of the pipe or damage to the joints. For all pipe structures where joints consist of materials other than mortar, immediate backfilling will be permitted.

(7) Reuse of Appurtenances. When existing appurtenances are specified on the plans for reuse, the portion to be reused shall be severed from the culvert and moved to the new position previously prepared by hoisting with a crane, rolling, or other approved methods. Connections shall conform to the requirements for joining sections of pipes, as designated herein or as shown on the plans. Any portion of the headwalls or pipe attached to the appurtenance damaged during the moving operations

by the Contractor shall be restored to its original condition at the Contractor's expense. The Contractor may remove and dispose of the existing appurtenances and construct new appurtenances at his expense in accordance with the pertinent specifications and design shown on the plans or as furnished by the Engineer.

(8) Protection of Pipe. Unless otherwise shown on the plans or permitted in writing by the Engineer, no heavy earth moving equipment will be permitted to haul over the structure until a minimum of 1.2 meters of permanent or temporary, compacted fill has been placed thereon. Pipe damaged by the Contractor's equipment shall be removed and replaced by the Contractor at the Contractor's expense.

464.4. Measurement. This Item will be measured by the meter. Such measurement will be made between the ends of the pipe barrel along the flow line, exclusive of safety end treatments. Safety end treatments shall be measured in accordance with Item 467, "Safety End Treatment". Where spurs or branches, or connections to existing pipe lines are involved, measurement of the spur or new connecting pipe will be made from the intersection of the flow line with the outside surface of the pipe into which it connects. Where inlets, headwalls, catch basins, manholes, junction chambers, or other structures are included in lines of pipe, that length of pipe tying into the structure wall will be included for measurement but no other portion of the structure length or width will be so included.

For multiple pipes, the measured length will be the sum of the lengths of the barrels measured as prescribed above.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

464.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Reinforced Concrete Pipe" and "Reinforced Concrete Pipe (Sewers)" of the size and D-load or class specified; and "Reinforced Concrete Pipe (Arch)", "Reinforced Concrete Pipe (Elliptical)", "Reinforced Concrete Pipe (Arch) (Sewer)", and "Reinforced Concrete Pipe (Elliptical) (Sewer)" of the design specified.

This price shall be full compensation for furnishing, hauling, placing and joining of pipes; for cutting of skews or slopes, for all connections to new or existing structures; for moving and reusing appurtenances where required; for removing and disposing of portions of existing structures as required; and for all labor, tools, equipment and incidentals necessary to complete the work.

Excavation, bedding and backfill will be paid for in accordance with Item 400, "Excavation and Backfill for Structures".

ITEM 465

MANHOLES AND INLETS

465.1. Description. This Item shall govern for the construction of manholes and inlets, complete in place or to the stage detailed on the plans, and in accordance with this Item, including furnishing and installing frames, grates, rings and covers. Drainage junction boxes will be classified as manholes.

Unless otherwise shown on the plans, the Contractor may furnish precast manholes, inlets, risers and/or appurtenances. Alternate designs acceptable to the Engineer may be utilized for precast construction of manholes and inlets. These units shall be designed by and the drawings shall bear the seal of a Registered Professional Engineer and shall not deviate from the functional dimensions shown on the plans.

465.2. Materials. All materials shall conform to the pertinent requirements of the following items:

Item 420, "Concrete Structures"
Item 421, "Portland Cement Concrete"
Item 440, "Reinforcing Steel"
Item 442, "Metal for Structures"
Item 471, "Frames, Grates, Rings, and Covers"

(1) Concrete. Concrete for manholes and inlets shall be Class "A" unless otherwise shown on the plans. Concrete for precast manholes and inlets shall be in accordance with ASTM C 478 or Class "A".

(2) Mortar. Mortar shall be composed of one part portland cement and two parts clean sand. Hydrated lime or lime putty may be added to the mix but in no case shall it exceed 10 percent by mass of the total dry mix.

(3) Brick. Bricks shall be of first quality, sound, hard-burned, perfectly shaped brick. Shale bricks, if used, shall be homogeneous, thoroughly and uniformly burned. Bricks shall not absorb more than 16 percent of water by mass when submerged in water for 24 hours, having been in a completely dry state prior to placing in water. Clay brick shall conform to the requirements of ASTM C 32, Grade MS or MM. Concrete brick meeting the requirements of ASTM C 55, Type I (Grade S-I), shall be acceptable.

(4) Concrete Blocks. Concrete blocks when shown on the plans shall conform to the requirements of ASTM C 139.

(5) Cast Iron or Aluminum. Cast iron for supports, steps and inlet units shall conform to the shape and dimensions shown on the plans. The castings shall be clean, free from sand or blow holes, or other defects. Cast iron castings shall conform to the requirements of "Gray Iron Castings", ASTM A 48, Class 30. Steps may be either cast iron conforming to the requirements of "Gray Iron Castings", ASTM A 48, Class 30, or "Ductile Iron Castings" conforming to ASTM A 536, Grade 65-45-12 (tensile 448, yield 310, elongation 12 in 50 mm), or aluminum conforming to the requirements of ASTM B 221, Alloy 6005-T5.

(6) Timber. Timber for temporary covers when used with Stage I Construction shall be sound, new or used timber of minimum 75 millimeters nominal thickness, reasonably free of knots and warps.

(7) Other Materials. Commercial type hardware of other mate-rials may be used with prior approval of the Engineer.

465.3. Steps. When steps are required by the plans they shall conform to ASTM C 478 Article, "Manhole Steps and Ladders".

465.4. Types. The various types of manholes and inlets are designated on the plans by letters or by numbers indicating the particular design of each. Each type shall be constructed in accordance with the details shown on the plans and to the depth required by the profile and schedules given.

465.5. Stages of Construction. All types of manholes and inlets may be built either complete in one stage or in two stages hereinafter described as Stage I Construction and Stage II Construction. Manholes and inlets designed to match the final roadway surface shall be built in stages and Stage II shall be constructed after the pavement structure is complete, unless otherwise approved by the Engineer.

Stage I Construction shall consist of that portion of manholes and inlets designated on the plans or as specified in this Item. Stage I Construction shall include the furnishing and installation of a temporary cover as approved by the Engineer for both manholes and inlets and the required manhole steps in accordance with the details shown on the plans.

For cast iron or steel inlet units, Stage I Construction shall consist of furnishing and installing the sewer pipe from the storm sewer to a point below the top of curb as indicated on the plans including the furnishing and installation of a temporary plug for the exposed end of the sewer pipe.

Stage II Construction shall consist of that portion of the complete manhole or inlet not covered under Stage I. This shall include the remaining wall height and top of manhole or inlet including the furnishing and installation of frames, grates, rings and covers, manhole steps, curb beams and/or collecting basins as shown on the plans.

465.6. Construction Methods.

(1) General. All concrete work shall be performed in accordance with the requirements of Item 420, "Concrete Structures", or Item 424, "Precast Concrete Structures (Fabrication)", or ASTM C 478, unless otherwise specified. Forms will be required for all concrete walls. Outside wall forms may be omitted with the approval of the Engineer if the surrounding material can be trimmed to a smooth vertical face. The outside form for concrete bases supporting brick walls may be omitted. Where brick is used in wall construction, steps shall be mortared into the joints as shown on the plans. Where concrete is used in wall construction, the steps shall be cast into the wall when the concrete is placed. All brick work shall be laid in a full bed of mortar in such a manner as will thoroughly bond them into the mortar. Joints shall be full mortar joints and shall be not more than 13 millimeters wide. Every fifth course of brick shall be a header course or bond course with the long axis of such course laid perpendicular to the long axis of the preceding four courses.

(2) Manholes and Inlets for Precast Concrete Pipe Sewers. The construction of manholes and inlets for precast concrete pipe sewers shall be done as soon as is practicable after sewer lines into or through the manhole or inlet locations are completed. All sewers shall be cut neatly at the inside face of the walls of the manhole or inlet and pointed up with mortar.

(3) Manholes and Inlets for Monolithic Pipe Sewers. Bases for manholes and inlets on monolithic pipe sewers may be placed monolithic with the sewer or, at the Contractor's option, may be placed after the sewer is constructed.

(4) Manholes for Box Sewers. Bases for manholes for box sewers shall be cast as an integral part of the sewer. The manholes may be constructed prior to backfilling or, if the Contractor so elects, the manhole opening may be covered temporarily, as approved by the Engineer, to facilitate the compaction of backfill for the sewer as a whole with tractor equipment. Thereafter, required excavation for the manhole shall be made and the manhole constructed and backfilled in accordance with the plans. Manholes for box sewers shall include all manhole steps required in the wall of the sewer.

(5) Inverts. The inverts passing out or through the manhole or inlet shall be shaped and routed across the floor of the manhole or inlet as shown on the plans. This shaping may be accomplished by adding and shaping mortar or concrete after the base is cast or by placing the required additional material with the base.

(6) Finishing Complete Manholes and Inlets. Manholes and inlets shall be completed in accordance with the plans. Backfilling to original ground elevation shall be in accordance with the provisions of Item 400, "Excavation and Backfill for Structures".

(7) Finishing Stage I Construction. Stage I Construction shall be completed by constructing the walls to the elevations shown on the plans and backfilling to required elevations in accordance with the requirements of Item 400, "Excavation and Backfill for Structures".

(8) Stage II Construction. Subgrade and base course or concrete pavement construction shall be completed over manholes or inlets constructed as provided for in Stage I, unless otherwise approved by the

Engineer. Stage II Construction of manholes or inlets shall consist therefore of excavating to expose the top of Stage I Construction and completing the manhole or inlet in accordance with the plans and these specifications, including backfill and cleaning of all debris from the bottom of the manhole or inlet.

(9) Inlet Units. Cast iron or steel inlet units shall be installed in conjunction with the construction of concrete curb and gutter. Prior to placing concrete for curb and gutter, the inlet units shall be set securely in position. Openings for the inlets and recesses in curb and gutter, as shown on the plans, shall be formed in conjunction with the curb and gutter forms. Concrete for curb and gutter adjacent to the inlets shall be placed using care to secure thoroughly consolidated concrete around the inlet castings and formed openings and recesses without displacement of the inlet units in the forms.

465.7. Measurement. All manholes and inlets satisfactorily completed in accordance with the plans and specifications will be measured by each manhole or inlet, complete, or by each manhole or inlet completed to the stage of construction required by the plans.

Extension to inlets will be measured by each extension separately from the inlet.

465.8. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for as follows:

(1) Manholes Complete. Payment for complete manholes will be made at the unit price bid for each "Manhole (Complete)", of the type specified.

(2) Inlets Complete. Payment for inlets will be made at the unit price bid for each "Inlet (Complete)", or "Inlet Unit", of the type specified. Payment for inlets with extensions of the length shown on the plans and measured as prescribed above shall be made at the unit price bid for each "Inlet Extension".

(3) Manholes Stage I. Payment for Manholes, Stage I will be made at the unit price bid for each "Manhole (Stage I)", of the type specified.

(4) Manholes Stage II. Payment for Manholes, Stage II will be made at the unit price bid for each "Manhole (Stage II)", of the type specified.

(5) Inlets Stage I. Payment for Inlets, Stage I will be made at the unit price bid for each "Inlet (Stage I)", of the type specified.

(6) Inlets Stage II. Payment for Inlets, Stage II will be made at the unit price bid for each "Inlet (Stage II)", of the type specified.

Payments as provided above shall be full compensation for furnishing all concrete, reinforcing steel, brick, mortar, aluminum and castings, frames, grates, rings and covers, excavation and backfill and for all other materials, tools, equipment and incidentals, required to complete the work.

ITEM 466

HEADWALLS AND WINGWALLS

466.1. Description. This Item shall govern for the materials, construction, furnishing and placing of headwalls and wingwalls at the locations shown, and in accordance with the details shown on the plans and with this Item. Unless otherwise shown on the plans, the Contractor has the option of furnishing cast-in-place or precast headwalls and wingwalls, hereinafter described as concrete units.

466.2. General. Concrete units shall be of the various types shown on the plans and designated by letters or by numbers to indicate the particular design of each.

466.3. Materials. All materials shall conform to the pertinent items as follows:

Item 420, "Concrete Structures"
Item 421, "Portland Cement Concrete"
Item 440, "Reinforcing Steel"

Unless otherwise shown on the plans, concrete for cast-in-place and precast concrete units shall be Class A.

466.4. Forms. Forms for cast-in-place units shall comply with Item 420, "Concrete Structures" and forms for precast concrete units shall comply with Item 424, "Precast Concrete Structures (Fabrication)".

466.5. Marking. The following information shall be clearly marked on each section of precast unit prior to leaving the casting yard:

(1) The date of manufacture.

(2) The name or trademark of the manufacturer.

(3) The type and size designation.

466.6. Storage and Shipment. Precast units shall be stored on level blocking in a manner acceptable to the Engineer. No loads shall be placed on the precast concrete units until design strength is reached. Shipment of acceptable units may be made when the design strength requirements have been met.

466.7. Rejection. Precast units may be rejected for nonconformity with any of the specification requirements and individual concrete units may also be rejected for any of the following reasons:

(1) Fractures or cracks passing through the wall.

(2) Surface defects indicating honeycombed or open texture.

All rejected units shall be plainly marked by the Engineer and shall be replaced by the Contractor with acceptable units meeting the requirements herein. Rejected units shall be removed immediately from the site of work.

466.8. Repairs. Occasional imperfections in manufacture or accidental damage during handling may be repaired and will be acceptable if, in the opinion of the Engineer, the repairs are sound and properly finished and cured and the repaired units conform with the requirements herein.

466.9. Construction Methods. Construction of cast-in-place concrete units and jobsite precast units shall conform to the construction methods of Item 420, "Concrete Structures". Plant precast units shall conform to Item 424, "Precast Concrete Structures (Fabrication)".

All excavation shall be in accordance with the requirements of Item 400, "Excavation and Backfill for Structures". Precast concrete units shall be bedded on foundations of firm and stable material accurately shaped to conform to their bases.

The Contractor shall provide adequate means to lift and place the precast concrete units. Lifting holes may be formed during production, or punched through the fresh concrete immediately after stripping forms; however, care shall be taken not to damage the unit by spalling large areas. All lifting holes shall be repaired in accordance with Article 466.8.

Connections to new or existing structures shall be made in accordance with the details shown on the plans. Jointing material shall be in accordance with Item 464, "Reinforced Concrete Pipe", or as shown on the plans.

466.10. Measurement. Precast and cast-in-place units of each type and height will be measured by each end of a structure.

Measurement for single barrel structures and multiple barrel structures with headwalls will include, when shown on the plans, the toewall, the apron, and for precast units, the curb.

Measurement for multiple barrel structures with wingwalls will include the toewall and, for precast units, the curb.

Any apron between the wingwalls of multiple box culverts will be measured as required by the pertinent item.

466.11. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Headwalls" or "Wingwalls" of the specified type and height. This price shall be full compensation for furnishing, transporting and placing all concrete and/or precast units, reinforcing steel and jointing to new or existing structures; for excavation

and backfill; and for all other material, labor, tools, equipment and incidentals necessary to complete the work.

ITEM 467

SAFETY END TREATMENT

467.1. Description. This Item shall govern for the materials, construction, furnishing and placing of Safety End Treatments (SETs) for drainage structures at the locations shown, and in accordance with the details shown on the plans and this Item.

467.2. Materials. All materials shall conform to the pertinent requirements of the following items:

Item 420, "Concrete Structures"
Item 421, "Portland Cement Concrete"
Item 432, "Riprap"
Item 440, "Reinforcing Steel"
Item 445, "Galvanizing"
Item 460, "Corrugated Metal Pipe"
Item 464, "Reinforced Concrete Pipe"

Concrete for cast-in-place SET units and precast SET units shall be Class A, unless otherwise shown on the plans.

When required, concrete riprap aprons and concrete collars shall be Class B, unless otherwise shown on the plans.

Galvanized steel for Prefabricated Metal End Sections shall conform to the requirements of Item 460, "Corrugated Metal Pipe".

When pipe runners are required, they shall conform to the requirements of ASTM A 53 (Type E or S, Gr. B), ASTM A 500 (Gr. B) or API5LX52, unless otherwise shown on the plans. When plates and angles are required, they shall conform to the requirements of ASTM A 36. When bolts and nuts are required, they shall conform to the requirements of ASTM A 307. All pipe, plates, angles, nuts and bolts shall be galvanized in accordance with Item 445, "Galvanizing".

467.3. Types.

(1) Type I. SET (Type I) shall consist of reinforced concrete wingwalls and pipe runners, when required. These installations are intended for small and intermediate size box culverts, large size pipe culverts and suitable multiple box or multiple (intermediate or large size) pipe culverts as shown on the plans.

(2) Type II. SET (Type II) shall consist of one of the following:

(a) Corrugated Metal Pipe (CMP) or Reinforced Concrete Pipe (RCP) mitered to the proper slope, as shown on the plans, concrete riprap aprons and pipe runners, when required.

(b) Prefabricated Metal End Sections, concrete riprap aprons and pipe runners, when required.

(c) Precast SET units, concrete riprap aprons, if required, and pipe runners, when required.

Unless otherwise shown on the plans, when CMP is specified for the pipe structure, the Contractor shall have the option of providing Prefabricated Metal End Sections in place of mitered CMP.

Unless otherwise shown on the plans, when RCP is specified for the pipe structure, the Contractor shall have the option of providing Precast SET units in place of mitered RCP.

These installations are intended for small size pipe culverts and multiple (small size) pipe culverts as shown on the plans.

467.4. Designations. The types of Safety End Treatments will be indicated on the plans by the following descriptions:

(1) SET (Type I).

Box Size: (Span x Rise)
Pipe Size: (Diameter or Design)
Slope: Slope will be designated as a ratio of vertical to horizontal (example 1:4)
Orientation: (Parallel or Cross) Orientation will only be shown when safety pipe run

(2) SET (Type II).

Pipe Size: (Diameter or Design)
Safety End Treatment Material: (RCP or CMP)
Slope: Slope will be designated as a ratio of vertical to horizontal (example 1:4)
Orientation: (Parallel or Cross) Orientation will only be shown when safety pipe runners are required.

467.5. Construction Methods. Safety end treatments shall be constructed in accordance with the details shown on the plans and in accordance with the construction methods required by the pertinent items.

Cast-in-place SET units and job site precast SET units shall be constructed in accordance with Item 420, "Concrete Structures". Plant precast SET units shall conform to Item 424, "Precast Concrete Structures (Fabrication)".

Damaged galvanizing shall be repaired by the Contractor in accordance with Item 445, "Galvanizing".

Any required structural excavation shall be in accordance with Item 400, "Excavation and Backfill for Structures".

Removal of portions of existing structures, when required, shall be in accordance with Item 496, "Removing Old Structures". The extension of concrete structures, when required, shall be in accordance with Item 430, "Extending Concrete Structures" or Item 462, "Concrete Box Culverts and Sewers". The extension of pipe culverts, when required, shall be in accordance with Item 460, "Corrugated Metal Pipe" or Item 464, "Reinforced Concrete Pipe", whichever is pertinent. Concrete aprons for end treatments to pipe shall be in accordance with "Concrete Riprap" of Item 432, "Riprap".

All drilling, doweling and grouting needed to complete the work shall be in accordance with Item 420, "Concrete Structures".

467.6. Measurement. This Item will be measured as follows:

(1) SET (Type I). Safety End Treatment (Type I) will be measured by each complete and accepted treatment for each separate barrel of each separate culvert end.

(2) SET (Type II). Safety End Treatment (Type II) will be measured by each complete and accepted treatment for each separate barrel (conduit) of each separate culvert end.

467.7. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for the various designations of "Safety End Treatment" specified as follows:

SET (Type I)(Box or Pipe Size)(Slope) or
SET (Type I)(Box or Pipe Size)(Slope)(Orientation);
SET (Type II) (Pipe Size) (Pipe Material)(Slope) or
SET (Type II) (Pipe Size) (Pipe Material)(Slope)(Orientation).

This price shall be full compensation for breaking and removing a portion of the existing structure, when required; for all structural excavation; for replacing a portion of the existing structure, when required; for constructing or furnishing and installing treatments; for connections to existing structures, when required; for furnishing all concrete, reinforcing steel, corrugated metal pipe or reinforced concrete pipe; for all pipe runners, riprap aprons and collars, nuts, bolts, plates and angles, when required; and for all labor, tools, equipment and incidentals necessary to complete the work.

When SET (Type I) is used for retrofit of existing structures without an extension, the removal of existing headwalls, wingwalls and a portion of the existing structure and the replacement of a portion of the existing structure for the purpose of anchorage of the treatment will not be paid for directly but will be considered subsidiary to this Item.

When SET (Type II) is used for retrofit of existing culverts without an extension, the Contractor shall have the option of removing the existing headwall with a length of pipe as shown on the plans and relaying that pipe or furnishing an equal length of new pipe. The removing and relaying of existing pipe or furnishing new pipe will not be paid for directly but will be considered subsidiary to this Item.

The mitered length of CMP or RCP that is a part of the SET (Type II) will not be paid for directly but will be considered subsidiary to this Item. The limits for payment for pipe will be as shown on the plans and paid for in accordance with the pertinent bid item.

Structural excavation will not be paid for directly but will be considered subsidiary to this Item, except for undercut situations as described in Item 400, "Excavation and Backfill for Structures".

ITEM 471

FRAMES, GRATES, RINGS, AND COVERS

471.1. Description. This Item shall govern for furnishing and installing frames, grates, rings and covers for inlets, manholes and other structures in accordance with the plans and this Item.

471.2. Materials. Welded steel grates and frames shall conform to the member size, dimensions and details shown on the plans and shall be welded into an assembly in accordance with those details. Steel shall conform to the requirements of ASTM A 36 or equal.

Castings, whether Carbon-Steel, Gray Cast Iron or Ductile Iron shall conform to the shape and dimensions shown on the plans and shall be clean substantial castings, free from sand or blow holes or other defects. Surfaces of the castings shall be free from burnt-on sand and shall be reasonably smooth. Runners, risers, fins, and other cast-on pieces shall be removed from the castings and such areas ground smooth. Bearing surfaces between manhole rings and covers or grates and frames shall be cast or machined with such precision that uniform bearing shall be provided throughout the perimeter area of contact. Pairs of machined castings shall be matchmarked to facilitate subsequent identification at installation.

Steel castings shall conform to the requirements of the specifications for "Mild to Medium Strength Carbon Steel Castings for General Application", ASTM A 27. Grade 485-250 shall be furnished unless otherwise specified.

Cast iron castings shall conform to the requirements of "Gray Iron Castings", ASTM A 48, Class 30.

Ductile iron castings shall conform to the requirements of "Ductile Iron Castings", ASTM A 536. Grade 60-40-18 (tensile 414, yield 276, elongation 18 in 50 mm) shall be used unless otherwise specified.

Commercial type frames, rings, risers and/or appurtenances may be used with prior approval of the Engineer.

Mill test reports or manufacturer's certification shall be furnished to the Engineer for each lot or shipment.

471.3. Construction Methods. Frames, grates, rings and covers shall be constructed in accordance with the details shown on the plans and shall be installed to the lines and grades indicated on the plans or as directed by the Engineer.

All welding shall conform to the requirements of Item 448, "Structural Field Welding". Grates and covers shall be tack welded to the frame or ring when directed by the Engineer.

Steel frames, grates, rings and covers shall be cleaned in accordance with the paint manufacturer's recommendations and given one (1) coat of commercial grade primer and two (2) coats of commercial grade aluminum paint. Iron castings will be painted when used in conjunction with structural steel shapes.

All bolts and nuts shall be galvanized. Commercial grade galvanizing will be acceptable.

471.4. Measurement. Frames, grates, rings and covers, when a part of the complete manhole or inlet, will not be measured for payment but will be considered subsidiary to Item 465, "Manholes and Inlets". Frames, grates, rings and covers when not a part of a Manhole (complete) or Inlet (complete) will be measured by the unit of each "Grate", "Frame", "Grate and Frame", "Frame and Cover", or "Ring and Cover", complete in place.

471.5. Payment. When payment is required in accordance with "Measurement", payment for frames, grates, rings and covers will be made at the unit price bid for each "Grate", "Frame", "Grate and Frame", "Frame and Cover", or "Ring and Cover" unless otherwise shown on the plans. This price shall be full compensation for furnishing all materials, tools, equipment, labor and incidentals necessary to complete the work.

ITEM 472

REMOVING AND RELAYING CULVERT AND STORM SEWER PIPE

472.1. Description. This Item shall govern for the removal and reinstallation of existing culvert pipe or pipe sewer at locations shown on the plans and in accordance with this Item.

472.2. Construction Methods. Existing pipe designated for use in new work, shall be removed, transported to the new locations, cleaned, and installed as shown on the plans and in accordance with this specification. The work shall be done in such manner as to prevent damage to the pipe and fittings. Excavation, bedding and backfill shall conform to the requirements of Item 400, "Excavation and Backfill for Structures". Installation of concrete pipe shall conform to the requirements of Item 464, "Reinforced Concrete Pipe". Corrugated metal pipe shall be installed in accordance with the requirements of Item 460, "Corrugated Metal Pipe". Connections to existing structures shall be made as shown on the plans. The connection shall conform to the requirements for connections as described in the pertinent pipe specifications. Portions of aluminum pipe that are to be in contact with concrete or metal other than aluminum shall be insulated from these materials by a coating of bituminous material meeting the requirements set forth under "Protective Coating" in Item 460, "Corrugated Metal Pipe". The coating applied to the pipe or pipe arch to provide an insulation between the aluminum and other material shall extend a minimum distance of 0.3 meter beyond the area of contact. The connection between reinforced concrete pipe and corrugated metal pipe shall be made with a suitable concrete collar having a minimum thickness of 100 millimeters.

The top and bottom of reinforced concrete pipe shall be marked prior to being moved and when relaid shall be placed in the same position with reference to top and bottom as before the pipe was removed.

When headwalls, aprons or other appurtenances are shown on the plans for reuse, the portion to be reused shall be severed from the culvert and moved to the new position. Connections shall conform to the requirements for joining sections of pipes as designated herein. Any portion of the headwall, apron or appurtenances damaged by the Contractor shall be restored to exiting condition at the Contractor's expense. The Contractor may remove and dispose of the existing structures and construct new structures at his expense in accordance with the pertinent specifications and design shown on the plans or as directed by the Engineer.

Structures designated for reuse, which are damaged by the Contractor shall be replaced with like material at the Contractor's expense.

472.3. Measurement. This Item will be measured by the meter, between the ends of the pipe barrel along the flow line as installed. Where spurs or branches, or connections to existing pipe lines are involved, measurement of the spur or connecting pipe shall be made from the intersection at its flowline with the outside surface of the pipe into which the pipe connects. Where inlets, catch basins, manholes, safety end treatments, or other structures are included in lines of pipe, that length of pipe tying into the structure wall will be included for measurement but no other portion of the structure length or width shall be so included.

472.4. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Removing and Relaying Culvert Pipe 450 millimeter Diameter and Under", "Removing and Relaying Culvert Pipe Over 450 millimeter Diameter", or "Removing and Relaying Storm Sewer Pipe", of the size specified. This payment will be full compensation for excavating and removing the pipe from its original location; for hauling, placing and joining of pipe; for cutting of pipe ends on skew or slope; for moving and reusing headwalls and safety end treatments; for all connections to existing structures and for all materials, labor, equipment, tools, and incidentals necessary to complete the work. Protection methods for excavations greater than 1.5 meter in depth will be measured and paid for as required under Item 402, "Trench Excavation Protection" or Item 403, "Temporary Special Shoring".

Excavation, bedding and backfill for relaying of pipe will be paid for in accordance with Item 400, "Excavation and Backfill for Structures".

ITEM 473

LAYING CULVERT AND STORM SEWER PIPE

473.1. Description. This Item shall govern for the installation of culvert and storm sewer pipe, furnished by the Department or others, at the locations and to the line and grades shown on the plans or as designated by the Engineer. Pipe furnished to the Contractor may be salvaged or new pipe or a combination of both.

473.2. Construction Methods. Excavation, bedding and backfill shall conform to the requirements of Item 400, "Excavation and Backfill for Structures". Installation of concrete pipe shall conform to the requirements

of Item 464, "Reinforced Concrete Pipe". Corrugated metal pipe shall be installed in accordance with the requirements of Item 460, "Corrugated Metal Pipe". Connections shall be made to existing structures as shown on the plans. When the connection is to an existing pipe of the same type as that to be laid, the connection shall conform to the requirements for jointing sections of pipe as described in the pertinent pipe specifications. Portions of aluminum pipe that are to be in contact with concrete or metal other than aluminum shall be insulated from these materials by a coating of bituminous material meeting the requirements of "Protective Coating" in Item 460, "Corrugated Metal Pipe". The coating applied to the pipe or pipe arch to provide an insulation between the aluminum and other material shall extend a minimum distance of 0.3 meter beyond the area of contact. The connection between reinforced concrete pipe and corrugated metal pipe shall be made with a suitable concrete collar having a minimum thickness of 100 millimeters. Any pipe damaged by the Contractor shall be replaced at his expense.

473.3. Measurement. This Item will be measured by the meter, between the ends of the pipe barrel along the flow line as installed. Where spurs or branches or connections to existing pipe lines are involved, measurement of the spur or connecting pipe will be made from the inter- section of the flow line with the outside surface of the pipe into which the pipe connects. Where inlets, manholes, safety end treatments, or other structures are included in lines of pipe, that length of pipe tying into the structure wall will be included for measurement but no other portion of the structure length or width will be so included.

473.4. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Laying Pipe", of the size specified. This payment shall be full compensation for hauling, placing and joining of pipe; for cutting of pipe ends on skew or slope; for all connections to existing structures, cutting pipe to proper length; and for all other items of materials, labor, equipment, tools, and incidentals necessary to complete the work. Protection methods for excavations greater than 1.5 meters in depth shall be measured and paid for as required under Item 402, "Trench Excavation Protection", or Item 403, "Temporary Special Shoring".

Excavation, bedding and backfill for laying pipe will be paid for in accordance with Item 400, "Excavation and Backfill for Structures".

ITEM 474

SLOTTED DRAIN

474.1. Description. This Item shall govern for furnishing, fabricating, and installing slotted drains and slotted drain outfalls conforming to the requirements herein and the details shown on the plans. Slotted drains shall consist of a slot attached longitudinally to a corrugated metal pipe. The slot is considered to be a complete assembly that forms the drain for water to enter the pipe. The slotted drain outfall shall consist of the corrugated metal pipe which connects the slotted drain to the main drainage line.

474.2. Materials and Manufacture. The pipes for the slotted drain and the slotted drain outfall shall be full circle, helically corrugated, lock seam or welded seam pipe or full circle, annular corrugated, riveted or welded lap joint pipe. Materials and fabrication shall be in accordance with Item 460, "Corrugated Metal Pipe", and shall be galvanized steel having a nominal thickness of 1.6 millimeters.

Unless otherwise specified on the plans or required herein, slotted drain may be constructed with either of the following slot assemblies:

(1)Type A - This slot assembly shall be constructed of metal plates and spacers. Details of the slot assembly shall meet the mechanical requirements of ASTM A 36, and shall be welded to fit over the longitudinal opening in the corrugated metal pipe. The completed slot assembly shall be galvanized after fabrication in accordance with Item 445, "Galvanizing".

Weld areas and the heat affected zones where the slot is welded to the corrugated pipe shall be thoroughly cleaned and painted with a good quality asphalt base aluminum paint.

(2)Type B - This slot assembly shall consist of a drain guide which is machine formed from metal sheet of nominal thickness 2.0 millimeters. The material for the metal sheet shall conform to Item 460, "Corrugated Metal Pipe". Details of the drain guide slot assembly shall be shown on the plans.

474.3. Construction Methods. The slotted drains and slotted drain outfalls shall be installed at the locations, lines, and grades shown on the plans unless otherwise directed by the Engineer. Installation shall conform to the details shown on the plans and to the governing requirements of Item 460, "Corrugated Metal Pipe". Excavation and backfill shall be in accordance with Item 400, "Excavation and Backfill for Structures". Trenches for slotted drains and slotted drain outfalls shall be backfilled as shown on the plans with low strength concrete (minimum 112 kilograms of cement per cubic meter) or as directed by the Engineer. Slotted drains shall be furnished in six (6) meter lengths wherever practical to minimize the number of joints required.

Where pipes with slotted drain are to be joined together, the pipe ends shall have annular corrugations. The width of the locking band shall be not less than 265 millimeters. The locking devices shall be centered on the locking band and shall consist of L 64 x 51 x 4.8 angles, at least 50 millimeters in length with the long leg spot welded to the locking band.

One 13 millimeters diameter bolt will be required to secure the band. The locking band shall be sized so that there is sufficient clearance between the ends of the band and the vertical sides of the slotted drain, in order for the locking band to be securely tightened around the pipes being joined. The slotted drain shall terminate as shown on the plans to provide a space between the ends of the drains, for the locking band bolt.

474.4. Measurement. "Slotted Drain" and "Slotted Drain Outfall" will be measured by the meter between the ends of the pipe along the flow line.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

474.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Slotted Drain" or "Slotted Drain Outfall" of the nominal pipe diameter specified. This price shall be full compensation for furnishing and transporting the drain pipe; for all excavation and backfill; for hauling, placing, and joining the drain pipe; for

all band couplers and other items of materials, including any required cement stabilized backfill; and for all labor, tools, equipment and incidentals necessary to complete the work.

ITEM 476

JACKING, BORING OR TUNNELING PIPE

476.1. Description. This Item shall govern for furnishing and installing of pipe by the methods of jacking, boring or tunneling as shown on the plans and in accordance with this Item.

476.2. Materials. Pipe may be either corrugated metal pipe conforming to Item 460, "Corrugated Metal Pipe", of the size, type, design and dimension shown on the plans, or reinforced concrete pipe, conforming to the special requirements for jacking, boring or tunneling of Item 464, "Reinforced Concrete Pipe", of the size, strength and dimension shown on the plans, or other types as may be specified by the Engineer or shown on the plans.

476.3. Construction Methods.

(1) General. If the grade of the pipe at the jacking, boring, or tunneling end is below the ground surface, suitable pits or trenches shall be excavated for the purpose of conducting the jacking, boring or tunneling operations and for placing end joints of the pipe. Excavations greater than 1.5 meters in depth shall be protected as specified in Item 402, "Trench Excavation Protection" or Item 403, "Temporary Special Shoring".

Where pipe is required to be installed under railroad embankments, highways, streets, or other facilities by jacking, boring or tunneling methods, construction shall be made in such a manner that will not interfere with the operation of the railroad, street, highway, or other facility, and shall not weaken or damage any embankment or structure.

Pipe damaged in jacking, boring or tunneling operations shall be repaired in place to the satisfaction of the Engineer. Pipe damaged beyond repair will be removed and replaced. Repair or removal and replacement of damaged pipe will be done at the Contractor's expense.

The pits or trenches excavated to facilitate jacking, boring or tunneling operations shall be backfilled immediately after the installation of the pipe has been completed.

(2) Jacking. Heavy duty jacks suitable for forcing the pipe through the embankment shall be provided. In operating jacks, even pressure shall be applied to all jacks used. A suitable jacking head and suitable bracing between the jacks and the jacking head shall be provided so that pressure will be applied to the pipe uniformly around the ring of the pipe. Joint cushioning material of plywood or other material may be used as approved by the Engineer. Plywood cushioning material shall be 13 millimeters minimum thickness for pipe diameters 750 millimeters and less and 19 millimeters minimum thickness for pipe diameters greater than 750 millimeters. Cushioning rings may be made up of single or multiple pieces. A suitable jacking frame or back stop shall be provided. The pipe to be jacked shall be set on guides, properly braced together, to support the section of the pipe and to direct the pipe in the proper line and grade. The whole jacking assembly shall be placed so as to line up with the direction and grade of the pipe. In general, the embankment material shall be excavated just ahead of the pipe, the material removed through the pipe, and the pipe forced through the embankment with jacks, into the space thus provided.

The Contractor shall furnish for the Engineer's approval, a plan showing the proposed method of jacking. The plan shall include the design for the jacking head, jacking support or back stop, arrangement and position of jacks, pipe guides, etc., complete in the assembled position.

The excavation for the underside of the pipe, for at least one-third of the circumference of the pipe, shall conform to the contour and grade of the pipe. Over-excavation to provide not more than 50 millimeters of clearance may be provided for the upper half of the pipe. This clearance shall be tapered to zero at the point where the excavation conforms to the contour of the pipe. Over-excavation in excess of 25 millimeters shall be pressure grouted the entire length of the installation.

The distance that the excavation shall extend beyond the end of the pipe depends on the character of the material, but shall not exceed 0.6 meter. This distance shall be decreased when directed by the Engineer.

Preferably, the pipe shall be jacked from the low or downstream end. The final position of the pipe shall not vary from the line and grade shown on the plans, or established by the Engineer, by more than eight (8) millimeters in one (1) meter. The variation shall be regular and in one direction and the final flow line shall be in the direction shown on the plans.

The Contractor may use a cutting edge of steel plate around the head end of the pipe extending a short distance beyond the end of the pipe with inside angles or lugs to keep the cutting edge from slipping back onto the pipe.

When jacking of pipe has begun, the operation shall be carried on without interruption, insofar as practicable, to prevent the pipe from becoming firmly set in the embankment.

(3) Boring. The boring shall proceed from a pit provided for the boring equipment and workmen. The location of the pit shall be approved by the Engineer. The boring shall be done mechanically either using a pilot hole or by the auger method.

When the pilot hole method is used an approximate 50 millimeters pilot hole shall be bored the entire length of the crossing and shall be checked for line and grade on the opposite end of the bore from the work pit. This pilot hole shall serve as the centerline of the larger diameter hole to be bored.

When the auger method is used, a steel encasement pipe of the appropriate diameter equipped with a cutter head to mechanically perform the excavation shall be used. Augers shall be of sufficient diameter to convey the excavated material to the work pit.

Excavated material shall be disposed of by the Contractor, as approved by the Engineer. The use of water or other fluids in connection with the boring operation will be permitted only to the extent necessary to lubricate cuttings; jetting will not be permitted.

In unconsolidated soil formations, a gel-forming colloidal drilling fluid consisting of at least 10 percent of high grade carefully processed bentonite may be used to consolidate cuttings of the bit, seal the walls of the hole, and furnish lubrication for subsequent removal of cuttings and immediate installation of the pipe.

Allowable variation from line and grade shall be as specified in Subarticle 476.3.(2). Overcutting in excess of 25 millimeters shall be remedied by pressure grouting the entire length of the installation.

(4) Tunneling. Where the characteristics of the soil, the size of the proposed pipe, or the use of monolithic sewer would make the use of tunneling more satisfactory than jacking or boring; or when shown on the plans, a tunneling method may be used, with the approval of the Engineer.

When tunneling is permitted, the lining of the tunnel shall be of sufficient strength to support the overburden. The Contractor shall submit the proposed liner method to the Engineer for approval. Approval by the Engineer shall not relieve the Contractor of the responsibility for the adequacy of the liner method.

The space between the liner plate and the limits of excavation shall be pressure-grouted or mud-jacked.

Access holes for placing concrete shall be spaced at maximum intervals of three (3) meters.

(5) Joints. If corrugated metal pipe is used, joints may be made by field bolting or by connecting bands, whichever is feasible. If reinforced concrete pipe is used, the joints shall be in accordance with Item 464, "Reinforced Concrete Pipe".

476.4. Measurement. This Item will be measured by the meter between the ends of the pipe along the flow line.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

476.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Jacking or Boring Pipe", or "Jacking, Boring or Tunneling Pipe" of the type, size, and strength or design specified.

This price shall be full compensation for excavation, grouting, backfilling and disposal of surplus material; for furnishing all materials, including pipe liner materials required for tunnel operations; for all preparation, hauling and installing of pipe and pipe liner materials; and for all labor, tools, equipment and incidentals necessary to complete the work except that protection methods for excavations greater than 1.5 meters in depth shall be measured and paid for as required under Item 402, "Trench Excavation Protection" or Item 403, "Temporary Special Shoring".

ITEM 479

ADJUSTING MANHOLES AND INLETS

479.1. Description. This Item shall govern for adjusting or capping of existing manholes or inlets as shown on the plans and in accordance with this Item or as directed by the Engineer. Subject to the approval of the Engineer, prefabricated metal extension rings may be furnished for the adjustment of manholes. Drainage junction boxes will be classified as manholes.

479.2. Materials. Manholes or inlet rings, plates, grates and covers, and brick in good condition, removed from the manholes and inlets in the process of abandonment, capping or adjustment, may be reused. Additional materials when required shall conform to the pertinent provisions of Item 465, "Manholes and Inlets".

479.3. Construction Methods. Manholes or inlet rings, covers, plates, and grates shall be removed carefully and the contact areas shall be cleaned of all mortar and grease. Rings, covers, plates, or grates broken in the process of removal and cleaning shall be replaced by the Contractor at his expense.

When prefabricated metal extension rings are furnished, they may be either single piece or multiple piece as necessary for the amount of adjustment. They shall be installed in accordance with the manufacturer's instructions.

If the adjustment involves lowering the top of a manhole or inlet, a sufficient depth of brick courses or concrete shall be removed to permit reconstruction on a batter not exceeding 25 millimeters horizontal to 50 millimeters vertical. In the case of brickwork, the mortar shall be

cleaned from the top course of brick remaining in place and from all brick to be reused and the manhole or inlet rebuilt to the original top dimensions. The manhole or inlet ring, cover, plate, or grate shall then be installed with the top conforming to the proposed new surface.

If the adjustment involves raising the elevation of the top of manhole or inlet, the top surface of brick or concrete shall be cleaned and built up vertically to the new elevation using new brick, brick salvaged from other manhole or inlet adjustments, concrete rings or Class "A" concrete, and the ring, cover, plate, or grate installed with the top conforming to the proposed new surface.

When capping of an inlet or manhole is required, it shall be removed to a minimum of 0.3 meter below subgrade elevation or as otherwise indicated on the plans, and capped as shown on the plans.

All work shall be in accordance with Item 465, "Manholes and Inlets".

Excavation and backfill shall conform to Item 400, "Excavation and Backfill for Structures".

479.4. Measurement. Manholes or inlets completely adjusted, or capped as prescribed above, will be measured as each manhole or inlet adjusted.

479.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Adjusting Manholes", "Adjusting Inlets", or "Adjusting Manholes and Inlets". This price shall be full compensation for furnishing all required materials, including backfill as required, excavation, tools, labor, equipment, and incidentals required to complete the work.

ITEM 480

CLEANING EXISTING CULVERTS

480.1. Description. This Item shall govern for the removal of all extraneous material from existing culvert barrels and/or culvert pipes at locations shown on the plans and in accordance with this Item.

480.2. Construction Methods. The work may be performed by hand or mechanical methods or a combination of methods in order to completely expose all inside surfaces of the specified culverts.

The work shall be performed in a manner which will not move the culvert out of position nor damage any portion thereof. Any movement or damage done shall be corrected by repairing or replacing the damaged or moved portion of the culvert as directed by the Engineer, at the Contractor's expense.

Material removed from the culvert shall be disposed of by the Contractor. If approved by the Engineer, material removed may be placed on the roadway slopes adjacent to the culvert.

The Contractor shall schedule cleaning of the structure to provide proper drainage during construction. The final cleaning shall be performed just prior to final acceptance of the project in accordance with Article 4.7.

480.3. Measurement. This Item will be measured by each cul-vert cleaned, regardless of the number of barrels and/or lines of pipe at each location, or by the cubic meter. If measurement is by the cubic meter, the volume of material to be removed will be computed by the method of average end areas in its original position.

480.4. Payment. The work performed in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Cleaning Existing Culverts". This price shall be full compensation for all excavation, disposal of excavated material, for furnishing all labor, tools, equipment and incidentals necessary to complete the work.

ITEM 481

PVC PIPE FOR BRIDGE DRAINS

481.1. Description. This Item shall govern for the furnishing and installing of Poly Vinyl Chloride (PVC) pipe, of the various sizes and types as shown on the plans, to be used for bridge drains.

481.2. Material. PVC pipe and fittings which are to be cast in concrete or buried shall meet the requirements of ASTM D 3034 Type SDR-35 of the nominal size shown on the plans. PVC pipe and fittings which are to be exposed shall meet the requirements of ASTM D 1785 and D2466, schedule 40, of the nominal size shown on the plans.

The Contractor shall furnish the Engineer a manufacturer's certification that the material was manufactured, sampled, tested, and inspected in accordance with and meets the requirements of the pertinent ASTM specification.

Pipe furnished under this specification shall bear the following markings:

1. Manufacturer's name or trademark and code
2. Nominal pipe size
3. The PVC cell classification (example: 12454-B)
4. The schedule, size or other legend (example: Type PSM SDR-35 PVC Sewer Pipe)
5. The specification designation (example: ASTM D 1785)

Fittings furnished shall bear the following markings:

1. Manufacturer's name or trademark
2. Nominal size
3. Material designation (example: PVC)
4. The schedule, size or other legend (example: sched 40)
5. The specification designation (example: ASTM D 3034)

Pipe and fittings shall be free from defects which, in the judgement of the Engineer, would hinder their ability to function as designed.

The dimensions of the PVC pipe shall be as shown on the plans. The fittings shall properly fit the pipe supplied.

481.3. Construction Methods. The pipe shall be installed at the locations and to the lines, grades and dimensions shown on the plans or as revised by the Engineer.

All fittings shown on the plans and any other fittings necessary to properly install the pipe, including splice fittings, if necessary, shall be attached to the pipe by solvent welding using solvent meeting ASTM D 2564 and in accordance with the manufacturer's recommendations.

Splicing will not be allowed unless the required length of a straight section of pipe exceeds six (6) meters. This requirement may be waived by the Engineer for special conditions.

Required guard plates and devices to attach the pipe to portions of structures or to other types of pipe shall be as shown on the plans or as approved by the Engineer.

Any excavation and backfilling required for installation of the pipe shall be in accordance with Item 400, "Excavation and Backfill for Structures".

Unless otherwise shown on the plans, all exposed PVC pipe and fittings shall be degreased, acrylic water-based primer applied, followed by a coating of the same surface treatment material and color as used for adjacent concrete surfaces or as otherwise directed by the Engineer.

481.4. Measurement. This Item will be measured by the meter along the centerline of the pipe as installed.

481.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "PVC Pipe" of the various sizes and types specified. This price shall be full compensation for furnishing and installing the PVC pipe; for all fittings, hangers, clamps, straps, anchors, guard plates, excavation, backfill and painting; and for all labor, tools, equipment and incidentals necessary to complete the work.

ITEM 483

SCARIFYING CONCRETE BRIDGE SLAB

483.1. Description. This Item shall govern for scarifying concrete bridge slabs to the depths shown on the plans, and for the removal and disposal of the cuttings produced.

483.2. Equipment. The scarifying equipment shall be of the rotary or drum type, and shall be self-propelled with sufficient power, traction,and stability to maintain accurate depth of cut and slope. It shall be capable of accurately establishing profile grades along each edge of the machine by referencing from an existing surface by means of a ski or matching shoe, or from an independent grade control. It shall have an automatic system for controlling cross slope at a given rate, and shall have a manual system which can uniformly vary the depth of cut while the machine is in motion. It shall be equipped with means to control dust created by the cutting action.

Unless otherwise permitted by the Engineer, the machine shall be equipped with integral loading and reclaiming devices to immediately remove the cuttings from the surface of the roadway and discharge them into a truck, all in one operation.

Adequate equipment (mechanical street sweepers, loaders, trucks, water trucks, etc.) and personnel shall be provided to insure that all cuttings are removed within the time limit established by the Engineer, or as required by the plans.

Chipping tools shall be used to remove concrete in small areas not accessible to the mechanical scarifier.

483.3. Construction Methods. The existing concrete slab, at locations shown on the plans or designated by the Engineer, shall be scarified to the depths shown on the plans. The depth shall be measured from the level of the existing surface to the high points on the scarified surface.

Care shall be taken to prevent damage to the bridge slab reinforcing steel, armored joints, slab joints, drainage hardware and other appurtenances.

The Engineer may require that the concrete scarifying operation be referenced from an independent grade control in those areas where he deems this type of control to be appropriate. For this type of operation, the independent grade control shall be established and maintained by the Contractor in a manner acceptable to the Engineer.

The cuttings shall be placed in a disposal site approved by the Engineer.

483.4. Surface Texture. After the existing concrete slab has been scarified, it shall present a uniform rough surface suitable for bonding a concrete overlay. It is the intent of this specification that the surface have a chipped appearance.

483.5. Measurement. This Item will be measured by the square meter of scarified area of existing concrete surfaces.

Uniform cuts and tapered cuts of varying depth made in accordance with the plans will be measured by the square meter for the nominal depth of scarifying specified.

483.6. Payment. The work performed and equipment furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Scarifying Concrete Bridge Slab". This price shall be full compensation for removing all material to the depths shown, texturing the surface, loading, hauling, unloading, and satisfactorily storing or disposing of the cuttings, and for all labor, tools, equipment, manipulation and incidentals necessary to complete the work.

ITEM 485

WET SANDBLASTING

485.1. Description. This item shall govern for wet sandblast cleaning of concrete structures.

485.2. Materials. The material to be used shall be finely graded, absolutely clean particles of silica sand. Unless otherwise shown on the plans, the size of the particles shall be as required to accomplish a thorough cleaning with the equipment approved for use. The water used shall be potable. Compressed air, when used, shall be filtered.

485.3. Equipment. The equipment shall consist of an air compressor, equipped with an operating filter for removing oil and other contaminates, piping, hoses equipped with a special nozzle to combine water, sand and compressed air, and a material hopper capable of regulating sand flow. The hopper shall have controls which will permit immediate stoppage of sand flow, to allow the surface to be rinsed free of surface contaminants by combined air and water pressure.

Other equipment which will provide an acceptably clean surface may be used with prior approval of the Engineer.

485.4. Construction Methods. Minimum air pressure at the nozzle shall be 485 kilopascal. Water pressure shall be normal hydrant pressure. The minimum sand nozzle opening shall be six (6) millimeters.

High pressure water blast, with or without sand, will be permitted if it can be demonstrated to the satisfaction of the Engineer that the method will produce the required cleaning.

Wet sandblasting shall remove dirt, oil, curing compound, laitance, mortar and other materials to produce a surface satisfactory to the Engineer.

All blast debris shall be removed and placed in a disposal site approved by the Engineer.

485.5. Measurement and Payment. The work performed, materials furnished and all labor, tools, equipment and incidentals necessary to complete the work under this Item will not be measured or paid for directly, but will be considered subsidiary to the various bid items of the contract.

ITEM 490

TIMBER STRUCTURES

490.1. Description. This Item shall govern for the construction of all culverts, bridges, bulkheads, retaining walls, piers, bents, fenders, or any portion thereof which involves the use of timber materials whether treated or untreated. This Item shall not include temporary timber construction which is not a part of the finished work.

490.2. Materials. All materials used in the construction of timber structures shall conform to the requirements of Item 491, "Timber for Structures", or other pertinent specifications.

490.3. Preservative Treatment. Lumber and piling for Timber Structures shall be "Treated" or "Untreated" as shown on the plans. "Treated" lumber and piling shall be impregnated with the quantity of

Item 492, "Timber Preservative and Treatment", unless otherwise specified preservative and in the manner and by one of the processes specified in on the plans.

490.4. Storage of Materials. Lumber and timber at the site of the work shall be stored in piles.

Untreated material shall be open-stacked at least 300 millimeters above the ground surface and arranged to shed water and prevent warping. It shall be protected from the weather by suitable covering.

Treated timber shall be close-stacked, and arranged to shed water and prevent warping. It shall be protected from weather and sun by a suitable covering.

The ground underneath and in the vicinity of all material piles shall be cleared of weeds and rubbish.

490.5. Handling. Timber shall be handled carefully without sudden dropping, breaking of outer fibers, or bruising. The surface of treated timbers shall not be penetrated with tools. Treated timbers shall be handled with rope slings or other approved methods. Use of cant dogs, hooks, or pike poles will not be permitted.

490.6. Workmanship. Workmanship shall be first class throughout. Competent bridge carpenters shall be employed and all framing shall be true and exact. Nails and spikes shall be driven with just sufficient force to set the heads flush with the surface of the wood. Deep hammer marks in wood surfaces shall be considered evidence of poor workmanship.

All lumber and timber shall be accurately cut and framed to a close fit so that the joints will have even bearing over the entire contact surface. Mortises shall be true to size for their full depth and tenons shall make snug fit therein.

Countersinking shall be done wherever smooth faces are required.

490.7. Framed Bents. Mud sills of treated or untreated timber shall be of durable material as shown on the plans. They shall be bedded firmly and evenly to solid bearing and carefully tamped in place.

Concrete pedestals for the support of framed bents shall be finished carefully so that the sills or posts will take even bearing on them.

490.8. Sills. Sills shall have true and even bearing on piling or pedestals. When possible, all earth shall be removed from around sills so that there will be free air circulation around them.

490.9. Post Covers. The tops of posts in framed bents, if untreated material, shall be given a thick coat of hot tar, hot asphaltum, or hot coaltar and covered with a sheet of 0.912 millimeter thick galvanized metal as indicated on the plans. The cover shall measure at least 150 millimeters more in each dimension than the diameter or side of the post. The edges shall be bent down over the post and fastened with large headed galvanized nails or secured by binding with galvanized wire as indicated on the plans.

For treated materials, the tops shall be saturated thoroughly with hot creosote oil. These shall be covered with a coat of hot tar pitch over which shall be placed a cover as specified for untreated material above.

490.10. Caps. Timber caps shall be placed to secure an even and uniform bearing over the tops of the supporting posts or piling and to secure an even alignment of their ends. All caps shall be secured to the posts or piling in accordance with the details shown on the plans. No shimming on tops of piling or posts will be permitted.

490.11. Bracing. Sway bracing shall be placed diagonally on bents and connected to the cap and all piling or posts as shown on the plans.

Sash bracing and longitudinal bracing shall be placed and fastened to the piling or posts as shown on the plans.

Bracing shall be fitted to the bents in a satisfactory manner without dapping or cutting the posts or piling.

490.12. Stringers. Stringers shall be sized to uniform depth at bearings and shall be placed in a position so that knots near the edges will be in the top portion of the stringers.

Stringers may have butt joints or lapped joints as shown on the plans. The lapped ends of untreated stringers shall be separated at least 13 millimeters to permit the circulation of air. When stringers are two

panels in length, adjacent stringers shall be lapped at alternate bents. All stringers shall be fastened securely by bolts where shown on plans.

490.13. Bridging. Cross bridging or diaphragms between stringers shall be framed neatly and accurately and securely toe-nailed with at least two nails in each end.

Treated bridging need not be framed before treating, but the framed ends shall be given two coats of hot creosote oil before placing.

490.14. Flooring. Planks for single plank floors shall be placed with the heart side down with six (6) millimeters openings between them for seasoned materials and with tight joints for unseasoned material. Unless otherwise provided, each plank shall be spiked to each stringer or nailing strip with not less than two spikes, the length of which shall be at least 75 millimeters greater than the thickness of the plank. The ends of the plank shall be cut off on a straight line parallel with the centerline of the roadway. The planks shall be selected carefully according to thickness and so laid that no two adjacent planks shall vary in thickness more than three (3) millimeters.

Where double plank floors are indicated on the plans, the top course shall be laid diagonally or parallel to the centerline of the roadway as shown and, unless otherwise provided, each plank shall be spiked to the lower course at intervals of not more than 0.6 meter with two spikes, the length of which shall be at least 75 millimeters greater than the thickness of the plank. Joints shall be staggered at least 0.9 meter. Where the planks are placed parallel to or diagonally with the centerline of the roadway, special care shall be exercised to securely fasten the ends, and at the ends of the bridge, the ends of all planks shall be cut to a straight line parallel to the end of the bridge.

For laminated floors, the strips shall be placed on edge and at right angles to the centerline of roadway. The strips shall be full length. Random lengths will not be permitted. Unless otherwise provided, each strip shall be spiked to the adjacent strip at intervals of 0.6 meter, the spikes being staggered 200 millimeters in adjacent strips. The spikes shall be of sufficient length to pass completely through two adjacent strips and approximately half way through the third strip. In addition, unless otherwise provided, the strips shall be toe-nailed to the stringer with spikes not less than 100 millimeters in length. The toe-nailing of successive strips

shall be staggered so that the spacing of spikes along each stringer shall be not less than 150 millimeters. For strips 75 millimeters in thickness, spikes driven vertically through the strips and extending into the stringer not less than 75 millimeters may be substituted for toe-nailing, with the approval of the Engineer. Strips on steel stringers shall be secured to the stringers by three (3) millimeters thick floor plates, slotted to fit the flange of the stringer and punched for two nails.

490.15. Wheel Guards. Wheel guards, as shown on the plans, shall be constructed on each side of the roadway.

490.16. Railings. Railings shall be constructed as shown on the plans. All connections shall be bolted wherever possible. Railings shall be so constructed that no two butt joints occur on the same post.

490.17. Cutting, Framing Holes for Bolts, Dowels, Rods, and Lag Screws. All cutting, framing and boring of treated timbers shall be done before treatment insofar as is practicable.

Holes for round drift bolts and dowels shall be bored with a bit 1.5 millimeters less in diameter than the bolt or dowel to be used. The diameter of holes for square drift bolts or dowels shall be equal to the least dimension of the bolt or dowel.

Holes for machine bolts shall be bored with a bit of the same diameter as the bolt.

Holes for rods shall be bored with a bit 1.5 millimeters greater in diameter than the rod.

Holes for lag screws shall be bored with a bit no larger than the root of the thread and shall be 13 millimeters deeper than the penetration of the lag screws.

All cuts, and drilled holes, in treated piling or timbers and all abrasions, after having been trimmed carefully, shall receive treatment as specified in Item 492, "Timber Preservative and Treatment".

490.18. Hardware. Machine bolts, drift bolts, and dowels may be either wrought iron or medium steel; washers may be O-gee cast or

malleable iron, or they may be cut from medium steel or wrought iron plate, as specified.

Machine bolts shall have square heads and nuts unless otherwise specified. Wire nails and spikes shall be of steel, or circular cross section without taper, with a head and point, and of good quality. Boat spikes shall be of steel or wrought iron with forged heads and wedge-shaped points.

Washers of the size and type specified shall be used at all points where bolt heads and nuts would otherwise come in contact with wood. Cast washers shall have a thickness equal to the diameter of the bolt and a diameter of four times the thickness. For plate washers, the thickness shall be equal to one-half the diameter of the bolt, and the sides of the square shall be equal to four times the diameter of the bolt.

All bolt threads shall be properly checked after the final adjustment of the nuts. All bolt stock projecting beyond six (6) millimeters from the top of the nut shall be removed.

All hardware, including nails, except cast iron washers, shall be galvanized in accordance with Item 445, "Galvanizing".

490.19. Painting. After completion of the structure, all bolt heads, threads, nuts, washers, and exposed portions of bolts shall be given a thorough coating of hot asphalt.

Railings shall be painted as provided on the plans. The materials and application shall conform to the requirements of Item 446, "Cleaning, Paint and Painting".

For untreated timber structures, the following surfaces shall be coated thoroughly with a thick coat of hot tar, hot asphaltum, or hot coal-tar creosote before assembling: the ends, tops, and all contact surfaces of pile caps; floor beam and stringer ends; joints and all contact surfaces of truss members; and laterals and braces. The back face of bulkheads and all other timber in contact with earth shall be coated thoroughly with one of the materials specified above.

490.20. Measurement and Payment. The work performed, materials furnished and all labor, tools, equipment and incidentals necessary to complete the work under this Item will not be measured or paid for

directly, but will be considered subsidiary to the various bid items of the contract.

ITEM 491

TIMBER FOR STRUCTURES

491.1. Description. This Item shall govern for the materials for treated or untreated timber used in the construction of timber structures or portions of structures, as shown on the plans. This Item shall not include temporary timber construction which is not a part of the finished work.

491.2. Materials. Unless specified on the plans, the material shall be either southern pine or douglas fir, of the grades shown below. (Timber grade designations refer to standard designations of the Southern Pine Inspection Bureau and the West Coast Lumber Association.)

Group (1)

Stringers, caps, flooring posts, railing, wheel guards and fender timbers

SPECIES	SIZE OF MEMBER	GRADE
Southern Pine	2" (nominal 50 mm) Thickness	No. 1 Dense-1850F (12.8 MPa)
Southern Pine	2-1/2" (nominal 64 mm) and Thicker	Dense Str.-72-1850F (12.8 MPa)
Douglas Fir	2" to 4" (nominal 50 mm to 100 mm) Thick	Select Str.-1900F (13.1 MPa)
Douglas Fir	5" (nominal 125 mm) and Thicker	Select Str.-1900F (13.1 MPa)

Group (2)

Nailing strips, sway bracing, bulkhead plank, bridging, edging strips, cleats and blocks

SPECIES	SIZE OF MEMBER	GRADE
Southern Pine	2" (nominal 50 mm) Thickness	No. 1-1600F (11.0 MPa)
Southern Pine	2-1/2" (nominal 64 mm) and Thicker	Dense Str. 65-1650F (11.4 MPa)
Douglas Fir	2" to 4" (nominal 50 mm to 100 mm) Thick	Dense Constr.-1750F (12.1 MPa)
Douglas Fir	5" (nominal 125 mm) and Thicker	Dense Constr.-1750F (12.1 MPa)

The dressing of all timber shall be as indicated on plans or bills of material. Unless otherwise indicated, all strip flooring from 2 by 4 inches (nominal 50 by 100 millimeters) to 3 by 6 inches (nominal 75 by 150 millimeters) in size shall be dressed S1S1E, full size, hit or miss. Under this requirement, all pieces which are more than three (3) millimeters in excess of full nominal width or thickness, or more than six (6) millimeters scant of full nominal width or thickness at any point, will be rejected.

491.3. Grading Requirements. Methods of grading and general requirements shall be in accordance with the "General Requirements for Stress Grades" as set forth in ASTM D 245. All material shall bear the grade mark of an approved American Lumber Standards Committee agency or identification mark of a state approved inspection agency.

In the case where the timbers are to be treated, a grade mark, or identification mark must be on the timber before treating.

491.4. Treated Timber. Treated timber shall be impregnated with the type and amount of preservative specified, and by the process designated in Item 492, "Timber Preservative and Treatment".

491.5. Workmanship. Timber structures, whether treated or untreated, shall be constructed in accordance with the requirements of Item 490, "Timber Structures".

491.6. Timber For Sign Posts. Lumber for sign posts shall be Southern Pine, Number 1 small timbers, medium grain, air-dried, or kiln-dried before treatment. Compression wood is prohibited on any face. Such wood will be permitted if wholly enclosed in the piece, not less than six annual rings from the surface, and not over six (6) millimeters wide in its

maximum dimension. Sign posts shall have a preservative treatment as specified on the plans in accordance with Item 492, "Timber Preservative and Treatment".

491.7. Measurement. The quantities of timber of the various classifications used in the completion of the structure in accordance with the plans and specifications shall be computed in cubic meters on nominal sizes and the shortest commercial lengths practicable of use. The measurement shall not include timber used for erection purposes such as form, falsework and/or temporary bracing.

491.8. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid per cubic meters for "Treated Timber" or "Untreated Timber". This price shall be full compensation for all materials, hardware, equipment, tools, labor, painting, preservative treatment and incidentals necessary to complete the work.

The payment provided herein shall not be interpreted to include payment for timber piling, bituminous or concrete wearing surfaces, or other portions of the completed structures for which payment is provided elsewhere in the contract.

ITEM 492

TIMBER PRESERVATIVE AND TREATMENT

492.1. Description. This Item shall govern for the preservative, and for the seasoning, preparation and treatment of piles, posts, timbers and lumber when treatment is specified on the plans or called for in the specifications. Unless otherwise specified on the plans, the preservative and retention shall be as shown in Table 1 of this Item.

492.2. Materials. Except as otherwise provided herein, American Wood-Preservers' Association (AWPA) Standard Specifications shall govern for materials and methods of treatments, including seasoning, incising, preservatives, treatment and inspection for treatment. Pretreated stock will not be accepted unless, in the opinion of the Engineer, an emergency exists.

492.3. Paintability. When painting is required by the plans, timber products treated with oilborne preservatives shall be steam cleaned after installation.

492.4 to 492.8

492.4. Treatment of Cuts. When it is necessary to bore holes or to cut pressure treated materials after treatment, or when any treated surface is badly scarred, the hole, cut or scarred surface shall be given a multi-application of Copper Naphthenate solution as specified in AWPA Standard M4. The supplier of the timber products shall furnish suitable liquid preservative for field treatment upon request from the Engineer. The method of application to the damaged or cut areas shall be as specified in AWPA Standard M4.

492.5. Inspection. Inspectors representing the Department shall have access to all parts and facilities of plants used in the conditioning and treating of forest products. The supplier shall provide the necessary assistance for the proper inspection of the materials being furnished.

492.6. Identification. Each piece or bundle of treated-timber products shall bear a legible brand mark or tag indicating the name of the treater, date of treatment or lot number and the AWPA Specification symbol to which the treatment conforms.

492.7. Treating Plants. Treating plants furnishing treated-timber products to the Department shall meet the requirements of AWPA Standard M3 and shall be approved by the Department. A list of approved treating plants will be maintained by the Materials and Tests Division.

492.8. Measurement and Payment. The work performed, materials furnished and all labor, tools, equipment and incidentals necessary to complete the work under this Item will not be measured or paid for directly, but will be considered subsidiary to the various bid items of the contract.

Table 1
MINIMUM NET RETENTION OF PRESERVATIVE

Product	Creosote (AWPA P1) kilogram per cubic meter	Creosote Coal Tar Solution (AWPA P2) kilogram per cubic meter	Penta-Chloro-phenol (AWPA P8 & P9) kilogram per cubic meter	(1) ACA CCA (AWPA P5) kilogram per cubic meter	Treating Specif-ications (AWPA Standard Specif-ication Numbers)
TIMBER PILING					C3
For Land or Fresh Water Use (Including Foundation Piles)					
Southern Pine	192 by Assay (0 to 75 mm Zone)		10 Dry Penta by Assay (0 to 75 mm Zone)		
Douglas Fir	272 by Assay (0 to 25 mm Zone)		14 Dry Penta by Assay (0 to 25 mm Zone)		
For Use in Coastal Waters					
Southern Pine	320 by Assay (0 to 75 mm Zone)	320 by Assay (0 to 75 mm Zone)			
West Coast Douglas Fir	320 by Assay (0 to 50 mm Zone)				C18

Product	Creosote (AWPA P1) kilogram per cubic meter	Creosote Coal Tar Solution (AWPA P2) kilogram per cubic meter	Penta-Chloro-phenol (AWPA P8 & P9) kilogram per cubic meter	(1) ACA CCA (AWPA P5) kilogram per cubic meter	Treating Specif-ications (AWPA Standard Specif-ication Numbers)
GURARD FENCE POSTS-ROUND & RECTANGULAR					C14
Southern Pine	160 by Assay (0 to 25 mm Zone)		8 Dry Penta by Assay (0 to 25 mm Zone)	8 by Assay (0 to 25 mm Zone)	
POSTS FOR WIRE FENCE-ROUND					C5
Southern Pine	128 by Assay (0 to 25 mm Zone)		7 Dry Penta by Assay (0 to 25 mm Zone)	7 by Assay (0 to 25 mm Zone)	
TIMBER FOR SIGN POSTS	160		8	8	C14
BRIDGE TIMBERS & FENDER TIMBERS					C2
Southern Pine	128		7	7	
Douglas Fir	128		7	7	

Note: (1) ACA: Ammoniacal Copper Arsenite
CCA: Chromated Copper Arsenate

ITEM 495

RAISING EXISTING STRUCTURES

495.1. Description. This Item shall govern for raising existing structures as shown on the plans and in accordance with this Item.

495.2. Materials. All materials shall conform to the pertinent requirements of the following Items:

Item 420, "Concrete Structures"
Item 421, "Portland Cement Concrete"
Item 435, "Elastomeric Materials"
Item 440, "Reinforcing Steel"
Item 442, "Metal for Structures"

495.3. Construction Methods. Before starting the work of raising the structure, the Contractor shall submit to the Engineer for his approval detail plans bearing the seal of a Registered Professional Engineer, showing the method, materials, cribbing, falsework or other required supports, and equipment proposed for this Item of work. Such approval shall not relieve the Contractor of any responsibility for the successful completion of the work nor for any liability for replacement of damaged portions of the structure should the approved method result in damage to the structure. The Contractor shall be responsible for any damage caused by his operation in the process of raising the structure and shall repair such damage without additional compensation.

The proposed construction method shall conform to the following:

(1) The arrangement of points of load application shall be such that the allowable stresses for bearing, shear and flexure will not be exceeded for any material required to carry the load. A factor of 100 percent of the dead load shall be added in calculating bearing, shear and flexural stresses.

(2) Suitable cribbing, falsework or other support shall be provided to prevent the various spans or units from excessive dropping due to jack failure or other causes during raising operations and until the span or unit is released to the finished substructure.

(3) All spans shall be jacked from the existing bent cap, or from temporary falsework, unless specifically noted otherwise on the plans.

(4) Prior to jacking the Contractor shall verify that the vertical movement is not restricted by any anchor bolts, closed joints or other appurtenances.

(5) For prestressed concrete beam simple spans.

(a) Unless otherwise shown on the plans, raising the prestressed beam spans by jacking against the bottom flanges of beams, end diaframs or against the bottom of the slab will be permitted provided extreme care is taken to reduce sudden overloads; a minimum of two jacks per beam spacing per bent will be required.

(b) Vertical forces for lifting the unit shall be applied so that all beams at one end of the span are raised simultaneously. One end of a simple span shall not be raised more than 150 millimeters above the opposite end at any time.

(6) For continuous I-beam or plate girder units.

(a) Vertical forces for lifting each span or unit shall be applied to the bottom flange of the beams or to structural steel struts welded to webs of beams, as near the ends of the spans or centerline of bearings as possible, and in such a manner as to raise the entire span or unit simultaneously. At no time during raising operations for the continuous steel unit shall the relative elevations of the various points on the unit deviate more than 38 millimeters from the existing relative elevations.

(b) Prior to raising the existing structure, all anchor bolt nuts shall be loosened and removed or cut to allow free vertical movement of the structure.

(c) All anchor bolts damaged, cut off, or missing shall be replaced by either butt welding to

existing bolts or by drilling into the existing concrete cap a minimum of 300 millimeters and grouting in new bolts

of the same diameter as the existing bolts. All anchor bolt nuts damaged or lost shall be replaced.

(d) All welding shall conform to the requirements of Item 448, "Structural Field Welding".

(7) Adequate external guides or force shall be provided to assure true vertical lifting and prevent drifting of the unit during the jacking operation.

495.4. Measurement. This Item will be measured by the lump sum, except that material for steel pedestals will be measured by the kilogram in accordance with Item 442, "Metal for Structures" and material for concrete pedestals will be measured by the cubic meter in accordance with Item 420, "Concrete Structures".

495.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Raising Existing Structure". This price shall be full compensation for all shoring, falsework, jacking, labor, tools and all incidental equipment required to complete the job and for furnishing all material except new pedestals. Pedestals will be paid for in accordance with Item 442, "Metal for Structures", or Item 420, "Concrete Structures". When shown on the plans new fabric pads and/or elastomeric bearings will be subsidiary to the unit price bid for "Raising Existing Structure".

ITEM 496

REMOVING OLD STRUCTURES

496.1. Description. This Item shall govern for the removal and disposal of old structures or portions of old structures, as noted on the plans, and shall include all excavation and backfilling necessary to complete the removal. The work shall be done in accordance with this Item.

496.2. Method of Removal.

(1) Culverts or Sewers. Pipe for reuse shall be removed by careful excavation of all material on the top and sides so that the pipe will not be damaged. Removal of all appurtenances shall be included with pipe removal. Those pipe which are deemed unsatisfactory for reuse by the Engineer may be removed in any manner the Contractor may select.

(2) Concrete, Brick or Stone Structures. Unless otherwise shown on the plans or approved by the Engineer, structures or portions of structures shall be removed by breaking the material into sizes capable of being safely removed by available equipment. Blasting may be used only with the approval of the Engineer.

Portions of structures below the permanent ground line, which will not interfere in any manner with the proposed construction, may be left in place, but removal shall be carried at least 0.6 meter below the permanent ground line and neatly squared off. Reinforcement shall be cut off flush with the surface.

When an existing concrete structure is to remain in use, the removal of any portions thereof shall be in accordance with Item 430, "Extending Concrete Structures".

(3) Steel Structures. Steel structures or steel portions of structures shall be dismantled in sections as shown on the plans or as approved by the Engineer. Sections shall be of such mass and dimensions which will permit convenient handling, hauling and storing. Dismantling shall be governed by the following:

(a) Steel designated for sale to the Contractor in accordance with Item 497, "Disposal of Salvageable Material", may be dismantled by flame-cutting or other methods approved by the Engineer.

(b) Steel to be retained by the State shall be dismantled by removing rivets and bolts by cutting the heads with a "cold cut" and punching or drilling them from the hole. Welded connections shall be arc-air gouged. Welded splices shall be flame-cut along a straight line at the splice. Other methods that will not damage the members for reuse may be approved by the Engineer.

(c) Steel to be re-erected shall be carefully dismantled without damage and matchmarked with paint in accordance with the approved erection drawings. Disassembly shall be done using methods specified above for reusable material.

(4) Timber Structures. Timber structures or timber portions of structures to be reused shall be removed with as little damage to the timber as possible. The Contractor shall remove all bolts and nails from lumber which is deemed salvageable by the Engineer.

Unless otherwise specified on the plans, timber piles shall be either pulled or cut off at a point not less than 0.6 meter below permanent ground line, at the Contractor's option.

496.3. Salvage. All material such as pipe, timbers, railings, etc., which the Engineer deems as salvageable for reuse and all structural steel shall be carefully placed in neat piles along the right-of-way at convenient loading points which will not interfere with traffic or construction or delivered to a location shown on the plans. All of these materials shall be the property of the Department.

The I-beams, girders, stringers, etc., which are to be put in storage or specified for reuse shall be blocked off the ground in an upright position to protect the members against damage.

Materials, other than structural steel, which are not deemed salvageable by the Engineer shall become the property of the Contractor and shall be removed to disposal sites off the right of way arranged for by the Contractor and approved by the Engineer or otherwise disposed of in a manner satisfactory to the Engineer.

The Contractor, with approval of the Engineer, will be permitted to use materials removed under this Item for the construction of detour structures. The Contractor shall dismantle and stack or dispose of the materials as required above as soon as the new structure is opened for traffic.

496.4. Blasting. The Contractor's attention is called to Article 7.9 regarding responsibility in the use of explosives.

496.5. Backfill. All excavation made in connection with this Item and all openings below the natural ground line caused by the removal of old structures or portions thereof shall be backfilled to the level of the original ground line, unless otherwise provided on the plans.

That portion of the backfill which will support any portion of the roadbed or embankment shall be placed in layers of the same thickness as those required for placing embankment. Material in each layer shall be wetted uniformly if required and shall be compacted to the density required in the adjoining embankment. In places inaccessible to blading and rolling equipment, mechanical or hand tamps or rammers shall be used to obtain the required compaction.

That portion of the backfill which will not support any portion of the roadbed or embankment shall be placed in layers not more than 250 millimeters in depth (loose measurement) and shall be compacted to a density comparable with the adjacent undisturbed material.

496.6. Measurement. This Item will be measured as each individual structure to be removed, except that pipe structures may be measured as each structure, or by the meter. When measured by either method, removal shall include all appurtenances.

496.7. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Removing Old Structures, (Large)", "Removing Old Structures, (Small)" and "Removing Old Structures (Pipe)". This price shall be full compensation for all labor, tools, equipment, excavation, backfilling, stockpiling materials, and incidentals necessary to complete the work.

ITEM 497

DISPOSAL OF SALVAGEABLE MATERIAL

497.1. Description. This Item shall govern for the sale to the Contractor of all structural steel, steel railing, timber or any other material salvaged from existing structures which have been removed in accordance with Item 430, "Extending Concrete Structures", Item 496, "Removing Old Structures", or as otherwise stated on the plans. The approximate quantity of materials to be salvaged will be shown on the plans. It will be the Contractor's responsibility to have all materials designated for sale removed from the site prior to final acceptance of the project.

497.2. Measurement. All salvaged structural steel, steel railing, timber or other material designated for sale to the Contractor will be measured as a lump sum unit.

497.3. Payment. The Contractor shall pay to the Texas Department of Transportation the lump sum bid for "Salvaged Material (Credit Item)". The amount bid will be deducted from the Contractor's estimate upon removal of the salvaged materials from the project site.

ITEM 498

PLANT INSPECTION LABORATORY
(Equipped)

498.1. Description. This Item shall govern for the furnishing of an inspection laboratory. A commercial fabricating plant from which the Contractor proposes to obtain precast prestressed and non-stressed concrete products, and any job site prestressed concrete plant (pretensioning or post-tensioning), shall provide an inspection laboratory, available for the use of the State, equipped as specified herein.

498.2. General Requirements. The laboratory shall be provided prior to beginning the casting of any prestressed or non-stressed concrete units required by the contract.

All equipment furnished shall be subject to approval of the Engineer. With the written permission of the Engineer, the Contractor may provide other suitable equipment and/or facilities for testing.

All equipment shall be calibrated properly and housed in a weatherproof enclosure. Recalibrations of any equipment furnished by the Contractor shall be done when directed by the Engineer at the expense of the Contractor.

The building and equipment shall be properly maintained and shall be repaired or replaced if either becomes inadequate for its intended use. The Contractor shall provide building janitorial service acceptable to the Engineer.

Department personnel and the Contractor's personnel shall not be housed in the same office or laboratory space.

498.3. Laboratory Building.

(1) Commercial Fabricating Plants. The building furnished shall be approved by the Engineer. It shall be partitioned to provide a separate laboratory and office. Unless otherwise authorized by the Engineer, laboratory and office space for plant operations requiring two (2) inspection personnel shall be not less than 37 square meters. For operations requiring three (3) or more inspection personnel, the laboratory and office space shall be not less than 55 square meters. The building shall be weatherproof, adequately lighted, heated, air conditioned, ventilated and shall be furnished with adequate electrical outlets, floor covering, rest room facilities and rest room supplies. Solar screens, blinds or shades may be required when deemed necessary by the Engineer. Potable drinking water shall also be furnished.

Adequate ventilation shall be provided for capping equipment. Curing, capping, capping ventilation equipment and testing facilities for concrete cylinders may be housed in the same building but partitioned off from the laboratory and office space, or contained in space convenient to the office and laboratory. If curing, capping and testing facilities are housed in the same building the space required for these facilities will be in addition to the above requirements for laboratory and office space. The building shall be located to provide visibility to plant operations unless otherwise approved by the Engineer.

(2) Job Site Plant. A laboratory building shall be furnished for inspection of prestressing operations. The building shall be a Type C structure as described in Item 504, "Facilities for Field Office and Laboratory", and shall be approved by the Engineer. It shall be watertight, adequately lighted, heated, air conditioned, and ventilated, equipped with rest room facilities and situated so the plant operations are visible therefrom, unless otherwise approved by the Engineer.

498.4. Equipment.

(1) Commercial Fabricating Plants. Equipment furnished shall be as follows:

(a) A sink with running hot and cold water.

(b) Work tables, file cabinets, plan file racks, bulletin boards, desks and chairs as deemed necessary by the Engineer.

(c)A compression machine meeting the requirements of Test Method Tex-418-A. The compression machine shall be capable of testing cylinders to their full strength while operating within 90 percent of its full capacity. Plants producing precast non-stressed products may, in lieu of furnishing a compression machine, have test cylinders tested by an approved commercial laboratory, at their expense.

(d)A scale or balance as required by Test Method Tex-401-A.

(e)For moisture and specific gravity determination, a gas pressure moisture content tester, a supply of 1.0 and 2.0 liter glass jars, pycnometer tops, wide spout funnel and siphon bulb.

(f)A complete set of sieves as required by Test Method Tex-401-A.

(g)An electrically powered mechanical sieve shaker, to accommodate the size of sieves furnished above.

(h)A thermostatically controlled electric or gas oven capable of maintaining a temperature of 110 °C ± 13 °C at loaded capacity.

(i)Cylinder molds meeting the requirements of Test Method Tex-447-A. The nominal molds sizes may be either 150 millimeters by 300 millimeters or 100 millimeters by 200 millimeters but all cylinders representing a casting line or lot shall be the same size and shall be made with the same type of mold.

A minimum of twelve (12) cylinder molds for each casting line for each day's casting shall be required for precast prestressed concrete plants.

A minimum of six (6) cylinder molds for each 40 cubic meters casting lot, or fraction thereof, for each day's casting shall be required for precast non-stressed concrete plants.

(j)One (1) small shovel and trowel for making concrete cylinders.

(k)Six (6) round aggregate pans.

(l)Capping equipment meeting the requirements of Test Method Tex-450-A. Plants producing precast non-stressed concrete products that have test cylinders tested by a commercial laboratory

will not be required to furnish this equipment.

(m) Equipment for determining the diameter of test cylinders to the nearest 0.25 millimeter. Plants producing precast non-stressed products that have test cylinders tested by a commercial laboratory will not be required to furnish this equipment.

(n) A curing tank meeting the requirements of Test Method Tex-447-A and large enough to accommodate a minimum of six (6) cylinders for each placement for at least 14 days of consecutive run.

(o) Equipment as required by Test Method Tex-404-A for running unit weight.

(p) A slump mold and tamping rod as required by Test Method Tex-415-A.

(q) All of the equipment required for performing the sand equivalent test in Test Method Tex-203-F.

(r) Recording thermometers when elevated temperature curing is used and during the period of November 1 through March 31 for all curing methods. A minimum of one (1) standby recording thermometer will be required for emergency use.

One (1) recording thermometer will be required for each 30 meter length of casting bed in simultaneous use at precast prestressed concrete plants.

A minimum of one (1) recording thermometer will be required for each 40 cubic meters casting lot, or fraction thereof, at precast non-stressed concrete plants.

(s) One (1) remote reading thermometer.

(t) When air entrained concrete is required, equipment meeting Test Method Tex-416-A.

498.5

(2) Job Site Operations. Equipment items (a), (c), (i), (l), (m), (n), (r), and (s) as required above for commercial fabricating plants shall be furnished by the Contractor. Other items required will be furnished by the State. In lieu of providing a compression testing machine as described in (c), the Contractor may provide, at his expense, to have test cylinders tested by an approved commercial laboratory. If test cylinders are tested by an approved commercial laboratory,

the equipment described in items (l) and (m) will not be required. Moisture content of the aggregate may be determined by the pycnometer method.

498.5. Measurement and Payment. The work performed, materials furnished and all labor, tools, equipment and incidentals necessary to complete the work under this Item will not be measured or paid for directly, but will be considered subsidiary to the various bid items of the contract.

PART II, CONSTRUCTION DETAILS

DIVISION V
INCIDENTAL CONSTRUCTION

ITEM 500

MOBILIZATION

500.1. **Description.** This Item shall govern for the establishment of office and other facilities at the project site and the movement of personnel, construction equipment and supplies to the project site or to the vicinity of the project site in order to enable the Contractor to begin work on the other contract items that will be performed by the Contractor. The cost of the payment bond and performance bond on projects that cannot begin because of a closed construction season or for the convenience of the Department will be considered part of the mobilization item under this contract.

500.2. **Measurement.** This Item will be measured by the "Lump Sum", as the work progresses.

500.3. **Payment.** Partial payments of the "Lump Sum" bid for mobilization will be as follows. The adjusted contract amount for construction items as used below is defined as the total contract amount less the lump sum bid for Mobilization.

(1) Upon presentation of a paid invoice for the payment bond, performance bond and/or required insurance, the Contractor will be paid that cost from the amount bid for mobilization.

(2) The mobilization of rock crushers, hot-mix asphaltic-concrete plants, concrete batch plants or other similar facilities, with supporting equipment, to the project site or to the vicinity of the project site will be considered as partial mobilization under this contract. The Contractor shall provide a certified statement of his expenditure for the mobilization and setup of the facility and supporting equipment. Upon approval by the Engineer, the certified expenditure will be paid from the amount bid for the Item, "Mobilization". In no case shall the combined amount for all these facilities be more than 10 percent of the mobilization lump sum bid or one (1) percent of the total contract amount, whichever is less.

(3) When one (1) percent of the adjusted contract amount for construction items is earned, 50 percent of the mobilization lump sum bid or five (5) percent of the total contract amount, whichever is less, will be paid. Previous payments under this Item will be deducted from this amount.

(4) When five (5) percent of the adjusted contract amount for construction items is earned, 75 percent of the mobilization lump sum bid or 10 percent of the total contract amount, whichever is less, will be paid. Previous payments under this Item will be deducted from this amount.

(5) When 10 percent of the adjusted contract amount for construction items is earned, 90 percent of the mobilization lump sum bid or 10 percent of the total contract amount, whichever is less, will be paid. Previous payments under this Item will be deducted from this amount.

(6) Payment for the remainder of the lump sum bid for "Mobilization" will be made on the next monthly estimate cycle after the retainage estimate.

ITEM 502

BARRICADES, SIGNS AND TRAFFIC HANDLING

502.1. Description. This Item shall govern for providing, installing, moving, replacing, maintaining, cleaning and removing upon completion of work, all barricades, signs, cones, lights and other such type devices and of handling traffic as indicated on the plans or as directed by the Engineer.

502.2. Construction Methods. All barricades, signs and other types of devices listed above shall conform to details shown on the plans or those indicated in the Texas Manual on Uniform Traffic Control Devices (TMUTCD).

For this project a Traffic Control Plan (TCP), responsive to the TMUTCD, has been established by the Engineer. The Contractor may propose his own TCP. Contractor-proposed major modifications to the Traffic Control Plan shall bear the seal of a Registered Professional Engineer. If his plan is approved in writing by the Engineer, it may be used. Prior to beginning work, the Contractor shall designate, in writing, a competent person who will be responsible and available on the project site

or in the immediate area to insure compliance with the TCP. The Engineer will designate a qualified Departmental person to observe implementation and who will have authority to assure compliance with the TCP.

All retroreflective traffic control devices such as barricades, vertical panels, signs, etc., shall be maintained by cleaning, replacing or a combination thereof such that during darkness and rain the retroreflective characteristics shall equal or exceed the retroreflective characteristics of the standard reflective panels in the Engineer's possession.

502.3. Measurement. This Item will be measured by the unit of measure "month" as indicated on the plans.

502.4. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Barricades, Signs and Traffic Handling". This price shall be full compensation for furnishing all labor, materials, supplies, equipment and incidentals necessary to complete the work as specified.

Payment will be made on the following basis:

(1) The total payment for this Item will not exceed 10 percent of the total contract amount prior to "Final Acceptance". The portion of the contract amount for this Item in excess of 10 percent of the total contract amount, less any adjustments as specified below, will be paid on the next estimate cycle after the retainage estimate.

(2) Payment for this Item will begin on the first payable estimate after barricades, signs and traffic handling devices have been installed in accordance with the TCP and construction has begun.

(3) Monthly payment will be made each succeeding month for this Item provided the barricades, signs and traffic handling devices have been installed and maintained in accordance with the TCP until the contract amount for Barricades, Signs and Traffic Handling has been paid unless adjusted by paragraph (4).

(4) The quantity under this Item will not exceed the total plan quantity except when modified by change order. Also when work is

suspended for the convenience of the Department, through no fault of the Contractor, additional quantity may be paid when approved by change order.

(5) An overrun of the plan quantity for this Item will not be allowed for approving designs, testing, material shortages, closed construction seasons, curing periods, test periods, failure to complete the work prior to payment of the amount allowed by (1) and (3) above nor delays caused directly or indirectly by requirements of the contract.

(6) If the contract is completed prior to payment of the amount allowed by (1), (3) and (7), the balance due will be paid on the next monthly estimate cycle after the retainage estimate. When the plans establish pay items for particular work called for in the TCP and/or plans, that work will be measured and paid for under the governing items.

(7) If the Contractor fails, within the time frame established by the Engineer, to provide or properly maintain signs and barricades in compliance with the contract requirements, as determined by the Engineer, the Contractor will be considered in non-compliance with this Item and no payment will be made for this Item for the month(s) in question.

ITEM 504

FACILITIES FOR FIELD OFFICE AND LABORATORY

504.1. Description. This Item shall govern for the erection or furnishing of facilities to be used by the Engineer during the construction of the project.

504.2. General Requirements. The types and number of structures required will be as shown on the plans.

The facilities shall be furnished subsequent to the receipt to begin work, but prior to beginning physical work on the project, unless otherwise approved by the Engineer. It shall remain in place until the project is accepted by the State as complete, unless otherwise directed by the Engineer. Such facilities shall be floored and roofed, weather-tight and constructed in a workmanlike manner. All windows shall be screened.

The building shall be constructed or furnished near the site of the work, at a location acceptable to the Engineer and may be either an independent structure or, if a portion of the structure is used by the Contractor, the Department field office or laboratory area shall not interconnect with Contractor utilized rooms. Access to the field office or laboratory shall be by direct outside entrance, controlled by the Engineer.

Should the facilities be destroyed or damaged in any manner, except through causes due to negligence of the Engineer, the Contractor shall immediately restore it. Upon the completion of the project the building shall be removed from the project site.

Unless otherwise shown on the plans, the buildings shall be electrically wired for lights, outlets and plugs and piped for water and fuel as directed by the Engineer. Unless otherwise shown on the plans, the Contractor shall furnish and install equipment, electricity, security lighting, potable water, fuel, adequate air conditioning, heating and an exhaust fan as directed by the Engineer. If the building is to serve as a laboratory for quality control of asphalt mix production, provisions shall be made for ventilation as indicated in Subarticle 504.3(4). Substantial and adequate workbenches, tables and chairs shall be provided. The building shall be serviced with sewer or septic tank with connections and shall contain a rest room properly partitioned and furnished with, as a minimum, a flush toilet and a lavatory. When approved by the Engineer, a portable toilet may be furnished and serviced in lieu of a flush toilet. The Contractor will be responsible for adequate collection and disposal of trash. If steps are needed for the building, they are to be furnished by the Contractor.

A rental building meeting specified minimum requirements in Article 504.3, at a suitable location and acceptable to the Engineer, may be furnished by the Contractor instead of the individual buildings required by this Item.

Unless otherwise shown on the plans, a parking area shall be constructed and/or furnished for the sole use of the Engineer and the inspection force and for overnight storage of state-owned vehicles during construction of the project. The parking area shall be as described on the plans or an equivalent as is acceptable to the Engineer. It shall be constructed or furnished near the field office at a location acceptable to the Engineer unless otherwise shown on the plans. The area shall remain until the project is completed, unless otherwise directed by the Engineer. Upon completion of the project and prior to acceptance by the State, disposition of the parking area will become the Contractor's responsibility.

Unless otherwise shown on the plans, the facility provided, including the parking area, shall be enclosed by a 1.8 meter chain link fence with three strands of barbed wire and a 3.6 meter gate. The enclosure shall be of the dimensions shown on the plans.

504.3. Type of Structure. Alternate floor space configurations may be substituted if approved by the Engineer.

(1) Type A Structure, Field Laboratory. This building shall be not less than three (3) meters by six (6) meters and 2.4 meters high. The building shall be partitioned into a minimum of two rooms, each room furnished with an exterior door and a minimum of two windows. The building shall contain a small work platform not less than 450 millimeters long and 300 millimeters wide mounted on a post of not less than 150 millimeter by 150 millimeter lumber, extending through the floor and firmly fixed in the ground.

(2) Type B Structure, Field Office and Laboratory. This building shall provide a minimum of 50 square meters of gross floor area. The floor area will be partitioned into a minimum of three rooms and furnished with doors, floor covering and a minimum of two windows in each room. The building shall have two exterior doors.

(3) Type C Structure, Field Office. This building shall not be less than 3.6 meters wide by ten (10) meters long and 2.4 meters high. The floor area shall be partitioned into a minimum of two rooms and furnished with doors, floor covering and a minimum of two windows in each room. The building shall have two exterior doors.

(4) Type D Structure, Asphalt Mix Control Laboratory. The laboratory portion of this structure, when used for asphalt mix quality control, shall be equipped with an exhaust fan of sufficient capacity to evacuate the fumes generated by the asphalt extraction procedure. The structure shall meet any dimensional requirements shown on the plans.

The fan shall be capable of reducing the fume concentrations to levels below OSHA maximums. The fan motor shall be explosion proof. The fan shall be located beneath the workbench in the extraction area and shall be exhausted to the outside. The top of the workbench shall be not less than 600 millimeters by 1500 millimeters and shall be constructed of expanded metal reinforced to support required testing equipment. The front and sides of the workbench shall be enclosed so that all exhaust airflow is through the expanded

metal top. The front of the workbench shall have a

door which, when opened in conjunction with placing a cover over the expanded metal top, will cause the exhaust to be pulled through the door opening. Sufficient area shall be allowed directly in front of this door for the placement and operation of a free standing extractor. A fresh air intake shall be located so solvent vapors are drawn away from workers. All safety considerations regarding the laboratory structure which are required for extraction testing in Test Method Tex-210-F shall be provided.

The oven used to dry extracted aggregate shall be vented to the outside.

(5) Type E Structure. This building shall be as described on the plans.

504.4. Measurement and Payment. The work performed and materials furnished in accordance with this Item will not be measured nor paid for directly, but shall be considered subsidiary to the various bid items in the contract.

ITEM 506

TEMPORARY EROSION, SEDIMENTATION AND WATER POLLUTION PREVENTION AND CONTROL

506.1. Description. This Item shall govern the control measures necessary to prevent and control soil erosion, sedimentation and water pollution which may degrade receiving waters including rivers, streams, lakes, reservoirs, tidal waters, groundwater and wetlands. The control measures contained herein shall be installed and maintained throughout the construction contract and coordinated with the permanent or existing temporary pollution control features specified elsewhere on the plans and in the specifications to assure effective and continuous water pollution control throughout the construction and post construction period. These control measures shall not be used as a substitute for the permanent pollution control measures unless otherwise directed by the Engineer in writing. The controls may include sediment control fences, baled hay, rock filter dams, dikes, swales, sediment traps and basins, pipe slope drains, paved flumes, construction exits, temporary seeding, sodding, mulching, soil retention blankets or other structural or nonstructural water pollution controls. This item does not apply to commercial operations.

506.2. Items of Work and Materials. The items, estimated quantities and locations of the control measures will be shown on the plans; however, the Engineer may increase or decrease the quantity of these items as the need arises. The materials will be shown on the plans and in the specifications. The Engineer may allow other materials and work as the need arises and as approved in writing.

506.3. Preconstruction Submittals.

(1) Operations on Right of Way. Prior to the start of construction, the Contractor shall submit to the Engineer, for written approval, schedules for accomplishment of the pollution control measures in accordance with the Storm Water Pollution Prevention Plan (SW3P). A plan for the disposal of waste materials generated on the project site must be submitted for approval, also. The Contractor shall submit to the Engineer, for written approval, the proposed SW3P for the industrial activities (such as hot mix plants, concrete batch plants, or material handling areas) on the right of way.

(2) Operations Off Right of Way. The Contractor shall provide the Engineer, for information purposes, proposed methods of pollution control for Contractor operations in areas which are outside the right of way (such as construction and haul roads, field offices, equipment and supply areas, and material sources).

Pollution control measures for the Contractor's facilities off the right of way are not covered by the Department's Environmental Protection Agency (EPA) NPDES general permit. The Contractor shall obtain his own Notice of Intent for the off-site operations. These pollution controls will not be measured for payment but shall be performed at the Contractor's expense. For facilities off the right of way, the Contractor is responsible for obtaining all permits required by any governmental entity as outlined in Article 7.2.

506.4. Construction Requirements.

(1) The Contractor shall provide control measures to prevent or minimize the impact to receiving waters as required by the plans and/or as directed by the Engineer in writing. Storm water discharges associated with industrial activities (such as hot mix plants, concrete batch plants or material handling areas) within the right of way must comply with the terms of the EPA's NPDES general permit.

For areas of the State which have an average annual rainfall less than 510 millimeters and where construction operations have ceased for an extended period of time, the disturbed area shall be stabilized as soon as possible. For all areas of the State with an average annual rainfall greater than 510 millimeters, in any disturbed area where construction activities have ceased, permanently or temporarily, the Contractor shall initiate stabilization of the area by the use of seeding, mulching, soil retention blankets or other appropriate measures within 14 days, except in areas where construction activities are scheduled to resume within 21 days.

The Contractor shall effectively prevent and control erosion and sedimentation on the site at the earliest practicable time as outlined in the approved schedule. Control measures, where applicable, will be implemented prior to the commencement of each construction operation or immediately after the area has been disturbed.

The Contractor shall limit the amount of disturbed earth to the area(s) shown on the plans or as directed by the Engineer. The Engineer has the authority to limit the disturbed surface area exposed by construction operations. If, in the opinion of the Engineer, the Contractor is not able to effectively control soil erosion and sedimentation resulting from construction operations, the Engineer will limit the amount of disturbed area to that which the Contractor is able to control.

Should the control measures fail to function effectively, the Contractor shall act immediately to bring the erosion and sedimentation under control by maintaining existing controls or by providing additional controls as directed by the Engineer. When in the opinion of the Engineer the site is adequately stabilized, the control measures, excepting mulches and soil retention blankets, will be removed and properly disposed of by the Contractor. Soil retention blankets shall be removed only when, in the opinion of the Engineer, final permanent perennial seeding would be adversely affected by the presence of an existing soil retention blanket.

All erosion, sediment and water pollution controls will be maintained in good working order. A rain gauge provided by the Department will be located at the project site. Within 24 hours of a rainfall event of 13 millimeters or more as measured by the project rain gauge, the Contractor and Engineer will inspect the entire project to determine the condition of the control measures. Sediment will be removed and devices repaired as soon as practicable but no later than seven (7) days after the surrounding exposed ground

has dried sufficiently to prevent further damage from equipment needed for repair operations.

506.4

In the event of continuous rainfall over a 24-hour period, or other circumstances that preclude equipment operation in the area, the Contractor will hand carry and install additional backup devices as determined by the Engineer. The Contractor will remove silt accumulations and deposit the spoils in an area approved by the Engineer as soon as practical. Any corrective action needed for the control measures will be accomplished in the sequence directed by the Engineer, however areas adjacent to waterbodies shall generally have priority followed by devices protecting storm sewer inlets.

(2) The Contractor shall also conform to the following practices and controls. All labor, tools, equipment and incidentals to complete the following work will not be paid for directly but shall be considered as subsidiary work to the various items included in the contract, unless otherwise noted.

(a) Disposal areas, stockpiles and haul roads shall be constructed in a manner that will minimize and control the amount of sediment that may enter receiving waters. Disposal areas shall not be located in any wetland, waterbody or streambed. Construction roads may not be located in or cross any waterbody or streambed without prior approval of the Engineer and shall be done in compliance with applicable rules and regulations.

(b) Construction operations in rivers, streams, lakes, tidal water wetlands and other waterbodies shall be restricted to those areas where it is necessary to perform the work shown on the plans. Wherever streams are crossed, temporary bridges, timber mats or other structures shall be used.

(c) Protected storage for paints, chemicals, solvents, fertilizers and other potentially toxic materials will be provided by the Contractor at a location approved by the Engineer.

(d) Construction staging areas and vehicle maintenance areas shall be constructed by the Contractor in a manner to minimize the runoff of pollutants. Those areas located on the right of way must be approved by the Engineer. The Contractor shall prevent pollution of receiving waters with petroleum products or other hazardous or regulated substances. When work areas or material sources are located adjacent to a waterbody, control measures shall be used to keep sediment and other contaminants from entering the adjacent waterbody. Control devices located on the right of way will be measured for payment. Care shall be taken during the construction and removal of control measures to

minimize down-gradient sedimentation.

(e) All waterways shall be cleared as soon as practicable of temporary embankment, temporary bridges, matting, falsework, piling, debris or other obstructions placed during construction operations that are not a part of the finished work.

(f) Disturbance of vegetation shall be minimized and limited to only what is shown on the construction plans or as directed by the Engineer in writing.

(g) The Contractor shall clean paved surfaces as necessary to remove sediment which has accumulated on the roadway.

(3) The project will not be accepted until the Contractor provides a uniform perennial vegetative cover with a density of 70 percent of adjacent undisturbed areas, or, if in the opinion of the Engineer, permanent measures (such as riprap, gabions, or geotextiles), supplemented by temporary measures (such as mulching with seed, hay bales, sediment control fences, earth dams, etc.) have been employed that will control erosion, sedimentation and water pollution until sufficient vegetative cover can be established.

506.5. **Measurement and Payment.** If the Contractor is required to install temporary erosion, sediment and water pollution control measures due to his negligence, carelessness, lack of maintenance, or failure to install permanent controls as a part of the work as scheduled, and measures are ordered in writing by the Engineer, such work shall not be measured for payment but shall be performed at the Contractor's expense. All labor, tools, equipment and incidentals to complete the work specified under Subarticle 4.(B) will not be paid for under applicable contract bid items but will be considered subsidiary to the various bid items, unless otherwise noted.

When the need for control measures can not be attributed to the Contractor's negligence, carelessness, lack of maintenance or failure to install permanent water pollution control measures and these measures are shown on the plans and/or directed by the Engineer, these measures shall be measured and paid for in accordance with applicable contract bid items. For work performed under the requirements of this item which is not comparable to work performed under contract bid items, such work shall be performed on a force account basis in accordance with Item 9 or by agreed unit prices. Removal of control measures not incorporated as permanent control measures shall be measured and paid for in accordance with applicable contract bid items.

In case of failure on the part of the Contractor to prevent and control soil erosion, sedimentation and water pollution which may degrade receiving water, the Engineer reserves the right to employ outside assistance or to use State forces to provide the necessary corrective measures. All costs including engineering costs will be deducted from any moneys due or to become due to the Contractor.

Pollution control measures may be applicable to Contractor operations outside the right of way where such work is necessary as a result of roadway related construction such as construction and haul roads, field offices, equipment and supply areas, and material sources. Pollution control measures outside the right of way will not be measured for payment but shall be performed at the Contractor's expense.

ITEM 508

CONSTRUCTING DETOURS

508.1. Description. This Item shall govern for the construction, maintenance and removal, if required, of detours of the length and to the lines, grades and typical cross sections shown on the plans.

508.2. Materials. The material for the required embankment shall be procured from the roadway excavation and/or approved sources.

Any pipe required for temporary drainage across the detour will be furnished by the Contractor, and will become the property of the Contractor upon removal. It shall be in accordance with the details shown on the plans.

Permanent pipe for use on this project may be used temporarily for the detour, if the sequence of work will permit. When, in the opinion of the Engineer, pipe so used is damaged such that it will not be acceptable in the completed project, it will remain the property of the Contractor and shall not be incorporated in the final project.

Unless otherwise shown on the plans, base material may be flexible base, cement-stabilized base, asphalt-stabilized base or asphaltic concrete

pavement. Unless otherwise shown on the plans, all base and surfacing materials shall conform to the pertinent requirements of the following items:

Item 247, "Flexible Base"
Item 275, "Portland Cement Treated Materials (Road Mixed)"
Item 276, "Portland Cement Treated Base (Plant Mixed)"
Item 316, "Surface Treatments"
Item 330, "Limestone Rock Asphalt Pavement (Class A)"
Item 334, "Hot Mix-Cold Laid Asphaltic Concrete Pavement"
Item 340, "Hot Mix Asphaltic Concrete Pavement"
Item 345, "Asphalt Stabilized Base (Plant Mix)"

508.3. Construction Methods. The detours shall be constructed at the locations and to the lines, grades and typical sections as shown on the plans and in conformance with the applicable items or as directed by the Engineer.

The finished base shall receive surfacing where shown on the plans in accordance with the pertinent surfacing items.

After detours are no longer needed for traffic, the materials shall become the property of the Contractor to be disposed of off the project; however, if approved by the Engineer the materials may be disposed of by spreading along the adjacent roadway slopes. When shown on the plans, the materials (embankment, base and surfacing) shall be reused within the roadway construction or stockpiled for future use, in which case the salvaging or stockpiling will be performed in accordance with the pertinent bid items.

508.4. Measurement. This Item will be measured by the method shown on the plans and described as either Class 1, 2, 3 or 4 as follows. The limits of measurement for payment will be as shown on the plans.

When Class 1 measurement is specified, constructing detours will be measured by the kilometer or portion there of, as detour constructed complete in place.

When Class 2 measurement is specified, constructing detours will be measured as each detour constructed complete in place.

When Class 3 measurement is specified, constructing detours will be measured by the square meter of pavement area, unless otherwise shown on the plans, of each detour constructed complete in place.

When Class 4 measurement is specified, constructing detours will be measured as each completed detour. Embankment, flexible base and surfacing, where required, will be measured in accordance with pertinent bid items.

508.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Constructing Detours" of the class indicated on the plans. The price bid for Class 1, Class 2, and/or Class 3 detours shall be full compensation for furnishing all materials required, except as noted below, including base and surfacing; all excavation and hauling of excavated material; all royalty, sprinkling and compacting; furnishing, installing and removing pipe; maintenance of detour; removal of detour where required, except as noted below; all work, labor, tools, equipment and incidentals necessary to complete the work. The price bid for Class 4 detours shall be full compensation for furnishing, installing and removing pipe; maintenance of detour, removal of detour where required, except as noted below; all work, labor, tools, equipment and incidentals necessary to complete the work except that embankment, flexible base and surfacing will be measured and paid for in accordance with other pertinent bid items. All other items not specifically addressed herein shall be paid for under the pertinent bid items, unless otherwise shown on the plans.

When the plans require the base and the surfacing to be removed and incorporated in the final roadway or stockpiled after use on the detour, this work will be performed, measured and paid for in accordance with the pertinent bid items shown on the plans for salvaging, replacing or stockpiling materials.

When the plans require the embankment to be removed and incorporated in the final roadway or stockpiled after use on the detour, this work will be performed, measured and paid for in accordance with the pertinent bid items shown on the plans.

ITEM 510

ONE-WAY TRAFFIC CONTROL

510.1. Description. This Item shall govern for "One-Way Traffic Control" as directed by the Engineer and as specified herein.

510.2. One-Way Traffic Control. The Contractor shall furnish a pilot

vehicle, driver and flaggers for the purpose of expediting the safe and

efficient passage of traffic through the work zone under one-way controls. The flaggers shall possess the qualifications and meet the requirements set forth in the TMUTCD. The Contractor shall furnish the signs to be attached to the pilot vehicle. The Contractor shall also furnish a minimum of two stop-slow signs. All signs shall meet the requirements in the TMUTCD and as shown on the plans. Flaggers shall be stationed at each entry point to the work zone to stop all oncoming traffic and to instruct the drivers to follow the pilot vehicle and not to pass the cars ahead.

510.3. Measurement. This Item will be measured by the hour for the combination of flaggers and pilot vehicle.

510.4. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "One-Way Traffic Control". This price shall be full compensation for furnishing and operating all equipment; for pilot vehicle driver; for flaggers; for furnishing signs; and for all labor, fuel, tools and incidentals necessary to satisfactorily perform the work.

ITEM 512

PORTABLE CONCRETE TRAFFIC BARRIER

512.1. Description. This Item shall govern for furnishing and placing precast concrete traffic barrier at the locations shown on the plans and for moving the precast barrier from one location and placing the barrier in a new location as required on the plans. Precast barrier furnished by the Contractor shall be constructed in accordance with the details shown on the plans and/or to the requirements herein. Barrier sections which are to be furnished by the State will be at a storage site shown on the plans.

The low profile concrete barrier is a patented design. Information concerning this barrier may be obtained from Texas Transportation Institute, Texas A & M University System, College Station, Texas 77843-3135, (409)845-1712.

512.2. Materials. All materials shall conform to the pertinent requirements of the following items:

Item 421, "Portland Cement Concrete"
Item 437, "Concrete Admixtures"

Item 440, "Reinforcing Steel"

Item 442, "Metal for Structures"
Item 526, "Membrane Curing"

A hardware assembly is defined as being sufficient hardware for one complete connection between two traffic-barrier sections, including all required bolts, nuts, washers, structural-steel shapes and/or dowels.

All connection hardware shall be hauled by the Contractor to the Department warehouse nearest the project, after use, unless otherwise shown on the plans.

When the Contractor elects to furnish barrier that has been constructed prior to this contract, he shall submit written certification that the barrier sections substantially conform to the requirements herein specified.

When the Contractor cannot verify that the barrier sections were constructed in compliance with the requirements herein specified, the Engineer may accept the barrier for use as a temporary barrier only, if:

(a) the barrier sections substantially meet typical cross-sectional-dimension requirements shown on the plans;

(b) the barrier sections are acceptable to the Engineer in regard to there being no evidence of structural damage such as major spalling or cracking; and

(c) the general condition of both the barrier sections and their connectors is acceptable to the Engineer.

In the event that previously constructed barrier has steel channel connectors for which the top flange protrudes outside the projected concrete surface of the barrier, the Contractor shall bevel each end of the top flange on a 30 degree bevel, with the 30 degrees being measured from the web.

512.3. Construction Methods. Prior to the beginning of casting, the Contractor shall give the Engineer notice in accordance with Item 424, "Precast Concrete Structures (Fabrication)" as to the location of the casting site and the date on which the work will begin.

The barrier sections shall conform to the dimensions and cross sections shown on the plans. Steel forms shall be used. Formwork shall be in accordance with Item 424, "Precast Concrete Structures (Fabrication)". **512.4 to 512.7**

The bottom surface of the barrier shall have a rough texture similar to a wood float finish.

Mixing, placing and finishing of concrete shall be in accordance with Item 424, "Precast Concrete Structures (Fabrication)". Concrete shall be form cured or water cured for a minimum of four curing days or may be cured with Type 1-D, Class B, membrane curing compound.

Forms may be removed after the concrete has reached sufficient strength to prevent physical damage to the member. Curing shall not be interrupted for more than 30 minutes. When the barrier sections have attained sufficient strength to permit handling without causing visible damage, the barrier sections may be moved to a storage area and placed on blocking to prevent damage.

Barriers shall be installed in accordance with details shown on the plans.

When portable barrier, not designated for permanent use, is no longer required on the project, it shall be stored by the Contractor at a site shown on the plans.

512.4. Defects and Breakage of Barrier. Concrete traffic barrier damaged in the process of fabricating, curing, handling or placing shall be repaired or replaced as directed by the Engineer. All replacements and repairs shall be made at the Contractor's expense.

512.5. Damage and Loss of Hardware. Hardware damaged or lost in the process of handling, placing, removing or resetting shall be repaired or replaced as directed by the Engineer. All replacement and repairs shall be made at the Contractor's expense.

512.6. Measurement. This Item will be measured by the meter, based on the nominal lengths of the barrier sections as shown on the plans.

512.7. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for the pertinent type barrier and shall include all manipulations, labor, tools, equipment and incidentals necessary to complete the work.

(1) Type A - "Portable Concrete Traffic Barrier (Furnish and Install)". This price shall be full compensation for furnishing and installing the barrier, providing hardware assemblies and making all connections.

(2) Type B - "Portable Concrete Traffic Barrier (From Stockpile, Install and Return)". This price shall be full compensation for removing the barrier, either from a stockpile or from an existing location on the highway facility, resetting in a new location, connecting and disconnecting
the barrier sections, and returning the sections and hardware assemblies to a stockpile or location shown on the plans or designated by the Engineer.

(3) Type C - "Portable Concrete Traffic Barrier (Move and Reset)". This price shall be full compensation for disconnecting the barrier sections, moving the barrier on the project, repairing the roadway, resetting the barrier at the new locations and connecting the sections.

(4) Type D - "Portable Concrete Traffic Barrier (Remove)". This price shall be full compensation for removing the barrier, including the hardware assemblies, from the roadway or structure, stockpiling the barrier and hardware assemblies in the area shown on the plans and for repairing the roadway.

(5) Type E - "Portable Concrete Traffic Barrier (Low Profile)(Furnish and Install)". This price shall be full compensation for furnishing and installing the low profile barrier, providing hardware assemblies and making all connections.

Low profile concrete traffic barrier will be allowed only when "(Low Profile)" is in the bid-item description.

ITEM 514

PERMANENT CONCRETE TRAFFIC BARRIER

514.1. Description. This Item shall govern for the construction of permanent concrete traffic barrier in conformance with the details, locations, lines and grades shown on the plans.

Unless otherwise shown on the plans, the barrier may be cast-in-place using conventional forms, may be slipformed or may be constructed of precast concrete sections.

514.2. Materials. All materials shall conform to the pertinent requirements of the following items:

Item 421, "Portland Cement Concrete"
Item 437, "Concrete Admixtures"
Item 440, "Reinforcing Steel"
Item 526, "Membrane Curing"

The class of concrete shall be as shown on the plans. Class "A" and Class "C" concrete shall be air-entrained.

514.3. Construction Methods.

(1) General. Any required excavation shall be done in accordance with Item 400, "Excavation and Backfill for Structures".

Reinforcing steel shall be placed in accordance with the requirements of Item 440, "Reinforcing Steel", and the details shown on the plans. When slipform placement is used, additional bars approved by the Engineer may be welded, by a qualified welder, to the reinforcing steel cage required by the plans.

Forms for conventionally formed barrier and for precast sections shall be of steel except that wood forms may be used for curves and transitions. Formwork shall be in accordance with Item 420, "Concrete Structures".

Drilled shaft foundations, when required, shall be constructed in accordance with Item 416, "Drilled Shaft Foundations", and the details shown on the plans.

Mixing, placing and finishing of concrete shall be in accordance with Item 420, "Concrete Structures". Concrete shall be form cured or water cured for a minimum of four curing days or may be cured with Type 1-D, Class B, membrane curing compound.

All exposed surfaces of the barrier shall receive an ordinary surface finish as specified in Item 427, "Surface Finishes for Concrete", unless otherwise shown on the plans.

Barriers shall be installed in accordance with details shown on the plans.

Concrete, mortar, oil or substances which have spilled or leaked onto the roadway shall be removed by the Contractor to the satisfaction of the Engineer.

(2) Cast-in-Place Barrier.

(a) Conventionally Formed Barrier. Forms shall be accurately set to the required line and grade, secured by a method not detrimental to the roadway pavement and maintained in a true position during concrete placement. Forms may be removed after the concrete has reached sufficient strength to prevent physical damage to the barrier.

(b) Slipformed Barrier. Concrete traffic barriers may be constructed by the use of slipform equipment provided that the finished barrier is true to the specified line and grade within a tolerance of ± six (6) millimeters in three (3) meters.

The barrier shall present a smooth, uniform appearance in its final position, and shall conform to the horizontal and vertical lines shown on the plans or directed by the Engineer. Any unsatisfactory section of the barrier shall be removed and replaced at the Contractor's expense.

The concrete shall be adequately consolidated and free of honeycomb. The concrete shall be of such consistency that after slip- forming it will maintain the shape of the barrier without support. Prior to the beginning of operations, the Contractor shall insure that a continuous supply of concrete is available to the slipform machine to minimize starting and stopping.

The slipform machine shall be guided by vertical and horizontal sensors that ride along a wire line. A grade line gauge or pointer shall be attached to the machine in such a manner that a continual comparison can be made between the barrier being placed and the established grade line. The slipform machine shall not exceed the speed recommended by the manufacturer. In lieu of sensor controls, the slipform machine may be operated on rails or supports set at the required grade.

(3) Precast Sections. Prior to the beginning of casting, the Contractor shall give the Engineer ample notice in accordance with Item 424, "Precast Concrete Structures (Fabrication)" as to the location of the casting site and the date on which the work will begin. Concrete shall be form cured until the concrete has reached sufficient strength to permit handling without visible cracks or other damage to the sections.

514.4. Defects and Breakage. Concrete traffic barrier damaged in the process of fabricating, curing, handling or placing shall be repaired or replaced, at the Contractor's expense, as directed by the Engineer.

514.5. Measurement. "Permanent Concrete Traffic Barrier" of the various types, including the terminal sections, will be measured by the meter. The barrier type providing for two longitudinal half sections will be measured along the center line between the two halves.

514.6. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement", will be paid for at the unit price bid for "Permanent Concrete Traffic Barrier" of the type specified. This price shall be full compensation for furnishing and placing all materials, including drilled shaft foundations, and for all excavation, manipulation, labor, tools, equipment and incidentals necessary to complete the placement of the concrete barrier rail.

When the contract does not include a bid item for asphaltic concrete pavement, the means of lateral support for the permanent concrete traffic barrier will not be paid for directly, but shall be considered subsidiary to this Item.

ITEM 520

WEIGHING AND MEASURING EQUIPMENT

520.1. Description. This Item shall govern for the weighing and measuring equipment utilized where materials are specified to be measured or proportioned by mass or volume.

520.2. General Requirements. Except as modified herein, all scales and scale installations shall meet the requirements of the National Institute of Standards and Technology Handbooks 44 and 112 (published by the U.S. Department of Commerce and available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402-9325), except that the required accuracy shall be 0.4 percent of the load being weighed or one (1) graduation on the dial of the scale. The Contractor shall provide personnel, facilities and equipment for checking the scales to the satisfaction of the Engineer.

All scales shall be checked prior to beginning of operations, after each move, at such other times when in the opinion of the Engineer there is a question as to their accuracy or adequacy, and at least once each six (6) months. The Contractor shall furnish a report of calibration from a scale mechanic licensed by the Texas Department of Agriculture using certified weights and approved by the Engineer, certifying that the scales meet the requirements of this Item. Plant operations shall cease during the checking operation. When inaccuracy or inadequacy is discovered, scale use will not be resumed until corrective measures have been completed and/or the scales calibrated as provided by this Item. Whenever equipment is adjusted, the adjustments shall be so made as to bring performance errors as close as practicable to zero value.

The Contractor shall furnish sufficient weights to check the accuracy and sensitivity of the scales. All weights shall be checked and certified by the Texas Department of Agriculture, Weights and Measures Section. All scales shall be satisfactorily insulated against shock, vibrations or movement of other operating equipment in the plant.

The weighing containers shall be sufficiently tight to prevent leakage of the contents and shall be of sufficient capacity to hold a complete batch without wasting or leveling by hand and shall be so designed that the entire batch will discharge quickly into the mixer. The weighing containers shall be so constructed that if in charging, an excess is introduced into the weighing containers, it may be removed by the operator. The weighing containers shall be provided with a close fitting and quick operating cut-off gate, so that there will be no leakage of the contents into the mixer, and shall be satisfactorily attached to the batching scales.

520.3. Equipment. Any electronic device which has been adapted for weighing that meets the calibration requirements of Article 520.2. will be acceptable. This type of scale may be substituted for any of the equipment described in this section. When shown on the plans or specified elsewhere, truck scales or suspended hopper scales for asphalt stabilized base, asphaltic concrete and flexible base shall have automatic printout. This printout shall be a continuous tape or tickets. One (1) copy of the printed tape shall be provided to the Engineer at the end of each day's run. If tickets are used, the Engineer shall be furnished three (3) tickets with each truck load.

(1) Truck Scales. These scales shall consist of a set of standard platform truck scales capable of weighing the load as a single draft; that is, the total mass of the truck or truck-trailer combination shall not be determined by adding together the mass obtained by separately weighing each end of such truck or by weighing individual elements of such truck or coupled combination. The Contractor shall provide a weather-tight building of sufficient size to house the Contractor's weigher and the State's Inspector.

(2) Aggregate Batching Scales. These scales used for weighing aggregate shall be equipped with a quick adjustment at zero to provide for any change in tare. The scales shall be provided with pointers or "tell-tale" indicators of the springless dial type to indicate full load for each aggregate. The dial or "tell-tale" device shall be in full view of the operator while charging the weigh box and he shall have convenient access to all controls.

(3) Portable Platform Scales. These scales shall consist of a portable platform scale having a container fastened securely to the platform and shall conform to the general requirements of this specification, except that they will not be required to be checked after each move or set-up within a given project, unless otherwise directed by the Engineer.

The capacity shall be not less than 225 kilograms. The weighing capacity may be verified by means of a weigh beam and loose weights.

When this scale is used, the Contractor shall provide a container of approximately the same size as the platform for weighing the aggregate, or he may provide an elevated hopper, the base of which is approximately the size of the platform from which the aggregates are to be discharged.

If the hopper is provided, it shall be of such design that the aggregates will be completely and quickly discharged and shall be of such construction that the position of the aggregates while being weighed will not affect the accuracy of the scales.

The Contractor shall not be permitted to increase the size of the original platform by constructing another platform on top of the original unless provisions are made to set the tare mass of the container or hopper separately from the batch mass. Separate scales for fine and coarse aggregate will be required.

(4) Suspended Hopper. These scales shall consist of a weighing container or hopper completely suspended from the scale equipment. Suitable provisions shall be made for leveling the scale equipment.

The appliances used for placing materials within or upon the weighing equipment shall so regulate and control the quantity supply that accurate adjustment to the weights required can be secured easily and quickly. A convenient means shall be provided for the addition or the removal of small amounts of material to adjust the quantity to the exact mass per batch.

(5) Cement Weighing Equipment. Where bulk cement is used it shall be batched by mass. The scales shall be of rugged construction. Provisions shall be made for indicating to the operator that the required load in the weigh box or container is being approached. This device shall indicate at least the last 25 kilograms of load. Where a closed type cement weigh box is used, the cement weighing scales shall be provided with a springless dial to indicate when the weigh box is empty. This indicator for the empty condition of the weigh box shall be in continuous operation. The weigh box shall be fitted with an approved vent, a tightly covered inspection opening of not less than 300 millimeters by 300 millimeters. The box and scales shall be maintained in a condition to meet the requirements for accuracy of mass.

Where portland cement to be mixed with subgrade, subbase or base material is not batched by mass and bulk cement is furnished, each truck shall have the mass of cement certified by a bonded public weigher or the Contractor shall place a set of standard platform truck scales or hopper scales at a location approved by the Engineer.

(6) Belt Scales. Belt scales used for proportioning aggregate into asphaltic mixtures shall be accurate to ± 1.0 percent, average of three (3) test runs, where no individual test run exceeds 2.0 percent when checked in accordance with Test Method Tex-920-K. Material tests shall be performed at least once each six (6) months. Simulated belt loading tests may be used as expeditious checks of scale accuracy between material tests. The manufacturer's operation and maintenance manual shall be made available to the Engineer.

(7) Automatic Proportioning Devices.

(a) Portland Cement Concrete. When shown on the plans, batching plants shall be equipped to proportion by mass, aggregates and bulk cement, by means of automatic proportioning devices of an approved type.

The scales shall be automatic to the extent that the only manual operation required for proportioning the aggregates for one (1) batch shall be a single operation of a switch or a starter.

When automatic scales are used in conjunction with automatic proportioning devices, they shall be equipped with a recorder capable of printing the mass or proportion of each ingredient and the total batch mass. The printout shall be in the form of tickets and shall include the project identification number and any other information shown on the plans and specifications or directed by the Engineer.

The bulk cement batcher and aggregate batcher shall be so interlocked that a new batch cannot be started until all weigh hoppers are empty, the scale at zero and the discharge gates closed. The interlock shall permit no part of the batch to be discharged until all aggregate hoppers and the cement hopper have been filled with the correct charge. The discharge gate on the cement hopper shall be designed to permit regulating the flow of the cement into the aggregate as directed by the Engineer.

Material discharged from the bins shall be controlled by gates or by mechanical conveyors. The means of withdrawal from the bins and the discharge from the weigh box shall be so interlocked that not more than one bin can discharge at a time; that the order of discharge can be changed as directed by the Engineer; and that the weigh box cannot be tripped until the required quantity from each of the bins has been deposited therein. Should a separate weigh box be used for each size aggregate, all may be operated and discharged simultaneously.

When the discharge from the bin is controlled by gates, each gate shall be actuated automatically so that the required mass is discharged into the weigh box after which the gate shall automatically close and lock.

The automatic weighing device shall be so designed that the number of proportions required may be set at the same time and both the proportions and the sequence of weighing individual sizes may be changed without delay. The locking mechanisms or devices shall be so arranged that they may be locked at the direction of the Engineer.

Automatic proportioning devices shall comply with the general requirements for scales. In order to check the accuracy of batch mass, the gross mass and tare mass of batch trucks, truck mixers and truck agitators shall be determined when directed by the Engineer. The equipment shall be weighed on truck scales conforming to the requirements of Subarticle 520.3.(1).

(b) Asphaltic Mixtures.

1. Weigh-batch Plant. Weigh-batch plants used in the production of asphaltic base and surface mixtures shall be equipped with approved fully automatic devices for the batching and cycling operations. There shall be interlock cut-off circuits to interrupt and stop all operations at any time there is a malfunctioning of any part of the control system.

The automatic proportioning controls shall include equipment for accurately proportioning batches of the various components of the mixture into each batch. The mixture shall be proportioned by mass except that asphaltic material and additive meters, measuring by volume, may be used. If a pressure type flow meter is used for asphaltic material, this system shall include an automatic temperature compensation device to maintain a constant percent by mass of asphaltic material in the mixture. Visible dial scales shall be provided to show the mass of each batch ingredient. If an asphaltic material meter is used, a suitable digital readout shall be provided to show the amount of asphalt used.

Over and under asphalt and aggregate mass check sensors shall be included in the proportioning system to check the accuracy of the asphalt and aggregate bin mass. The over-under tolerance limits for aggregate shall be selected by the Engineer after the amounts of the various ingredients have been determined for a batch of mixture. The equipment shall be capable of a tolerance range of ± 0.5 percent to ± 2 percent as applied to the material being weighed. The tolerance limits for asphalt shall be ± 1 percent of the total asphalt being weighed. The tolerance limits for the no-load conditions shall be 0.1 percent of the scale capacity for the aggregate scales and for the asphalt scales. The tolerances shall be locked in such manner that the settings for the over and under sensors cannot be altered or bypassed without the written approval of the Engineer. The system shall incorporate provisions for a manual check to be performed by the operator periodically as requested by the Engineer.

At least one (1) set of scale dials shall be provided, one (1) dial for aggregate and one (1) dial for asphalt. The scale dials shall be divided into

increments not to exceed 1/1000 of the total dial capacity. The scale dials may be located either in the dust proof control room or on the plant near the weighing hopper. The scale dials shall accurately indicate the mass in the weighing hopper from zero load to the maximum batch mass.

If the scale dials are located on the plant outside the control room, there shall be provided either an identical set of scale dials inside the control room or digital mass indicators. Either type of dial or mass shall duplicate within a tolerance of 0.1 percent of the scale capacity for aggregate scales and for asphalt scales any reading of the scale dial indicators located outside on the plant. The scale dials shall be so positioned that the dial and indicators are in full view of the operator. The normal mass of a batch of aggregate shall be not less than one-half the aggregate scale dial capacity.

The automatic proportioning system shall be provided with low bin indicators arranged in such manner that under normal working operations the batching operation will be automatically stopped when the level of material in any supply bin is not sufficient to complete the weighing of a complete batch of the asphaltic mixture.

The system shall include a batch counter which can be preset for determining the number of batches which may be desired in one (1) uninterrupted production sequence, and a counter to show the number of batches for the day's run.

The mixer shall have an accurate time-locking device to control the operation of a complete mixing cycle by locking the weigh box gate(s) after charging the mixer. It shall remain locked until the mixing cycle is complete, the mixture has been dumped, and the mixer discharge gate is closed. The timing device shall automatically control the dry and wet mixing period in accordance with the governing specification.

The control of the timing shall be adjustable and capable of being preset at the time intervals directed by the Engineer. Changes in mixing time shall be made only when approved in writing by the Engineer.

The aggregate dryer and asphalt tank heaters shall be equipped with burners that are automatically controlled by thermostats. This automatic equipment shall control the heat of the materials within the specified tolerances. Manual controls shall be used only as directed by the Engineer.

The automatic heat control panel shall be located inside the dust-proof control room.

520.3

Automatic controls shall be housed in a dust-proof room located so that the mixer discharge chute is in full view of the operator.

If at any time the automatic control devices become inoperative, the plant operations will be allowed to continue under manual controls for not more than two days of operation, at which time all plant operations shall cease until the necessary repairs are made. Continuous and frequent breakdowns of the automatic control devices shall be cause for suspending operations until the devices are properly repaired.

If payment is to be based on batch mass, or when indicated on the plans, the automatic proportioning system at the plant shall be equipped with an automatic digital record printer that will record batch mass and print out the required information on a continuous tape or ticket through the use of a printing calculator. Unless otherwise indicated on the plans, the printout shall include the project identification number, date, mass of each component, total batch mass and the number of batches in the day's run.

When requested by the Engineer, the Contractor shall demonstrate the accuracy of the printout device, within a tolerance of ± 1 gradation for asphalt scales. The printout accuracy shall also apply to the no-load condition.

The automatic digital record printer shall be in the same room as the automatic batching console unit. The recording unit may be separate from the console.

2. Modified Weigh-Batch Plant. Modified weigh-batch plants used in the production of asphaltic base and surface mixtures shall be equipped with approved fully automatic devices for the batching and cycling operations. There should be interlock cut-off circuits to interrupt and stop all operations at any time if there is a malfunctioning of any part of the control system. Aggregate control will be provided at the cold feeds. The cold feed bins will be the same as those required for the drum-mix plant.

Automatic proportioning devices for all plant components except for the cold bins and cold feeds shall meet the requirements for weigh-batch plants in Subsection 1, except that only one hot bin will be required to feed into the weigh hopper.

3. Continuous Mixing Plant. Continuous mixing plants shall provide satisfactory means to afford positive interlocking or mechanical control between the flow of aggregate through the gates and flow of asphaltic material and additive through their respective meters.

Devices capable of automatically sampling and weighing the quantity of each bin shall be installed as part of the plant equipment. In addition, each aggregate bin and the asphaltic material feed line shall have interlock circuits to stop the plant operations if either aggregate or asphaltic material flow is discontinued or reduced.

The plant shall automatically proportion aggregate from each bin to the mixer with such accuracy that the mass of material from each bin shall not deviate from the design value by an amount more than 1.5 percent of the total mass of asphaltic concrete delivered per revolution or interval of time.

4. Drum Mix Plant. Drum mix plants shall provide means to assure positive interlock between dry mass of aggregate flow and the flow of asphaltic material and additives through their respective meters.

The total aggregate feed shall be weighed continuously by a belt scale meeting the requirements of this specification. Provisions shall be made for introducing the moisture content of the total aggregate feed into the belt scale weighing signal and correcting wet aggregate mass to dry aggregate mass. The automatic proportioning system shall be capable of adjusting the flow of asphaltic material to compensate for any variation in the dry mass of aggregate flowing into the drum mixer. Automatic digital readings of both the dry mass of aggregate flow and asphaltic material flow shall be displayed and totaled in appropriate units of mass and time.

The automatic proportioning system shall be provided with bin flow indicators arranged in such manner that under normal working conditions a signal will automatically be given when flow of aggregate from any cold aggregate bin is interrupted.

In addition, each aggregate bin and the asphaltic material feed line shall have interlock circuits to stop the plant operations if either aggregate from any cold bin or asphaltic material flow is discontinued or reduced.

The drum mixer burner and asphalt tank heaters shall be automatically controlled by thermostats. This automatic equipment shall control

the heat of the materials within the specified limits. Plants shall be equipped to continuously record the asphaltic mixture temperature as it leaves the drum mixer.

5. **Specialized Recycling Plant.** Specialized recycling plants shall provide means to assure positive interlock between the flow of recycled asphaltic pavement (RAP), virgin aggregate, virgin asphaltic material, and any other required materials such as rejuvenating or recycling agents.

Automatic proportioning devices for all plant components shall meet the requirements for drum-mix plants in Subsection 4.

(8) Asphaltic Material Bucket. The asphaltic material bucket shall be of sufficient size to hold the necessary asphaltic material for one (1) batch. If the asphaltic material is measured by mass, the bucket shall be properly attached to the scales. If the proportioning is by volume based on mass, the measuring bucket used shall be of the overflow type and shall meet the approval of the Engineer. The valves at the asphaltic material bucket shall be of a quick cutoff type that does not leak.

(9) Asphaltic Material Meter. Provisions of a permanent nature shall be made for checking the accuracy of the meter output for asphaltic material. The line to the asphaltic material meter shall be protected with a jacket of hot oil or other approved means to maintain the temperature of the line near the temperature specified. Accuracy of asphaltic material meters shall be checked at least once each six (6) months.

(a) Weigh-batch and Modified Weigh-batch Plant. Pressure type flow meters for volumetric measurement of asphaltic material shall automatically measure the asphaltic material within ± 1.0 percent when tested in accordance with Test Method Tex-921-K. The meter shall be so constructed that any setting may be locked and the meter will automatically reset itself to this setting after the discharge of the asphaltic material to the batch. A thermometer shall be installed in the asphalt line to accurately measure the temperature within ± 3 °C over a range from 10 °C to 230 °C.

(b) Continuous, Drum Mix and Specialized Recycling Plants. Asphaltic material meters shall provide an automatic digital display of the volume or mass of asphaltic material which has passed through the line leading to the spray bar. The meter shall register within ± 1.0 percent when checked in accordance with Test Method Tex-921-K.

(10) Water Measuring Device. This device for measuring water by volume shall indicate the quantity in liters and fractions thereof for asphaltic materials mixtures and in liters for portland cement concrete. When a volumetric tank or bucket is used for measuring the water, the supply inlet shall cut off automatically and remain off until the container has emptied completely and the discharge line to the mixer is closed. When water is measured by mass, the weigh bucket shall be properly attached to scales meeting the general requirements of this specification. When a pressure type flow meter is used for volumetric measurement of the water, the meter shall be so constructed that any setting may be locked and the
meter can be manually or automatically reset to this setting after the addition of water to each batch.

Regardless of the method of water measurement used, the operating mechanism shall regulate the quantity of water required for any given batch to within ± 0.2 percent of the total batch for bituminous mixtures and to within ± four (4) liters of the specified quantity of water required for portland cement concrete mixes. Provisions of a permanent nature shall be made for checking the accuracy herein specified.

(11) Asphaltic Additive Meters. Provisions of a permanent nature shall be made for checking the accuracy of meter output for asphalt primer, fluxing material and liquid additives. The meters shall read in increments of 400 milliliters or less. The accuracy of these meters shall be checked at least once each six (6) months. The meters shall register within ± 5.0 percent of the actual flow when checked in accordance with Test Method Tex-923-K.

520.4. Measurement and Payment. The work performed, materials furnished, and all labor, tools, equipment and incidentals necessary to complete the work under this Item will not be measured and paid for directly, but shall be considered subsidiary to the various bid items in the contract.

ITEM 522

PORTLAND CEMENT CONCRETE PLANTS

522.1. Description. This Item shall govern for the plant facilities, equipment and operation of portland cement concrete plants.

522.2. Class of Plants. The class of plant shall be in accordance with one of the classes specified herein. Unless the class and type of plant

is specifically indicated on the plans, either a central or transit mix batch plant may be furnished.

(1) A Class 1 plant shall be for the exclusive use of the Department for a single project and when required, will be designated on the plans as one of the following:

(a) Class 1A: Central mix plant
(b) Class 1B: Transit mix or central mix batch plant

(2) A Class 2 plant shall be for the exclusive use of the Department which may be used for more than one project as specified by the Engineer and when required, will be designated on the plans as one of the following:

(a) Class 2A: Central mix plant

(b) Class 2B: Transit mix or central mix batch plant

(3) A Class 3 plant shall be a plant designated for the exclusive use of the Department during continuous placements only, as specified by the Engineer, but available for commercial work during other periods and when required, will be designated on the plans as one of the following:

(a) Class 3A: Central mix plant

(b) Class 3B: Transit mix or central mix batch plant

(4) A Class 4 plant shall be a commercial plant, either central mix or transit mix, which will be required to dedicate sufficient trucks.

All classes of plants shall be located to meet the time requirements for hauling and placing concrete.

522.3. Approval of Plant. Before mixing and hauling concrete to Departmental projects, the plant will be thoroughly inspected and must be approved by the Engineer. All scales, water measuring devices, mixers, agitators, hoppers and storage bins shall be in satisfactory operating condition and together with the method of operation, storage facilities, materials and any other necessary item required in the manufacture and delivery of concrete will be inspected for approval by the Engineer.

Weighing and measuring equipment shall be in good working condition, properly calibrated and shall meet all requirements of Item 520, "Weighing and Measuring Equipment".

The mixer shall have a plate affixed showing the manufacturer's recommended operating data. The data shall include the drum paddle speed of rotation for mixing and agitating and the capacity of the unit for complete mixing and/or agitating only. A copy of the manufacturer's design, showing dimensions and arrangement of blades, shall be available.

When the equipment and/or facilities fail to meet the specified requirements, approval of the plant will be withdrawn until the defects are corrected and the plant reapproved.

522.4. Equipment.

(1) General Requirements for Batch Plants. The batch plant shall be provided with adequate bins for batching all aggregates and materials required by the specifications.

A separate scale and hopper entirely free and independent of that used for weighing aggregate shall be provided for weighing bulk cement and fly ash. The scale provided may be used for the accumulated weighing of the bulk cement and fly ash.

Admixture dispensing equipment shall be as specified in Item 437, "Concrete Admixtures".

(2) Types of Mixing Equipment. Portland cement concrete shall be mixed and delivered by means of one of the following approved methods:

(a) Mixed completely in a stationary mixer and transported to the point of delivery in a truck agitator or a truck mixer operating at agitation speed (Central mix concrete).

(b) Mixed completely in a stationary mixer and transported to the job site in approved non-agitating trucks. This method of transporting will be permitted for concrete pavement only (Central mix concrete).

(c) Mixed completely in a transit mix truck and transported to the point of delivery at mixing and/or agitating speed (Transit mix concrete).

(d) Mixed completely in a truck mounted paving mixer and transported to the point of delivery in the truck mounted paving mixer or in an approved non-agitating truck.

(e) Mixed completely in a mobile, continuous volumetric mixer at the job site in accordance with Item 421, "Portland Cement Concrete".

(f) Mixed completely in a paving mixer, operated at the construction site or at a central location and used for mixing concrete for concrete pavement only. If a paving mixer is furnished and operated at the site of construction, it shall be equipped with a power controlled boom and bucket, so designed as to permit uniform distribution of the concrete for the full width of the pavement.

(3) General Requirements for Mixers and Agitators.

(a) General. Mixers shall be an approved stationary or truck-type mixer capable of combining the ingredients into a thoroughly mixed and uniform mass conforming to the requirements of Item 421, "Portland Cement Concrete".

Facilities shall be provided to permit ready access to the inside of the drum for inspection, cleaning and repair of blades.

Mixers and agitators may be subject to daily examination for changes in condition due to accumulation of hardened concrete and/or blade wear. Any hardened concrete shall be removed to the satisfaction of the Engineer before the mixer or agitator is approved for use. Worn blades and/or fins, shall be repaired or replaced with new blades or fins when worn as much as 10 percent from the original height of the manufacturer's design.

In some instances blade or fin extensions may have been added similar to those shown in Figure 1. When these extensions have been made to the original blade or fins by welding or bolting, repair or replacement of the extensions as specified herein will not be required.

Any original blade or fin with holes therein must be repaired or replaced.

FIGURE 1

(b) Stationary Mixers. These mixers shall be either a rotating drum type or twin paddle with stationary drum type. Multiple drum mixers will be permitted provided that their operation is properly synchronized. The mixing time for multiple drum mixers shall be determined exclusive of the time required to transfer concrete from one drum to the next drum.

A transit mix truck or a truck mounted paving mixer mounted on a stationary base will not be considered a stationary mixer.

(c) Truck Mounted Paving Mixers and Transit Mix Trucks. Truck mounted paving mixers and transit mix trucks shall comply with the following requirements:

Each truck mounted paving mixer shall be approved by the Engineer prior to use on the project. It shall be so designed that uniform and low slump concrete (approximately 40 millimeter slump) can be mixed without segregation. The mixer shall be capable of discharging low slump concrete at a speed of one (1) cubic meter per 15 seconds or faster.

Truck mounted paving mixers and transit mix trucks shall be equipped with actuated counters by which the proper number of revolutions of the drum as specified in Article 522.5. may be readily verified. The counters shall be read and recorded at the start of mixing at mixing speeds.

Each unit shall have adequate water supply and accurate metering or gauging devices for measuring the amount of water used.

522.5. Operation of Plant and Equipment.

(1) General. The production and delivery of concrete shall equal or exceed the rate specified on the plans or approved by the Engineer for continuous placements. In all cases, the delivery of concrete to the placement site shall assure compliance with the time limits in the applicable specifications for depositing successive batches in any monolithic unit. The Contractor shall satisfy the Engineer that adequate standby trucks are available.

For all uses of concrete, except miscellaneous, either a printout or batch ticket record shall be furnished by the Contractor for each batch of concrete. The information to be shown on the printout or batch ticket shall be the same as shown on Department Form 596, "Concrete Batch Ticket", for that portion of the ticket to be recorded at the batch plant. When documented as part of the mix design data, the identity of materials need not be shown on the printout or the batch ticket. Revolution counter readings may be handwritten on automatic printout tickets.

Additional mortar, consisting of 40 kilograms of cement, three (3) parts of sand and sufficient water to coat the inside of the mixer drum, shall be added to the initial batch of concrete mixed and after each wash out.

Spilling of materials from the mixer drum during charging or mixing shall be corrected by additional aprons and baffles or by reducing the size of the batch.

The entire contents of the drum shall be discharged before any materials are placed therein for the succeeding batch.

The maximum size batch shall not exceed that of the rated mixing capacity of the mixer.

Except as provided below for transit mix trucks or truck mounted paving mixers, retempering or remixing of concrete will not be permitted.

Admixtures shall be measured and dispensed as specified in Item 437, "Concrete Admixtures".

An approved work plan for the use of high-range water reducers will be required. The work plan will govern when a conflict exists with these specifications.

(2) Central Mix Plants. When a stationary mixer is used for the entire mixing operation, the concrete shall be mixed not less than 50 seconds nor more than 90 seconds, or as recommended by the manufacturer of the mixer, measured from the time the last material enters the mixer to the time discharge of the concrete into hauling equipment begins. When necessary to achieve suitable mixing, the Engineer may require adjustment of the mixing time.

(3) Truck Mounted Paving Mixers and Transit Mix Trucks. The mixing speed shall be attained as soon as all ingredients are in the mixer. Each complete batch shall be mixed not less than 70 nor more than 100 revolutions of the drum at mixing speed, except as provided below. Trucks will be permitted to transport concrete to the job site at mixing speed if equipped with double actuated counters which will separate revolutions at mixing speed from total revolutions.

Trucks equipped with a single actuated counter counting total revolutions of the drum shall mix the concrete at the plant not less than 50 nor more than 70 revolutions at mixing speed, transport the mix to the job site at agitating speed and complete the required mixing before the concrete is placed.

Mixing and agitating speed shall be as designated by the mixer manufacturer. All revolutions after prescribed mixing shall be at agitating speed. Except for short periods of time during discharge, the drum shall be kept in continuous motion from the time mixing is started until the discharge is completed.

For concrete mixed in a transit mix truck a portion of the mixing water, required by the batch design to produce the desired slump, may be withheld and added at the job site, but only with the permission and under the supervision of the Engineer. When water is added at the job site, 25 revolutions (minimum) at mixing speed, will be required to uniformly disperse the additional water throughout the mix. Water used to flush down the blades after charging shall be accurately measured and included in the quantity of mixing water. The introduction of the initial mixing water, except blade washdown water and that permitted in this article shall be prior to or simultaneous with the charing of the aggregates and cement.

When used as an agitator only, the loading of transit mix trucks shall not exceed 80 percent of the drum volume.

(4) Storage of Materials. All material shall be stored in accordance with Article 421.3.

(5) Measurement of Materials. All material shall be measured in accordance with Article 421.4.

522.6. Mixer Performance Test. Mixers producing concrete which is acceptably uniform to the satisfaction of the Engineer need not be tested. All other mixers will be tested as specified herein.

Mixers failing any of these tests will not be permitted on further work until corrective measures are taken. Corrective measures may include mixing smaller loads, requiring a more efficient charging sequence, blade repair, drum cleanout or other measures necessary to comply with the performance requirements.

Mixers shall be capable of mixing a batch using normal job mixing requirements to a uniformity conforming to Table 1. Tests will be performed at the job site after completion of mixing requirements.

In making a performance test, the variation within a batch will be determined for each concrete property listed in Table 1 as the difference between the highest and the lowest value obtained from different portions of the batch. The comparison will be between two (2) representative samples, taken after discharge of approximately 15 percent and 85 percent respectively of the maximum load recommended by the manufacturer. Both samples shall be obtained within a period of 15 minutes or less.

TABLE 1
REQUIREMENTS FOR UNIFORMITY OF CONCRETE

Concrete Property	Requirement, expressed as maximum of tests of samples taken from two (2) locations in the concrete batch.
Mass per cubic meter calculated to an air-free basis (Test Method Tex-417-A)	16 kg/m^3
Air content, percent by volume of concrete (Test Method Tex-416-A)	1.0 %
Slump	
If average slump is 100 millimeters or less	25 mm
If average slump is 100 to 150 millimeters (Test Method Tex 415-A)	40 mm
Coarse aggregate content, portion by mass of each sample retained on 4.75 mm sieve, percent	6.0 %

522.7. Measurement and Payment. The work performed, materials furnished and all labor, tools, equipment and incidentals necessary to complete the work under this Item will not be measured or paid for directly, but will be considered subsidiary to the various bid Items of the contract.

ITEM 524

HYDRAULIC CEMENT

524.1. Description. This Item shall govern for portland cement, blended cement and masonry cement, in accordance with the requirements herein.

524.2. Materials.

(1) Portland Cement. Type I, Type II and Type III portland cements shall conform to all the requirements of AASHTO M 85, "Portland Cement", with the following modifications:

(a) The specific surface area requirement is waived on cements used in concrete piling or prestressed members and on white cement, when white cement is specified.

(b) The 55 maximum percent of tricalcium silicate for Type II cement is waived.

(c) When the cement is to be used in concrete with potentially-reactive aggregates, one of the following shall be adhered to: the cement shall have an alkali content $Na_2O + 0.658\ K_2O$ of 0.60 percent or less; the cement shall be Type IP; or the cement may have an alkali content in excess of 0.6 percent provided 25 to 35 percent, by absolute volume, of the cement is replaced with fly ash meeting the requirements of Departmental Materials Specification D-9-8900 and has an available alkali content of 1.5 percent or less.

(2) Masonry Cement. Masonry cement shall conform to the requirements of ASTM C 91.

(3) Blended Cement. Type IP - portland-pozzolan cement shall conform to all the requirements of ASTM C 595, with the following modifications:

(a) Portland-pozzolan cement shall be a uniform blend of portland cement and pozzolan produced by intergrinding portland cement clinker and pozzolan, in which the pozzolan constituent is between 20 and 35 percent absolute volume percent of the portland-pozzolan cement. Portland blast-furnace slag cement shall not be used.

(b) The pozzolan shall conform to the Departmental Materials Specification D-9-8900, "Type A". Copies of the Departmental Materials Specifications are available from the Texas Department of Transportation, Materials and Tests Division, 125 East 11th Street, Austin, Texas 78701-2483.

524.3. General.

(1) Shipment and Storage. All shipments of bagged or bulk cement shall be accompanied by bills of lading and shipping invoices stating the type, brand and source of manufacture. Cement which has become partially air set, lumpy or caked will be rejected. All cement shall be stored in weatherproof buildings or bins which will protect it from dampness. Different brands or different types of cement, or the same brand or type from different mills shall not be mixed in storage. Bulk shipments of either truck or rail shall be sealed at the time of loading and shall have seals intact at point of delivery.

(2) Basis of Acceptance. Cement may be accepted for use prior to testing provided it is from a prequalified source. A manufacturer shall become qualified by establishing a history of satisfactory quality control as evidenced by results of tests performed by the Materials and Tests Laboratory and upon approval of production and storage facilities by the Director of Materials and Tests. Continued acceptance of cement from a prequalified source will remain in effect as long as all test results on samples conform to the requirements herein. Failure of cement to meet the requirements shall be just cause to remove a manufacturer from the prequalified status. In this event, all cement from that source will be subject to testing prior to use. This procedure will continue until the Director of Materials and Tests has determined that adequate quality control has been reestablished. Cement from nonprequalified sources will require sampling and testing prior to use.

524.4. Measurement and Payment. The work performed, materials furnished and all labor, tools, equipment and incidentals necessary to complete the work under this Item will not be measured or paid for directly, but will be considered subsidiary to the various bid items of the contract.

ITEM 526

MEMBRANE CURING

526.1. Description. This Item shall govern for the curing of concrete by the use of membrane curing compound in accordance with the plans and specifications.

526.2. Materials. The liquid membrane-forming curing compound shall comply with Departmental Materials Specification D-9-8120, "Liquid Membrane-Forming Compounds for Curing Concrete".

Copies of Departmental Materials Specifications are available from the Texas Department of Transportation, Materials and Tests Division, 125 East 11th Street, Austin, Texas 78701-2483.

Sampling and testing will be in accordance with the Department's Manual of Testing Procedures.

526.3. Packaging. The compound shall be delivered to the job only in the manufacturer's original sealed containers. The manufacturer shall legibly mark these with the brand name of the compound, the type of compound, and a batch number or symbol with which test samples may be correlated. All approved containers will be stamped with a Materials and Tests Division approval stamp and the month after which retesting is required.

526.4. Equipment. The membrane curing compound shall be applied by means of approved mechanical-powered pressure sprayers, either air or airless. With approval of the Engineer, the Contractor will be permitted to use hand-pressurized spray equipment only on small miscellaneous concrete repairs and/or placements. All sprayers shall be equipped with appropriate atomizing nozzles.

Equipment used to apply the compound to concrete pavement shall travel at a uniform speed and be mechanically driven. The equipment shall be of such design that it will insure uniform and even application of the compound. Similar equipment may be used for application of interim membrane curing on bridge decks if it can be adapted to the rail system used by the screed.

When hand-operated spray equipment is used the spraying device shall be hand-operated spray bar equipped with two or three fan-spray nozzles. The spray from each nozzle shall overlap the spray from adjacent nozzles approximately 50 percent. The nozzles shall be held approximately 0.5 meter above the surface of the concrete and moved along the deck parallel with the striated finish. The nozzles may be held higher or lower as dictated by wind condition. The spray bar shall be held perpendicular to the striated finish.

For all spraying equipment the Contractor shall take suitable precautions to prevent loss of the compound between the nozzles and the concrete surface during spraying operations and to prevent the formation of runs and sags.

526.5. Construction Methods. Just before using the membrane curing compound, it shall be thoroughly agitated in its original container until any settlement has been uniformly redispersed. Redispersion shall be checked with a 25 millimeter by 25 millimeter wooden slat or similar device scraped along the interior of the container and then examined for accumulation of settlement and uniformity of dispersion. The compound shall be maintained in a uniform condition, substantially free of settlement, during its use.

The compounds shall not be applied to a dry surface and if the surface of the concrete has become dry, it shall be thoroughly moistened by water fogging prior to application of membrane.

The membrane curing compound shall be applied after the surface finishing has been completed, and immediately after the free surface moisture has disappeared. The surface shall be sealed with a single coat of the specified type of curing compound applied uniformly at the rate of coverage recommended by the manufacturer and directed by the Engineer, but not less than one (1) liter per five (5) square meters of surface area. The curing compound shall not be thinned or diluted in any manner prior to application. The Contractor shall provide satisfactory means and facilities to properly control and check the rate of application of the compound.

At locations where the coating shows discontinuities, pinholes, or other defects, or if rain falls on the newly coated surface before the film has dried sufficiently to resist damage, an additional coat of the compound shall be applied immediately at the same rate of coverage specified herein.

To insure proper coverage, the Engineer will inspect all treated areas after application of the compound for the period of time designated in the governing specification for curing, either for membrane curing or for other methods. Dry areas are identifiable because of the lighter color of dry concrete as compared to damp concrete. All suspected areas shall be tested by placing a few drops of water on the suspected areas. If the water stands in round beads or small pools which can be blown along the surface of the concrete without wetting the surface, the water-impervious film is present. If the water wets the surface of the concrete as determined by obvious darkening of the surface, or by visible soaking into the surface, no water-impervious film is present. Should the foregoing test indicate that any area during the curing period is not protected by the required water-impervious film, an additional coat or coats of the compound shall be applied immediately, and the rate of application of the membrane compound shall be increased until all areas are uniformly covered by the required water-impervious film.

When temperatures are such as to warrant protection against freezing, curing by this method shall be supplemented with an approved insulating material capable of protecting the concrete for the specified curing period.

If at any time there is reason to believe that this method of curing is unsatisfactory or is detrimental to the work, the Contractor, when notified, shall immediately cease the use of this method and shall change to curing by one of the other methods specified under this contract.

526.6. Measurement and Payment. The work performed, materials furnished and all labor, tools, equipment, and incidentals necessary to complete the work under this Item will not be measured or paid for directly, but will be considered subsidiary to the various bid Items of the contract.

ITEM 529

CONCRETE CURB, GUTTER AND COMBINED CURB AND GUTTER

529.1. Description. This Item shall govern for construction of curb, gutter and combined curb and gutter, with or without reinforcing steel, composed of portland cement concrete on approved subgrade, foundation material or finished surface in accordance with the lines and

grades established by the Engineer and in conformance with the details shown on the plans.

As used in this Item, the word "curb" refers to concrete curb, concrete gutter and combined concrete curb and gutter.

529.2. Materials. All materials shall conform to the pertinent requirements of the following items:

Item 360, "Concrete Pavement"
Item 420, "Concrete Structures"
Item 421, "Portland Cement Concrete"
Item 437, "Concrete Admixtures"
Item 440, "Reinforcing Steel"
Item 526, "Membrane Curing"

Concrete used in conventionally formed and slipformed construction shall be Class "A" concrete or concrete as specified for concrete pavement. Unless otherwise shown on the plans, concrete for extruded construction shall be Class "A", except that the coarse aggregates shall meet the requirements of Grade 8. Other grades of coarse aggregate may be substituted, if approved by the Engineer.

529.3. Construction Methods.

(1) Conventionally Formed Concrete. Prior to curb construction, the subgrade, foundation or pavement surface shall be shaped to the line, grade and cross section shown on the plans and, if considered necessary by the Engineer, hand tamped and sprinkled. When directed by the Engineer, the subgrade or foundation material shall be sprinkled lightly immediately before concrete is deposited thereon.

Forms shall be of wood, metal or other approved material, of a section satisfactory to the Engineer, straight, free of warp and of the depth required. They shall be securely staked to line and grade, and maintained in a true position during the placing of concrete.

The reinforcing steel, if required, shall be placed as shown on the plans. Care shall be exercised to keep all steel in its proper location during concrete placement.

Unless other methods are shown on the plans or approved by the Engineer, the concrete shall be placed into the forms and then struck off with a template which is approximately six (6) millimeters to ten (10) millimeters less than the dimension of the finished curb. After the concrete has been struck off and after it has become sufficiently set, the surface shall be plastered with a mortar consisting of one part of portland cement and two parts fine aggregate. The mortar shall be applied with a template made to conform to the finished curb dimensions as shown on the plans. Exposed edges shall be rounded by the use of an edging tool to the radius shown on the plans. All exposed surfaces shall be brushed to a smooth and uniform surface.

Curbs, gutters and combined curb and gutters shall be placed in sections of 15 meters maximum length unless otherwise approved by the Engineer.

Joints shall be of the type and spacing shown on the plans.

Hand finishing will be permitted.

The completed work shall be cured for a period of not less than 72 hours by one of the methods specified in Item 420, "Concrete Structures".

(2) Extruded or Slipformed Concrete. The concrete shall be placed with self-propelled equipment approved by the Engineer. When placement is directly on subgrade or foundation materials, the foundation shall be hand-tamped and sprinkled if considered necessary by the Engineer. If the concrete is placed directly on the surface material or pavement, such surface shall be thoroughly cleaned. If required by plan details, the cleaned surface shall then be coated with an approved adhesive or other coating as specified at the rate of application shown.

The reinforcing steel, if required, shall be placed as shown on the plans. Care shall be exercised to keep all steel in its proper location during concrete placement.

The line shall be maintained from a guideline set by the Contractor based on the alignment data shown on the plans. The outline shall strictly

conform to the details shown on the plans. The forming tube of the extrusion machine or the form of the slipform machine shall be readily adjustable vertically during the forward motion of the machine to provide required variable heights necessary to conform to the established grade line. To provide a continual check on the grade, a pointer or gauge shall be attached to the machine in such a manner that a comparison can be made between the extruded or slipform work and the guideline. Other methods may be used if approved in writing by the Engineer.

Concrete shall be fed into the machine in such a manner and at such consistency that the finished work will present a well-compacted mass with a surface free from voids and honeycomb, and true to the required shape, line and grade.

Any additional surface finishing specified and/or required shall be performed immediately after extrusion or slipforming. Joints shall be of the type and spacing shown on the plans.

Hand finishing will be permitted.

The completed work shall be cured for a period of not less than 72 hours by one of the methods specified in Item 420, "Concrete Structures".

529.4. Measurement. This Item will be measured by the meter, complete in place.

529.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Concrete Curb", "Concrete Gutter" or "Concrete Curb and Gutter" of the type specified. This price shall be full compensation for furnishing all materials required; for surface preparation of base; and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work.

ITEM 530

DRIVEWAYS AND TURNOUTS

530.1. Description. This Item shall govern for the construction of new driveways and turnouts and/or the paving of existing driveways and turnouts. Driveways and turnouts shall be concrete, asphaltic concrete pavement or

surface treatment of the design type specified and to the details shown on the plans.

530.2 to 530.4

530.2. Materials. Base, stabilized base, asphalt surfacing, concrete pavement, reinforcing steel and other materials shall conform to the material requirements of the pertinent items.

530.3. Construction Methods. The driveways and turnouts shall be constructed and/or paved at the locations and conforming to the details shown on the plans or as directed by the Engineer. Unless otherwise directed by the Engineer, the Contractor shall provide uninterrupted access to the adjacent property.

Stabilization of subgrade will be required where specified on the plans in accordance with the construction methods of the pertinent stabilization items.

Base material shall be placed on the subgrade, sprinkled, bladed, compacted and shaped to conform to the typical sections shown on the plans and specified in the construction methods of the pertinent base item.

The subgrade, foundation, or pavement surface shall be shaped to line, grade and cross sections and constructed in accordance with the details shown on the plans.

When concrete pavement is specified on the plans it shall be in accordance with the construction methods of Item 360, "Concrete Pavement". Reinforcing steel shall be placed as shown on the plans. Care shall be exercised to keep all steel in its proper location during concrete placement. The use of ready mix concrete in accordance with the provisions of Item 522, "Portland Cement Concrete Plants", will be permitted. Hand finishing will also be permitted.

When asphaltic pavement or surface treatment is specified on the plans it shall be in accordance with the construction methods of the pertinent item.

Asphaltic pavement or surface treatment shall be applied to the finished base or existing driveways and/or turnouts where shown on the plans in accordance with the construction methods of the pertinent paving items.

530.4. Measurement. This Item will be measured as each driveway or turnout, complete in place, or by the square meter of the complete surface portion of the installation.

530.5. **Payment.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Driveways (Concrete)", "Driveways (Asphaltic-concrete Pavement)", "Driveways (Surface Treatment)", "Turnouts (Concrete)", "Turnouts (Asphaltic-concrete Pavement)" or "Turnouts (Surface Treatment)" of the design type shown on the plans. This price shall be full compensation for furnishing all materials required; all labor, tools, equipment, all excavation and hauling of excavated material, and all royalty, sprinkling, compacting and incidentals necessary to complete the work except that drainage structures will be measured and paid for in accordance with the pertinent bid items.

ITEM 531

SIDEWALKS

531.1. **Description.** This Item shall govern for portland cement concrete sidewalks constructed on approved subgrade, foundation material or finished surface in accordance with the lines and grades established by the Engineer and in conformance with details shown on the plans.

531.2. **Materials.** All materials shall conform to the pertinent requirements of the following items:

Item 360, "Concrete Pavement"
Item 420, "Concrete Structures"
Item 421, "Portland Cement Concrete"
Item 437, "Concrete Admixtures"
Item 440, "Reinforcing Steel"
Item 526, "Membrane Curing"

Concrete used in conventionally formed and slipformed construction shall be Class "A" concrete or concrete as specified for concrete pavement. Unless otherwise shown on the plans, concrete for extruded construction shall be Class "A", except that the coarse aggregates shall meet the requirements of Grade 8. Other grades of coarse aggregate may be substituted, if approved by the Engineer.

531.3. **Construction Methods.**

(1) Conventionally Formed Concrete. Prior to sidewalk construction the subgrade, foundation or pavement surface shall be shaped to the

line, grade and cross section shown on the plans and, if considered necessary by the Engineer, hand tamped and sprinkled. When directed by the Engineer, the subgrade or foundation material shall be sprinkled lightly immediately before concrete is deposited thereon.

Forms, where needed, shall be of wood or metal, of a section satisfactory to the Engineer, straight, free of warp and of the depth required. They shall be securely staked to line and grade and maintained in a true position during the placing of concrete.

The reinforcing steel shall be placed in position as shown on the plans. Care shall be exercised to keep all steel in its proper location during concrete placement.

Sidewalks shall be constructed in sections of the lengths shown on the plans. Unless otherwise shown on the plans or approved by the Engineer, no section shall be less than 2.4 meters or more than 12 meters in length. Sections shall be separated by premolded or board joint of the thickness shown on the plans, placed vertically and at right angles to the longitudinal axis of the sidewalk. Where the sidewalk abuts a curb or retaining wall, approved expansion material shall be placed along their entire length. Similar expansion material shall be placed around all obstructions protruding through sidewalks. Sidewalks shall be marked every 1.2 meters in length, by the use of approved jointing tools. Each day's production will be terminated at an expansion joint.

(2) Extruded or Slipformed Concrete. Concrete shall be placed with equipment approved by the Engineer. When placement is directly on subgrade or foundation materials, the foundation shall be hand tamped and sprinkled if considered necessary by the Engineer. If the concrete is placed directly on the surface material or pavement, such surface shall be thoroughly cleaned. Concrete shall be fed into the machine in such a manner and at such consistency that the finished work will present a well-compacted mass with a surface free from voids and honeycomb, and true to the required shape, line and grade.

Any additional surface finishing specified and/or required shall be performed immediately after extrusion or slipforming. Joints shall be constructed at such locations as directed by the Engineer and conforming to the details shown on plans.

(3) General. The completed work shall be cured for a period of not less than 72 hours by one of the methods specified in Item 420, "Concrete Structures".

Regardless of the method of construction, hand finishing will be permitted. All exposed surfaces shall be brushed to a smooth and uniform surface.

Wheelchair ramps shall be in conformance with the details shown on the plans.

531.4. Measurement. Sidewalks, including any required wheelchair ramps, will be measured by the meter or by the square meter of surface area, complete in place.

531.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Concrete Sidewalks" of the width shown on the plans. This price shall be full compensation for furnishing all materials required; surface preparation of base; and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work.

ITEM 532

CONCRETE EROSION RETARDS

532.1. Description. This Item shall govern for portland cement concrete erosion retards, constructed at such places as shown on the plans or as designated by the Engineer, in accordance with these specifications and in conformity with the lines, grades, dimensions and other details shown on the plans.

532.2. Materials. Unless otherwise shown on the plans, all concrete materials shall conform to the requirements of Item 421, "Portland Cement Concrete". When permitted on the plans, the base course material may be used as aggregate subject to compliance with the gradation requirements of the base course specification and approval of the Engineer. The proportions of cement and base course materials shall be as shown on the plans.

532.3. Construction Methods. Prior to placing the concrete, excavation for retards shall be made to proper section, and if considered

necessary by the Engineer, the bottom of excavation area shall be hand tamped and sprinkled. The excavated area for retards shall be moist when the concrete is placed.

After the concrete has been placed, consolidated and shaped to conform to the dimensions of typical sections shown on the plans, and the concrete has become sufficiently set, it shall be given a wood float surface finish.

No concrete work shall be done when the temperature is below 2 °C and all work shall be protected from freezing. After completion of the concrete erosion retard, all exposed surfaces shall be covered with burlap, cotton mats or other approved covering and kept wet for a period of three (3) days. Curing compound conforming to the requirements of Item 526, "Membrane Curing", will be permitted when applied to all exposed surfaces.

Material excavated from the trench shall be uniformly spread on adjacent areas, or otherwise disposed of as directed by the Engineer.

532.4. Measurement. This Item will be measured by the cubic meter, complete in place.

532.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Concrete Erosion Retards". This price shall be full compensation for all excavation; furnishing, hauling and placing all materials required (including any royalty costs); disposal of excavated material; and for all manipulation, labor, tools, equipment and incidentals necessary to complete the work.

ITEM 534

STRUCTURE APPROACH SLABS

534.1. Description. This Item shall govern for the construction of concrete structure approach slabs in conformance with the details and typical cross sections shown on the plans and to the lines and grades as established by the Engineer.

534.2. Materials. All materials shall conform to the pertinent requirements of the following Items:

Item 360, "Concrete Pavement"
Item 421, "Portland Cement Concrete"
Item 433, "Joint Sealants and Fillers"
Item 440, "Reinforcing Steel"

Unless otherwise shown on the plans, concrete shall be Class S or Class P.

534.3. Construction Methods. Unless otherwise shown on the plans, the subgrade and/or subbase shall be constructed from the bridge and for a minimum distance of 30 meters prior to the approach slab.

The subgrade or foundation for the approach slab shall be compacted and finished to the typical cross section and to the lines and grades established by the Engineer. The surface of the subgrade or foundation shall be moist, or lightly sprinkled if dry, before concrete is placed thereon.

Outside forms shall be wood or metal of a section satisfactory to the Engineer, straight, free of warp, and of a depth equal to or greater than the depth of the specified section. The forms shall be securely staked to line and grade and maintained in position. Inside forms for curbs, if used, shall be of such design to provide the curb required and shall be rigidly attached to the outside forms.

The reinforcing steel shall be placed as shown on the plans and in accordance with Item 440, "Reinforcing Steel".

Concrete shall be mixed, placed, consolidated, cured and finished as specified in Item 420, "Concrete Structures", and Item 421, "Portland Cement Concrete".

The structure approach slab shall receive a texture finish in accordance with Article 420.19.

Joint sealants shall be installed in accordance with the details shown on the plans and Item 438, "Cleaning and/or Sealing Joints and Cracks (Portland Cement Concrete)".

Protection of the structure approach slab and opening to traffic shall be in accordance with Article 360.12.

534.4. Measurement. This Item will be measured by the cubic meter of concrete complete in place, based on dimensions shown on the plans or those established in writing by the Engineer.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

534.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement", will be paid for at the unit price bid for "Structure Approach Slabs". This price shall be full compensation for excavation necessary in preparation of the subgrade, disposal of excavated material and preparation of subgrade; for furnishing and placing reinforcement; for furnishing, hauling and mixing all concrete materials; for placing, consolidating, curing and finishing all concrete; for all grouting and pointing; for furnishing and placing all drains and joints and for all labor, tools, equipment and incidentals necessary to complete the work.

ITEM 536

CONCRETE MEDIANS AND DIRECTIONAL ISLANDS

536.1. Description. This Item shall govern for the construction of cast in place portland cement concrete medians and/or directional islands on designated or prepared foundations in accordance with the lines and grades established by the Engineer and in conformance with the details shown on the plans.

536.2. Materials. All materials shall conform to the pertinent requirements of the following items:

Item 420, "Concrete Structures"
Item 421, "Portland Cement Concrete"
Item 433, "Joint Sealants and Fillers"
Item 440, "Reinforcing Steel"
Item 526, "Membrane Curing"
Item 529, "Concrete Curb, Gutter and
Combined Curb and Gutter"

Concrete used for concrete medians and directional islands shall be Class A, unless otherwise shown on the plans.

536.3. **Construction Methods.** Forms, where required, shall be of wood or metal, straight, free of warp and of the depth required. They shall be securely held in place, true to line and grade, during the concrete placing operations. Reinforcing steel and/or dowels shall be securely held in position.

The concrete shall be placed on the prepared foundation to the lines, grades and dimensions shown on the plans. Concrete shall be mixed and placed in a manner satisfactory to the Engineer. Each section shall be placed to the dimensions shown on the plans. When shown on the plans, sections shall be separated from adjacent curbs or adjoining sections by expansion or contraction joints of the type and size specified. When shown on the plans or permitted by the Engineer, a curb section may be used for the perimeter of the median or island. Such curbs shall be constructed in conformance with Item 529, "Concrete Curb, Gutter and Combined Curb and Gutter".

After the concrete has been struck off and has set sufficiently, the exposed surfaces shall be thoroughly worked with a wooden float. Exposed edges shall be rounded by the use of an edging tool to the radius indicated on the plans.

When the concrete has set sufficiently, the forms shall be carefully removed and the exposed surface shall be pointed up where necessary, then wetted and rubbed with a wood block to remove all form marks and other irregularities, producing a smooth, uniform finish. When directed by the Engineer, mortar consisting of one part portland cement and two parts fine aggregate shall be used to plaster exposed formed surfaces. The mortar shall be applied with a template made to conform to the desired cross section shown on the plans.

The completed work shall be cured for a period of not less than 72 hours by one of the methods specified in Item 420, "Concrete Structures".

536.4. **Measurement.** This Item will be measured by the meter or by the square meter complete in place.

536.5. **Payment.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Concrete Median" or "Concrete Directional Island". This price shall be full compensation for preparing foundation surfaces, furnishing, hauling, and placing all materials; for furnishing and placing reinforcing steel; for furnishing and placing joint materials; for curb used as part of the concrete median or directional island; for curing and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work.

ITEM *538*

RIGHT OF WAY MARKERS

538.1. **Description.** This Item shall govern for constructing, installing and/or removing and relocating concrete right of way markers on right of way lines at points designated on the plans or as directed by the Engineer.

538.2. **Materials.** Right of way markers shall be either precast or cast in place. Precast right of way markers furnished by a commercial supplier shall be made of Class "A" concrete. Cast in place right of way markers shall be made of Class "A", "B" or "C" concrete. All concrete shall conform to the requirements of Item 421, "Portland Cement Concrete".

Reinforcing steel shall conform to the requirements of Item 440, "Reinforcing Steel".

When bronze disks are required by the plans, they will be furnished by the Department to the Contractor at no cost. The Contractor shall place his order for disks through the Engineer sufficiently in advance of the work to insure available stock at the Department Warehouse.

Markers to be used in "Removing and Relocating Right of Way Markers" shall be obtained in the removal of those existing on the old right of way.

538.3. **Construction Methods.** Right of way markers shall be cast and finished in accordance with the requirements of Item 420, "Concrete Structures", except that a surface finish will not be required for the portion

of the markers to be placed below the ground line. The shape and dimensions of the markers and the placement of steel shall be in accordance with details shown on the plans.

Markers shall be installed at designated points to the depth, lines and grades established by the Engineer, and as shown on the plans. The Contractor shall install all markers which will be used for control points during construction or that are critical Right of Way points, before the original points are destroyed. Backfilling shall be thoroughly tamped in 150 millimeter layers.

The Contractor will be required to exercise due care in the removal of right of way markers to prevent damage and will be required to replace markers damaged due to his carelessness at his expense.

538.4. Measurement. This Item will be measured as each marker, complete in place and/or removed.

538.5. Payment. The work performed and material furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Right of Way Markers (Furnish and Install)", of the type specified. This price shall be full compensation for furnishing all materials, all preparation and erection, all hauling, and for all manipulation, labor, tools, equipment and incidentals necessary to complete the work.

When bids are requested for "Right of Way Markers (Install)", satisfactory markers will be furnished to the Contractor free of charge at sources indicated on the plans for installation at designated points. The work performed in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Right of Way Markers (Install)". This price shall be full compensation for all hauling and erection, and for all manipulation, labor, tools, equipment and incidentals necessary to complete the work.

When bids are requested for "Right of Way Markers (Removing and Relocating)", markers will be removed from the old right of way line and installed at new locations as shown on the plans. The work performed in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Right of Way Markers (Removing and Relocating)". This price shall be full compensation for the removal of all existing markers as designated on the plans and the installation of such markers at new locations as shown on plans or as directed by the Engineer,

which price shall be full compensation for removal, transportation to new locations, installation at new locations, and for all manipulation, labor, tools, equipment and incidentals necessary to complete the work.

When bids are requested for "Right of Way Markers (Remove)", markers will be removed from the old right of way line. The work performed in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Right of Way Markers (Remove)". This price shall be full compensation for the removal of all existing markers as designated on the plans, which price shall be full
compensation for removal and disposal and for all manipulations, labor, tools, equipment and any incidentals necessary to complete the work.

ITEM 540

METAL BEAM GUARD FENCE

540.1. Description. This Item shall govern for furnishing and installing a single line of metal beam rail element supported on timber or steel posts as shown on the plans. Metal beam guard fence (barrier) shall consist of multiple lines of rail element supported on timber or steel posts. Metal beam guard fence and metal beam guard fence (barrier) shall be constructed of materials and workmanship as prescribed by these specifications, at such places as shown on the plans or as designated by the Engineer, and in conformity with the plans and typical details shown.

540.2. Materials.

(1) Rail Elements. The rail elements shall be of the W-beam type fabricated to develop continuous beam strength and shall consist of metal plate or sheet formed into a beam as shown on the plans. The beam shall be free from warp. When tested with a straight edge or string along either edge of a 3.8 meter sectional length of beam, the maximum deviation of the beam edges from the straight edge shall not exceed 13 millimeters at any point.

The steel for the rail elements shall conform to the requirements of AASHTO M-180. The rail shall be 3.43 millimeters ± 0.20 millimeter or 2.67 millimeters ± 0.20 millimeter as shown on the plans. Rail elements shall contain not more than 0.04 percent phosphorous nor more than 0.05 percent sulphur.

The rail element for the terminal anchor section shall be of the same materials as the rail element used throughout the project.

Unless otherwise shown on the plans, the rail element shall be galvanized in accordance with the requirements of Item 445, "Galvanizing", except that the galvanized coating shall not be less than 0.5 kilogram per square meter of double exposed surface (single spot test).

(2) Posts. The posts may be either timber or steel unless otherwise shown on the plans and shall meet one of the following requirements.

(a) Timber Posts.

All round timber posts shall conform to the American National Standards Institute Specifications and Dimensions for Wood Poles (ANSI) 05.1., except as modified herein.

Species. All timber posts shall be Southern Pine (including minor species) as defined by ASTM D 1165.

Dimensions. Posts shall not be less than 175 millimeters in diameter, at any point, as determined by a circumference-diameter tape. The top of the posts shall not exceed 200 millimeters in diameter below the dome or bevel. The diameter at the butt of a post shall not exceed the diameter of the top of that post by more than 50 millimeters. The length of the posts shall be as shown on the plans; the length shall not vary more than 25 millimeters from the specified length.

Manufacture. Posts may be domed or beveled, as specified. When posts are domed, the dome shall be approximately hemispherical in shape and the radius of the dome of each post shall be one-half the diameter of the posts at the base of the domed portion. The dome shall be smooth, and the distance from the top of the dome to the base of the dome shall not vary more than 25 millimeters at any location.

When posts are beveled, the bevel will be a minimum of 10 degrees and a maximum of 15 degrees for acceptance.

All posts shall be smooth shaved by machine. No "ringing" of the posts as caused by an improperly adjusted peeling machine is permitted. All outer and inner bark shall be removed during the shaving process. All knots and

knobs shall be trimmed smooth and flush with the surface of the posts.

540.2

The groundline, for the purpose of applying those restrictions of ANSI 05.1 that reference the groundline, shall be defined as being located one (1) meter from the butt end of each post.

Holes shall be drilled as shown on the plans for the type of posts being manufactured, with a location tolerance of six (6) millimeters in any direction. All manufacturing shall be completed prior to preservative treatment.

Knots. The maximum diameter of any single knot shall not exceed 75 millimeters. The sum of diameters of all knots greater than 13 millimeters in any 300 millimeter section shall not exceed 200 millimeters.

Scars. Scars are permitted as defined in ANSI 05.1 provided that the depth of the trimmed scar is not more than 25 millimeters.

Shape and Straightness. All timber posts shall be nominally round in cross section. A straight line drawn from the center of the top to the center of the butt of any post shall not deviate from the centerline of the post more than 30 millimeters at any point. Posts shall be free from reverse bends.

Splits and Shakes. Splits or ring shakes are not permitted in the top. Splits are not permitted in the butt. A single shake is permitted in the butt, provided it is not wider than one-half the butt diameter.

Timber Spacers. When timber spacers are required, the timber species shall be the same as those furnished for the timber posts. The size and hole location shall be as shown on the plans, with a tolerance of six (6) millimeters.

Spacers shall be of medium grain, at least four (4) rings per 25 millimeters on one end, and free from splits, shakes, compression wood or decay in any form. Individual knots, knot clusters or knots in the same cross section of a face are permitted, provided they are sound or firm, and are limited in cumulative width (when measured between lines parallel to the edges) to no more than one-half the width of the face. Wane or the absence of wood is limited to one-third of the face on no more than 10 percent of the lot. Grain deviation is limited to 25 millimeters in 150 millimeters. The material may be rough sawn or surfaced, full size, hit or miss, with a tolerance of six (6) millimeters for all dimensions.

All manufacturing shall be completed prior to preservative treatment.

Treatment. Timber posts and spacers shall be preservative treated in accordance with Item 492, "Timber Preservative and Treatment". In addition to the referenced following provisions shall apply:

Each post treated shall have a minimum sapwood depth of 25 millimeters, as determined by examination of the tops and butts of each post. The use of peeler cores is prohibited. Material that has been air dried or kiln dried shall be inspected for moisture content in accordance with AWPA Standard M2 prior to treatment. Tests of representative pieces shall be conducted. The lot shall be considered acceptable when the average moisture content does not exceed 25 percent. Pieces exceeding 29 percent moisture content shall be rejected and removed from the lot.

(b) Steel Posts. Steel posts and spacers shall be rolled sections as shown on the plans and conform to the requirements of ASTM A 36. The top of all posts shall be beveled or square as shown on the plans. The posts and spacers shall be drilled or punched for rail attachment as shown on the plans.

Steel posts and spacers shall be galvanized in accordance with the requirements of Item 445, "Galvanizing".

(3) Fittings. Fittings shall consist of bolts, nuts and washers conforming to the details shown on the plans and to the requirements of Item 442, "Metal for Structures". Fittings shall be galvanized in accordance with Item 445, "Galvanizing".

(4) Terminal Connectors. Terminal connectors, where required, shall conform to the details shown on the plans and to the materials and galvanizing requirements specified for rail elements.

(5) Concrete. Unless otherwise shown on the plans, the concrete for terminal anchor posts or for embedment of other posts in concrete, where embedment is required, shall meet the requirements for Class "A" concrete as specified in Item 421, "Portland Cement Concrete".

540.3. Sampling and Testing. When directed by the Engineer, a sample of the rail and terminal section shall be taken for each project or for each shipment to a project. Samples of bolts and nuts may also be required. All

samples shall be furnished to the Department free of charge.

540.4 to 540.5

The uniformity of the zinc coating shall be determined by visual inspection. If, in the opinion of the Engineer, visual examination is not conclusive, the uniformity of the coating may be determined by magnetic thickness gauge measurement, in accordance with ASTM E 376.

540.4. Construction Methods. The posts shall be set plumb and firm to the line and grade shown on the plans. Unless the plans call for setting in concrete, the posts shall be backfilled by thoroughly tamping the material in 100 millimeter layers. Where shown on details the rail element shall be blocked out from the posts with spacers. The rail elements shall be erected to produce a smooth, continuous rail paralleling the line and grade of the roadway surface or as shown on the plans. The rail elements shall be joined end to end by bolts and lapped in the direction of traffic in the lane adjacent to the guard fence. When shown on the plans, the rail elements shall be curved. Curving of rail elements shall be done during fabrication of the rail elements. Holes for special details may be field-drilled or punched, when approved by the Engineer.

Driving will be an acceptable method of attaining the established line and grade for posts. A structural steel driving head suitable for the type and size of post being driven shall be used. Wood cushion blocks shall be used as necessary to prevent damage to the post. Rope mat, belting or other similar cushioning material may be used in addition to wood cushion blocks. When posts are driven, the driving may be performed with power hammers (steam, compressed air or diesel) or gravity hammers approved by the Engineer. Pilot holes may be required or permitted. The size and depth shall be determined by the Contractor with the approval of the Engineer based on results of trial operations of the first few posts driven. Loosened soil around the post shall be thoroughly tamped and any void between the soil and the post resulting from the driving shall be filled with suitable material and thoroughly compacted as directed by the Engineer.

After erection, all parts of galvanized steel posts, spacers, washers, bolts and rail elements on which the galvanizing has become scratched, chipped or otherwise damaged shall be repaired in accordance with Item 445, "Galvanizing".

540.5. Measurement. Metal Beam Guard Fence will be measured by the meter of fence, complete in place, measurement being made upon the face of the rail in place, from center to center of end posts, from terminal anchor sections or in the case of structure to railing connection, from the points shown

on the plans, except as follows: Where bids are requested for "Terminal Anchor Sections", measurement will be made as each section,

complete in place, each section consisting of a terminal anchor post and one 7.6 meter rail element, as shown on the plans.

540.6. **Payment.** The work performed and material furnished in accordance with this Item and measured as provided under "Measurement", will be paid for at the unit price bid for "Metal Beam Guard Fence", "Metal Beam Guard Fence (Barrier)", "Metal Beam Guard Fence (Barrier) (Blockout)" or "Metal Beam Guard Fence (Blockout)", of the thickness specified. This price shall be full compensation for furnishing all materials, except timber posts furnished by the Department, including necessary boring for preparation, for hauling and erection; for setting posts in concrete when required; for spacers where required and for all labor, tools, equipment and incidentals necessary to complete the work, including driving posts, excavating, backfilling and disposing of surplus material.

When bids are requested for "Terminal Anchor Section" measured as provided under "Measurement", payment will be made at the unit price bid for "Terminal Anchor Section" of the thickness specified. This price shall be full compensation for furnishing the turn-down rail element, anchor assembly, terminal anchor post and foundations or for installing the salvaged turn-down rail element anchor assembly, terminal anchor post and foundations; and for all labor, tools, equipment and incidentals necessary to complete the work including excavation, backfilling and disposal of surplus materials.

ITEM 542

REMOVING METAL BEAM GUARD FENCE

542.1. **Description.** This Item shall govern for the removal of existing metal beam guard fence and its storage at locations shown on the plans or as directed by the Engineer.

542.2. **Construction Methods.** All rail elements shall be carefully removed in original lengths and neatly stacked. All fittings shall be removed from the posts and the metal rail. The posts shall then be loosened and pulled. Removal of all materials shall be performed in such a manner that they will not be marred or damaged. Any material damaged during removal shall be repaired or replaced at the Contractor's expense.

Posts which are set in concrete may be cut off 0.3 meter below the new subgrade elevation leaving in place the remaining concrete and bottom

of post. Any remaining concrete less than 0.3 meter below the new subgrade elevation shall be removed.

Eyebolts anchored to deadmen need not be removed but may be cut off or bent down at an elevation at least 0.3 meter below the new subgrade elevation and left in place along with the deadman.

All materials thus removed and salvaged shall be neatly stored at designated sites or disposed of as directed by the Engineer.

The Contractor will not be required to haul the salvaged material beyond the limits of the project unless otherwise shown on the plans.

Unless otherwise directed by the Engineer, the resulting post holes shall be backfilled with material equal in composition and density to the surrounding soil. Any necessary backfill material shall be furnished by the Contractor.

542.3. Measurement. This Item will be measured by the meter of fence in its original position, measurement being made along the face of the rail in place, from center to center of end posts, from terminal anchor sections, or in the case of structure to railing connection, from the points shown on the plans, except as follows: Where bids are requested for "Removing Terminal Anchor Sections", measurement will be made as each section removed, each section consisting of a terminal anchor post and one 7.6 meter rail element, as shown on the plans.

542.4. Payment. The work performed and materials furnished in accordance with this Item, and measured as provided under "Measurement", will be paid for at the unit price bid for "Removing Metal Beam Guard Fence", "Removing Metal Beam Guard Fence (Barrier)" or "Removing Terminal-Anchor Section". This price shall be full compensation for removing all materials, loading, hauling, unloading and satisfactorily storing or disposal; for furnishing all backfill material; for backfilling post holes and for all manipulation, labor, tools, equipment and incidentals necessary to complete the work.

ITEM 550

CHAIN LINK FENCE

550.1. Description. This Item shall govern for furnishing and installing chain link fence and gates at locations shown on the plans or as **550.2**

designated by the Engineer, including all posts, bracing and accessories as specified herein and as shown on the plans.

550.2. Materials. Prior to installation of the chain link fence, on this project, the Contractor shall furnish certification from the manufacturer, to the Engineer, stating that all fencing materials comply with the requirements set forth in this Item.

(1) Fabric. Fabric and appurtenances shall meet the following requirements:

(a) Wire fabric for fencing shall be 3.76 millimeters steel with a minimum breaking strength of 1750 newton per meter. Mesh size shall be 50 millimeters ± three (3) millimeters between parallel wires and such that in a vertical dimension of 585 millimeters along the diagonals of the openings there shall be at least seven meshes. The overall height of the fence when erected shall be the height above grade as shown on the plans. Unless otherwise shown on the plans, the top and bottom edge of the fabric shall be knuckled selvage. Except as provided herein, the chain link fence shall conform to the specifications of ASTM A 392, Class I or ASTM A 491.

(b) Between posts, the fabric shall be fastened at 300 millimeter intervals to a top and bottom tension wire. When top rail is shown on the plans, the fabric shall also be fastened in the same manner. On gate frames, the fabric shall be fastened to top and bottom of the gate frame at all 300 millimeter intervals. Steel wire fabric ties of not less than 3.76 millimeter steel shall be used.

(2) Posts. Except for thin-wall, high-strength pipe posts, steel pipe used for posts and gate frames shall conform to ASTM F 1083. Thin-wall, high-strength pipe posts shall be manufactured by cold rolling using steel strip conforming to ASTM A 569. C-Sections shall conform to ASTM A 570, Grade 310. Steel H-beam sections used for posts shall conform to ASTM F 669. All material shall be new, and no used, rerolled or open seam material will be acceptable. All fittings required for posts shall be pressed or rolled steel, forged steel, malleable iron or wrought iron of good commercial quality and spaced as shown on the plans. The size and mass of post and the embedment depth shall be as shown on the plans.

(a) Line Posts. Line posts may be either C-section or tubular. Tubular line posts shall be fitted with watertight malleable iron caps. Line

posts shall be furnished in sufficient quantity to provide a maximum spacing between posts of three (3) meters.

(b) Terminal Posts. All end, corner and pull posts shall be known as terminal posts and shall be of either round or square sections. All terminal posts shall be furnished with watertight malleable iron caps. Fabric shall be fastened to terminal posts by steel stretcher bars and stretcher bar bands fitted with carriage bolts and nuts of the size and spacing shown on the plans.

(c) Gate Posts. Gate posts shall be either round or square. All gate posts shall be furnished with watertight malleable iron caps. The fabric shall be attached to the gate posts by means of steel stretcher bars and stretcher bar bands fitted with carriage bolts and nuts of the size and spacing shown on the plans.

(3) Post Caps. Post caps for pipe sections shall be designed to exclude all moisture. Where barbed wire is shown on the plans, barbed wire support arms shall be integral with post caps. Where top rail is shown on the plans, post caps shall have an opening for the top rail. All post caps shall have a 50 millimeter skirt for rigidity.

(4) Gates. Gate frames shall be fabricated from sections either round or square and shall be fabricated from pipe of the size and mass as shown on the plans. Fabric on gates shall be the same as that specified for fencing. The following accessories shall be furnished for each gate:

(a) Corner and tee fittings of malleable iron or pressed steel having means for attaching diagonal bracing members.

(b) Hinges of malleable iron providing for a full 180 degree swing with bottom hinges to be ball and socket type. Hinges shall not twist or turn under the action of the gate, shall be so arranged that a closed gate cannot be lifted off the hinges to obtain entry and shall be easily operated by one person.

(c) All gates shall be equipped with a positive stop which will not permit any portion of the gate to swing over an adjacent traffic lane and shall be equipped with a positive means of maintaining the gate in a closed position.

(d) Diagonal braces shall consist of ten (10) millimeter diameter truss rods with turnbuckles, two to each gate frame. Vehicle gates shall

have a vertical pipe brace, of the size and mass shown on the plans, at the center of each gate leaf.

(e) Latches of malleable iron or steel for single gates shall have a single fork latch with padlock eye and double leaf gates shall have two fork latches mounted on a center plunger rod with a padlock eye.

(f) Holdbacks shall be provided for each leaf of vehicular gates, employing a semi-automatic holdback catch to be anchored at least 300 millimeters into a 300 millimeter diameter by 600 millimeter deep concrete footing.

(g) A malleable iron center rest, designed to receive the plunger rod, to be anchored as shown on the plans, shall be provided for all double leaf gates.

(h) The top of all gate frames shall align with the fencing top tension wire or top rail, when top rail is shown on the plans. If curbs are shown on the plans, vehicular gates shall be provided which are greater in overall height than the adjacent fencing by the height necessary to extend to within 50 millimeters of pavement between the curbs.

(5) Top Rail. Top rail, when shown on the plans, shall be 42 millimeter O.D. steel pipe, sch-40, weighing 0.3 kilogram per meter or high strength pipe weighing 0.25 kilogram per meter or shall be 41 x 32 millimeter C-section weighing 0.2 kilogram per meter. Top rail shall be furnished in random lengths, not less than 5.5 meters per section, and shall be joined with outside steel sleeve couplings not less than 150 millimeters long and having a wall thickness of not less than 18 millimeters. The couplings shall be designed to allow for expansion movement of the top rail.

(6) Tension Wire. Unless otherwise shown on the plans, tension wire shall be furnished for the top and bottom edge of all fence fabric. Tension wire shall be 4.5 millimeter carbon steel wire and shall have a minimum breaking strength of 2650 newton per meter.

(7) Trussed Bracing. Trussed bracing, when shown on the plans, shall be furnished for each panel adjacent to a terminal, pull, corner or gate post. The compression member shall be 41 millimeter O.D. pipe or C-section as specified for top rail material. Tension members shall be ten (10) millimeter diameter steel rods with turnbuckles.

For 1.8 meter fences with top tension wire, braced panels shall consist of a horizontal pipe brace, located approximately 100 millimeters below the top of fabric, a diagonal pipe brace, attached at the midpoint of the terminal post and at the bottom of the adjacent line post and a truss rod attached to the top of the adjacent line post, extending diagonally to the bottom of the terminal post.

For 1.8 meter fences with top rail, when top rail is specified on the plans, braced panels shall consist of a horizontal pipe brace, midway between top and bottom of fence fabric, with a truss rod extending from midpoint of the line post diagonally to bottom of terminal post.

1.2 meter fences with top rail, when top rail is specified on the plans, shall be braced with a truss rod connected to the bottom of the terminal post and extending to top of adjacent line posts.

1.2 meter fences with top tension wire shall have a horizontal brace pipe at the top of the fabric and a diagonal truss rod installed as described above.

(8) Cables. Cable shall be a seven wire strand. The diameter of the finished cable shall not be less than ten (10) millimeters. Cables shall be installed on all terminal posts, as shown on the plans, and shall extend to the adjacent posts. All corner and pull posts shall have cables on each side, unless otherwise shown on the plans. All cables shall be installed with a ten (10) millimeter drop-forged eye-and-eye or eye-and-clevis turnbuckle. All cable shall be manufactured of galvanized annealed steel.

(9) Barbed Wire. Barbed wire, when specified on the plans, shall be 2.51 millimeter wire, twisted with two-point 2.03 millimeter barbs spaced approximately 125 millimeters apart and shall conform to ASTM A 121 or ASTM A 585. Three strands of barbed wire will be required when a barbed wire top is specified on the plans.

(10) Barbed Wire Support Arms. Barbed wire support arms shall be at an angle of 45 degrees from vertical and shall have clips for attaching three (3) strands of barbed wire to each support arm. Each support arm shall be of sufficient strength to support a mass of 90 kilograms applied at the outer strand of barbed wire.

(11) Stretcher Bars. Stretcher bars shall be not less than five (5) millimeters by 20 millimeters flat steel and not more than 50 millimeters shorter than the fabric height. One stretcher bar shall be provided for each

gate and end post. Two stretcher bars shall be provided for each corner and pull post. Stretcher bars shall be attached to terminal posts with 25 millimeters x three (3) millimeter flat steel bands with ten (10) millimeter carriage bolts at intervals not exceeding 380 millimeters.

(12) Miscellaneous Fittings and Fasteners. Miscellaneous fittings and fasteners shall be furnished in sufficient quantities to erect all fencing materials in a proper manner.

550.3. **Protective Coating.** All materials used in chain link fence shall receive a protective coating meeting the following requirements.

The uniformity and quality of the coating shall be determined by visual inspection. Excessive roughness, blisters, sal ammoniac spots, bruises and flaking, if present to any considerable extent, shall provide a basis for rejection.

Damaged zinc coating shall be repaired in accordance with Item 445, "Galvanizing".

(1) Fabric. The fabric shall be either hot-dip galvanized in accordance with ASTM A 392, Class I (0.4 kg/m^2), aluminum coated in accordance with ASTM A 491 (0.1 kg/m^2) or coated with zinc-5% aluminum-mischmetal alloy in accordance with ASTM F 1345, Class I (0.2 kg/m^2).

(2) Posts, Braces and Gates. All posts (except for thin-wall, high-strength pipe posts), rails, braces, frames and gates shall be hot-dip galvanized inside and outside in conformance with ASTM F 1083 (0.5 kg/m^2) or coated inside and outside with zinc-5% aluminum-mischmetal alloy in conformance with ASTM F 1234, Type C (0.3 kg/m^2).

C-sections galvanized before fabrication shall have cut edges coated in accordance with ASTM A 780.

Thin-wall, high-strength pipe posts shall be externally hot-dip galvanized with a minimum mass of coating of 0.3 kilogram per square meter. After galvanizing, thin-wall, high-strength pipe posts shall also be externally chromated by total immersion followed by application of clear polyurethane finish. Internally, thin-wall, high-strength pipe posts shall have either a hot-dip galvanized coating, a zinc base coating with thickness 13 micrometer plus or minus 5 micrometer. The coating shall be 94 percent zinc powder by mass.

550.4

All tubular posts, rails and braces shall comply with the following salt spray performance requirements when tested in accordance with ASTM B 117.

Exterior - 1250 hours to maximum 5% red rust
Interior - 650 hours to maximum 5% red rust

(3) Fittings, Bolts and Other Miscellaneous Hardware. All fittings, bolts and miscellaneous hardware shall be galvanized in conformance with Item 445, "Galvanizing".

(4) Tension Wire. Zinc coated tension wire shall have a minimum coating of 0.2 kilogram per square meter and aluminum coated tension wire shall have a minimum coating of 0.09 kilogram per square meter.

(5) Barbed Wire. Barbed wire shall be zinc coated in accordance with ASTM A 121 (0.2 kg/m^2) or aluminum coated in accordance with ASTM A 585 (0.09 kg/m^2).

(6) Pull Cable. Pull cable shall have a minimum coating of 0.2 kilogram per square meter of uncoated individual-wire surface when tested in conformance with ASTM A 116.

550.4. Construction Methods. The chain link fence shall be erected to the lines and grades established by the Engineer in accordance with the details shown on the plans. The fence shall be true to line, taut and shall comply with the best practice for fence construction of this type.

(1) Clearing and Grading. The Contractor shall perform all clearing of brush, rocks and debris necessary for the installation of this fencing.

Unless otherwise shown on the plans, the Contractor shall stake and the Engineer will verify the locations for corner posts and terminal posts in this installation. The fencing panels between corner and terminal posts shall generally follow the finished ground elevations. However, the Contractor shall grade off minor irregularities in the path of the fencing in accordance with Subarticle 550.4.(3).

(2) Erection of Posts. Posts shall be set plumb and permanently positioned and anchorages firmly set before fabric is placed.

(a) Post Spacing. Maximum spacing for line posts shall be three (3) meters. Pull posts shall be located not more than 150 meters apart and at each change in direction exceeding 20 degrees vertically.

Corner posts shall be placed at each horizontal angle point. Corner and pull posts shall have braces as specified above and as shown on the plans. Runs of fencing over 150 meters, but less than 300 meters shall have a pull post in the center of the run.

(b) Postholes. Holes for concrete footings for all posts shall be drilled to provide footings of the dimensions as shown on the plans.

Where solid rock is encountered without an overburden of soil, line posts shall be set a minimum depth of 300 millimeters, and end, corner, gate and pull posts a minimum of 450 millimeters into the solid rock. The hole shall have a minimum diameter 25 millimeters greater than the largest dimension of the post section to be set.

After the post is set and plumbed, the hole shall be filled with grout consisting of one part portland cement and three parts clean, well graded sand. Other grouting materials may be used if approved by the Engineer. The grout shall be thoroughly worked into the hole so as to leave no voids. The grout shall be crowned to carry water from the post.

Where solid rock is covered by an overburden of soil or loose rock, the posts shall be set to the full depth shown on the plans unless the penetration into solid rock reaches the minimum depths specified above, in which case, the depth of penetration may be terminated. Concrete footings shall be constructed from the solid rock to the top of the ground. Grouting will be required on the portion of the post in solid rock.

If the ground is firm enough to permit excavation of the post hole to neat lines, the concrete may be placed without forms by completely filling the hole. Under these conditions the earth coming in contact with the concrete shall be moistened to a depth of at least 50 millimeters prior to placing concrete. No curing will be required other than covering concrete with not less than 100 millimeters of loose moist material, free of clods and gravel, immediately after placing concrete.

Where the ground cannot be satisfactorily excavated to neat lines, forms shall be used for footings. Under these conditions, when the soil is not moist, not less than four (4) liters of water shall be poured into each hole and as soon as this water has been absorbed, the concrete shall be ***550.4***

placed. The forms shall remain in place for a minimum of least 24 hours. As soon as each form is removed, the footing shall be backfilled, with moistened material, and thoroughly tamped. The top of the concrete shall then be covered with not less than 100 millimeters of loose moistened material. All excess excavated material and loose material used for curing, shall be spread neatly and uniformly to leave the area as sightly as possible.

(c) Concrete for Footings. Concrete for footings shall be Class "B" concrete in accordance with Item 421, "Portland Cement Concrete", unless otherwise specified on the plans.

All concrete footings shall be cast up to finish grade and crowned 25 millimeters to shed water. Excess concrete not used in the footings, and any other construction debris, shall be removed from the site.

Concrete footings shall not be less than the dimensions shown on the plans except as modified in 550.4.(2)(b). Posts shall be approximately centered in their footings. All concrete shall be placed promptly and compacted by tamping or other approved methods. Hand mixing of concrete will be permitted on batches under 0.5 cubic meter. All batches exceeding this volume shall be machine mixed.

(3) Erection of Fabric. After all posts have been permanently positioned and anchorages firmly set, with the cables drawn taut with the turnbuckles, the fabric shall be placed by securing one end and applying sufficient tension to the other end to remove all slack before making attachments. Unless otherwise shown on the plans, the fabric shall be cut and each span shall be attached independently at all corner posts and pull posts.

Fastening to end, pull, corner and gate posts shall be with stretcher bars which shall be secured to the posts with stretcher bar bands at intervals not exceeding 380 millimeters.

Fence fabric shall generally follow the finished contour of the site with the bottom edge of fabric located approximately 50 millimeters above the grade. In uneven areas the ground shall be graded so that the maximum distance between bottom of fabric and ground is limited to 150 millimeters.

Any necessary backfilling required, in order to comply with these provisions, shall be considered subsidiary work and will not be paid for directly.

(4) Electrical Grounds.

Each 300 meters of fence shall be provided with a ground located near the center of the run. At least one electrical ground shall be provided for each fence installation.

In addition a ground shall be provided directly under the point where a power line passes over the fence.

The ground shall consist of a copperweld rod 2.4 meters long and a minimum of 16 millimeters in diameter driven, or drilled in, vertically until the top of the rod is approximately 150 millimeters below the top of the ground. A No. 6 solid copper conductor shall be brazed to the rod and to the fence in such a manner that each element of the fence is grounded.

550.5. **Measurement.** Chain Link Fence will be measured by the meter of fence measured at the bottom of the fabric along the centerline of the fence from center to center of terminal posts, excluding gates. Gates will be measured as each gate, complete in place.

550.6. **Payment.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Chain Link Fence" or "Chain Link Security Fence" of the height specified. This price shall be full compensation for furnishing and installing all fencing materials, except gates, including all miscellaneous fittings, pull cables, braces, post caps, line wires, connection clips or wires; for digging post holes and grouting in rock where required; for furnishing and placing concrete for setting posts; for furnishing and installing all electrical grounds; for all hauling and handling charges; for all cleaning and grading including backfilling and disposing of surplus material; and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work.

Gates measured as provided under "Measurement" will be paid for at the unit price bid for "Pedestrian Gate" or "Vehicular Gate", of the type, height and width of opening specified. This price shall be full compensation for furnishing all materials; for fabricating, preparation, hauling, handling and erecting, including all miscellaneous fittings, braces, latches, gate hinges, stops and center anchorages; and for all manipulations, labor, tools, equipment and incidentals necessary for a complete gate installation.

ITEM *552*

WIRE FENCE

552.1. **Description.** This Item shall govern for constructing one line of fence supported on metal or wood posts in accordance with the details and at the locations shown on the plans. The fence shall consist of barbed wire or a combination of woven fence fabric and barbed wire as specified on the plans.

552.2. **Materials.**

(1) Metal Posts and Braces. Steel pipe used for posts and braces shall conform to the specifications of ASTM A 120. Steel sections used for posts and braces shall be a good commercial quality weldable steel. All material shall be new and no used, rerolled or open seam material will be acceptable. All posts and braces shall meet the mass and length requirements shown on the plans. Galvanized steel sections shall conform to ASTM A 123. All posts and braces, except galvanized products, shall be painted with an approved anti-corrosive paint and after installation all areas where the paint coat has been damaged shall be spot-coated with paint of the same color as the shop coat. No other painting will be required. All fittings required for posts and braces shall be pressed or rolled steel, forged steel, malleable iron or wrought iron of good commercial quality and shall conform to the details shown on the plans.

(a) Metal Line Posts, Pull Posts and Braces for Pull Posts. Metal posts and braces shall be "H" column, tubular or any other approved shape and shall be properly adapted to provide means for attaching the fencing to the posts in a manner that will not damage the posts nor fencing material. Metal line posts, pull posts and braces for pull posts shall each be of the mass and dimensions shown on the plans. Line posts shall be provided with tapered anchor plates securely attached thereto. The anchor plates shall be of the area, size and mass shown on the plans. The anchor plate may be omitted provided the post is set in a concrete footing as shown on the plans.

(b) Metal Corner, End and Gate Posts. Metal corner, end and gate posts and braces shall be any one of the shapes specified for line posts. Metal posts shall each be of the mass and dimensions shown on the plans.

(2) Untreated Wood Posts and Braces. Untreated wood posts and braces shall be cedar or mesquite of the length and size shown on the plans *552*.2

and shall be cut from sound timber. Posts shall have a minimum diameter as indicated on the plans and shall be approximately round, shall be trimmed of all knots and knobs and shall be straight and relatively smooth. The posts shall be free from defects such as injurious ring shakes, unsound or loose knots, splits or other defects that might impair their strength and durability. Sound knots will be permitted provided they are not in clusters and do not exceed one-third of the small diameter or least dimension of the posts. A line drawn from the center of each end of the post shall not fall outside the center of the post at any point more than 50 millimeters.

Braces shall be similar to the regular posts and shall be notched in place. Other types of braces, equal in strength and durability, may be used when approved by the Engineer.

(3) Treated Wood Posts and Braces. Treated wood posts and braces shall be pine or fir timber of the size and dimensions shown on the plans. The timber shall be sound and free from all decay, shakes, splits or any other defects which would weaken the posts or braces or otherwise make them structurally unsuitable for the purposes intended.

The posts and braces shall be round, square or sawed rectangular shape. The slope of grain in sawed, square or rectangular posts for the full length shall not exceed one in ten and knots shall be sound, tight, well spaced and shall not exceed one-third of the small diameter or least dimension of the post. A line drawn from the center of each end of the post shall not fall outside the center of the post at any point more than 50 millimeters. All posts and braces shall have a creosote, pentachlorophenol, ACA or CCA treatment, all in accordance with Item 492, "Timber Preservative and Treatment", with the minimum net retention of preservative in accordance with the amounts shown for "POSTS FOR WIRE FENCE-ROUND, Southern Pine". Posts shall be inspected at time of treatment. Round posts and braces shall be peeled to remove all outer bark and all inner cambium bark, except that occasional strips of bark may remain if not over 15 millimeters wide or over 75 millimeters long. All knots shall be trimmed flush with the sides, spurs and splinters removed and the ends cut square. The allowable taper from end to end of round posts and braces shall not exceed 40 millimeters.

(4) Gates and Gate Posts. Gates and gate posts shall be of the materials and to the dimensions detailed on the plans.

(5) Barbed Wire. Barbed wire shall conform to ASTM A 121, Class 1. The barbed wire shall consist of two strands of 2.51 millimeter

wire, twisted with two-point 2.03 millimeter barbs spaced not more than 127 millimeters apart, or may be as specified on the plans for high tensile wire.

(6) Wire Mesh. Wire mesh fabric shall conform to ASTM A 116, Class 1. The wire mesh shall be of the height and design shown on the plans. The top and bottom wires shall be 3.43 millimeter minimum and the intermediate wires and vertical stays shall be 2.51 millimeter minimum.

***552.3.* Miscellaneous.** Galvanized bolts, nuts and washers for attaching braces and straps to metal posts and suitable galvanized devices
for holding barbed wire and wire mesh firmly in position shall be of good commercial quality and design.

Staples used to secure barbed wire and wire mesh fabric to wood posts shall be not less than 40 millimeters long and the wire from which they are made shall be galvanized.

***552.4.* Construction Methods.** Fence posts shall be spaced at the intervals and set in a vertical position to the depth shown on the plans. Corner and pull posts shall be braced in two directions. End and gate posts shall be braced in one direction. Where alignment changes 30 degrees or more, a corner post shall be installed. At alignment angles varying between 15 and 30 degrees, the angle post shall be braced to adjacent line posts by diagonal tension wires. Where steel posts are specified, a pull post assembly shall be installed at approximately 150 meter intervals and where wood posts are specified the spacing of pull post assemblies shall be approximately 300 meters, unless otherwise shown on the plans. Metal line posts may be driven in place providing such driving does not damage the posts. Metal corner, end, pull posts and braces shall be set in portland cement concrete footings crowned at the top to shed water. All posts shall be placed the minimum depth below ground as shown on the plans or as directed by the Engineer. Posts shall be set plumb and firm to the line and grade shown on the plans. Backfilling shall be thoroughly tamped in 100 millimeter layers. The timber post braces shall be notched as shown on the plans.

The corner, end or angle post assembly shall be installed before stretching the wire between line posts. At all grade depressions where stresses tend to pull the posts out of the ground, the fencing shall be snubbed or guyed at the critical point by means of a double 3.76 millimeter galvanized wire connected to the top horizontal line of barbed wire or to the

top and bottom wire or wire mesh fabric, and to a deadman weighing not less than 45 kilograms, buried in the ground as shown on plans. The fencing shall be stretched before being snubbed and guyed. Existing cross-fences shall be connected to the new fences and corner posts with braces which shall be placed at junctions with existing fences. The barbed wire and wire fabric shall be drawn taut and fastened to posts with galvanized ties or staples as shown on the plans.

552.5. **Measurement.** Fencing will be measured by the meter of wire fence, measured at the bottom of the fabric along the centerline of the fence from center to center of end posts, excluding gates. Gates will be measured as each gate, complete in place.

552.6. **Payment.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Wire Fence" of the type shown on the plans. This price shall be full compensation for furnishing and installing all fencing materials (except gates); for all preparation, hauling and installing of same; and for all labor, tools, equipment and incidentals necessary to complete the work, including excavation, backfilling and disposal of surplus material.

Gates measured as provided under "Measurement" will be paid for at the unit price bid for "Gate" of the type, height and opening shown on the plans. This price shall be full compensation for furnishing all materials; for fabricating; for all preparation, hauling and erection; for all labor, tools, equipment and incidentals necessary for a complete in place gate installation.

ITEM *556*

PIPE UNDERDRAINS

556.1. **Description.** This Item shall govern for the installation of pipe underdrains embedded in filter material enveloped in a filter fabric, constructed at locations shown on the plans or as directed by the Engineer and in accordance with the lines and grades established by the Engineer.

556.2. **Materials.**

(1) Pipe. The pipe shall be of the type shown on the plans and the size indicated shall be the inside diameter. Only one type of material for

pipe underdrains will be permitted for any underdrain system on the project. The pipe shall meet the following requirements:

Type 1. Perforated Corrugated Steel Pipe.

Perforated corrugated steel pipe shall be fabricated from corrugated galvanized sheets. Galvanized steel pipe shall conform to AASHTO M36 and with the following modifications: The pipe may conform to any one of the types specified in M36.

Type 2. Perforated Corrugated Aluminum Pipe.

Perforated corrugated aluminum pipe shall be fabricated from corrugated sheets. Aluminum pipe shall conform to the requirements of AASHTO M196, Type I or Type IA for circular pipe.

Type 3. Perforated Corrugated Steel Pipe (Bituminous Coated).

The pipe shall conform in all particulars to the requirements specified above for perforated corrugated steel pipe (Type 1).

The pipe shall be uniformly coated inside and out with a bituminous coating to a minimum thickness of 1.3 millimeters.

The bituminous material used to coat the pipe shall meet the following requirements when tested in accordance with Test Method Tex-522-C:

Solubility, % by mass in Trichloroethylene....99.5 min.
Brittleness Test.....Pass
Flow, millimeters.....6 max.

Type 4. Perforated Corrugated Aluminum Pipe (Bituminous Coated).

The pipe shall conform in all particulars to the requirements specified above for Type 2 perforated corrugated aluminum pipe.

The pipe shall be uniformly coated inside and out with a bituminous coating to a minimum thickness of 1.3 millimeters.

The bituminous material used to coat the pipe shall meet the following requirements when tested in accordance with Test Method Tex-522-C:

Solubility, % by mass in Trichloroethylene....99.5 min.
Brittleness Test.....Pass
Flow, millimeters.....6 max.

Type 5. Perforated ABS Pipe.

ABS (acrylonitrile-butadiene-styrene) pipe shall conform to the requirements of ASTM D 2751, SDR-35 designation. Perforations shall comply with the requirements of ASTM F 758.

Type 6. Perforated Corrugated Polyethelene Plastic Tubing.

Tubing shall conform to AASHTO M252.

Type 7. Perforated Corrugated PVC Pipe.

Corrugated PVC (poly vinyl chloride) pipe shall conform to the requirements of ASTM F 949 for corrugated exterior wall pipe with smooth inner wall.

Type 8. Perforated Smooth-Wall PVC Pipe.

Smooth-wall PVC (poly vinyl chloride) pipe shall conform to the requirements of ASTM F 758, Type PS46 or AASHTO M278, Class PS46.

Type 9. Perforated as shown on the plans.

Type 10. Non-perforated as shown on the plans.

(2) Filter Material. Filter material for use in backfilling trenches under, around and over underdrains shall consist of hard, durable, clean sand, gravel, crushed stone, crushed shell or other material specified on the plans and shall be free from organic matter, clay balls or other deleterious matter. Unless otherwise shown on the plans, crushed limestone will not be permitted.

The percent composition by mass of the filter material in place shall conform to the following gradings:

PERCENT RETAINED ON SIEVE

Sieve Size	Type A	Type B	Type C	Type D	Type E	Type F
37.5 mm	-	-	0-10		Shall conform to Item 302, "Aggregates for Surface Treatments"	As Shown on the Plans
19 mm	-	0-10	20-40			
9.5 mm	-	15-35	-	-		
4.75 mm	0-10	35-55	40-60	0-5		
2.36 mm				0-20		
1.18 mm				15-50		
600 µm				40-75		
300 µm				70-90		
150 µm				90-100		

That portion of the filter material of Type A, B or C that is finer than 4.75 millimeter sieve shall be graded as follows:

Sieve Size	Percent Retained
850 µm	35-65
300 µm	75-100

The loss by decantation shall not exceed one percent on the material retained on the 4.75 millimeter sieve and shall not exceed four percent on the material passing the 4.75 millimeter sieve. Unless otherwise shown on the plans, Type B or Type C filter material, at the option of the Contractor, shall be used around underdrains. If Type A or Type D filter material is specified, it shall not be placed within 150 millimeters of any perforation. If Type E filter material is specified it shall not be placed within 150 millimeters of the water bearing strata.

(3) Filter Fabric. The filter fabric shall meet the requirements of

Departmental Material Specification D-9-6200.

556.3. **Construction Methods.** The excavation of each trench shall begin at the outfall and proceed toward its upper end. The trench must not be excavated below the proposed grade line and shall be located as indicated on the plans or as directed by the Engineer, and true to line and grade. All perforated pipe shall be laid with the perforations on the sides below the horizontal axis with the perforated pipe centered in the excavated ditch to the established grade and when required will be joined by appropriate couplers.

Filter fabric shall be placed in the trench prior to placing any pipe underdrains or filter material in such a manner as to line the walls and bottom of the trench. After placing the pipe underdrains and filter material, the filter fabric shall be lapped over the top of the filter material in accordance with the manufacturer's recommendations unless otherwise shown on the plans.

After the pipes have been laid and approved by the Engineer, the filter material shall be carefully placed to the depth shown on the plans and in such manner as not to displace the pipe or joint covering around and over the pipe. The depth of filter material shall in no case be less than 300 millimeters above the bottom of the pipe and such depth shall be placed where no dimension is shown on the plans. The remainder of the trench shall be backfilled with suitable materials which shall be tamped in layers not exceeding 100 millimeters.

Unless otherwise shown on the plans, the minimum horizontal limits of excavation for filter material shall be as follows:

Depth of Trench (Meter)	**Minimum Limits of Excavation for Filter Material, Distance Outside Neat Lines of Pipe Underdrain (Millimeter)**
0 to 1.8	300
over 1.8 to 3.0	450
over 3.0 to 4.6	600
over 4.6	750

Approved plugs shall be placed in the upper ends of all pipes and all exposed ends of underdrains shall be covered with 13 millimeters galvanized hardware cloth as directed by the Engineer.

556.4 to 560.3

Jointing of plastic pipes shall be according to the applicable specifications and the manufacturer's recommendations. No tar paper strips shall be used.

The Contractor shall provide sections of non-perforated pipe connectors between the perforated pipe and the outfall. These sections of pipe shall be of the same type as designated on the plans. This pipe will not require filter material or filter fabric.

556.4. **Measurement.** This Item will be measured by the meter of pipe measured along the top of the pipe and shall include the length of all elbows, wyes, tees and other branches.

556.5. **Payment.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Pipe Underdrains" of the type and size specified. This price shall be full compensation for all excavation and backfill; for furnishing and placing all underdrains, filter fabric and filter material when required, connectors, couplers, plugs and screens; and for all labor, tools, equipment and incidentals necessary to complete the work.

All riprap or headwalls required by the plans will be measured and paid for in accordance with the provisions of Item 432, "Riprap", or Item 420, "Concrete Structures".

ITEM *560*

MAILBOX ASSEMBLIES

560.1. **Description.** This Item shall govern for the removal, temporary relocation and permanent installation of mailbox assemblies along the roadway in accordance with details shown on the plans and at locations established by the Engineer.

560.2. **Materials.** Materials for mailbox assemblies shall conform to the details shown on the plans.

560.3. **Construction Methods.** The Contractor shall remove and temporarily relocate all mailbox assemblies existing along a roadway to a point outside the limits of the proposed construction. The temporary relocation of mailboxes may be accomplished by mounting mailboxes on portable stands furnished by the Contractor and approved by the Engineer. All mailboxes and mailbox assemblies shall be maintained by the Contractor

in an upright position and serviceable condition during the construction period. Any existing mailboxes or mailbox assemblies damaged or destroyed as a result of the Contractor's operations shall be replaced by the Contractor at his expense.

In the event additional mailbox installations are required after construction has begun, an approved mailbox will be furnished to the Contractor by others and the Contractor shall install either a temporary and/or a permanent supporting assembly. After all construction work in the area has been completed, mailboxes shall be removed from their temporary position and positioned in permanent locations as shown on the plans or as directed by the Engineer.

560.4. **Measurement.** This Item will be measured as each permanent installation of mailbox assemblies complete in place. Additional permanent mailbox assemblies installed during construction will also be measured as each installation complete in place. The types of installation shall be either "single" for mounts supporting a single mailbox, "double" for mounts supporting two mailboxes or "multiple" for mounts supporting three or four mailboxes.

560.5. **Payment.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Mailbox Installation (Single)", "Mailbox Installation (Double)" or "Mailbox Installation (Multiple)". This price shall be full compensation for temporarily relocating mailbox assemblies, providing portable mailbox stands, installing mailboxes in permanent locations; for furnishing all materials and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work. No compensation will be made for temporarily relocating mailboxes more than once.

ITEM *575*

EPOXY

575.1. **Description.** This Item shall govern the various types of epoxy materials shown on the plans and in this Item.

575.2. **Materials.** Epoxy materials described herein shall be in accordance with Departmental Materials Specification D-9-6100. Additional information regarding epoxy characteristics and copies of specification D-9-6100 are available from the Texas Department of Transportation, Materials and Tests Division, 125 East 11th Street, Austin, Texas 78701-2483. All epoxy materials shall consist of a resin component and a hardener

575.3

component which are mixed just prior to use of the finished epoxy. Unless otherwise shown on the plans, epoxy shall not be used if the substrate temperature is below 10 °C. The materials covered by this Item are as follows:

(1) Traffic marker adhesives
(2) Concrete adhesives
(3) Binder for epoxy grout or concrete

(4) Epoxy for crack injection
(5) Epoxy coating for concrete

575.3. **Types.** The various types of epoxy materials and their uses are described below:

(1) Traffic Marker Adhesives. The following epoxy adhesives are used for bonding ceramic, plastic or metal traffic markers to roadway, bridge, or other concrete surfaces.

Types I and I-M - Rapid setting marker adhesive for use when a very fast set is required or if markers must be placed when pavement temperature is below 10 °C.

Types II, II-M and II-MA - Medium setting marker adhesive.

Types III and III-M - Standard setting marker adhesive.

Types IV and IV-M - Slow setting marker adhesive for use where setting time is not a consideration.

Those adhesives designated as Types I through IV are intended for hand mixing and application. On projects where the adhesive is to be handled by automatic metering, mixing and application equipment, Types I-M through IV-M, which are designated specifically for machine application, shall be used. Type II-MA adhesive is designed for placement of all-weather markers. For all types of marker adhesives, the resin component shall be pigmented white and the hardener component black.

The type of adhesive to be used for placing ceramic or plastic markers on a specific project shall be based upon the setting time required under the prevailing weather and traffic conditions and approved by the Engineer.

(2) Concrete Adhesives. The following epoxy adhesives with different viscosities are used to bond fresh portland cement concrete to existing portland cement concrete, hardened concrete to hardened concrete and steel to fresh or hardened concrete.

Type V - Standard (medium viscosity) for applying to horizontal and vertical surfaces. This material is suitable for surface sealing of fine cracks in concrete and setting of dowel bars in accordance with Item 420, "Concrete Structures".

Type VI - Low viscosity for application with spray equipment to horizontal surfaces.

Type VII - Paste consistency for overhead application and where a high build-up is required. This material is suitable for surface sealing of cracks in concrete which are veed out prior to sealing.

Any specific coloring of resin and hardener components shall be as directed by the Engineer.

(3) Epoxy Binder (Type VIII). This material is used for mixing with selected aggregates to produce an epoxy mortar or concrete for grouting dowel bars or repairing spalls and other defects in existing portland cement concrete. Type VIII shall comply with the requirements for Type VI epoxy except that the mixing ratio of resin and hardener shall be as specified by the manufacturer and the requirement for ability to bond fresh portland cement concrete to hardened concrete does not apply.

The aggregates used with the epoxy binder to form epoxy mortar or concrete shall be clean and dry. Silicious aggregates are required unless otherwise approved by the Engineer.

(4) Crack Injection (Type IX). This material is a low viscosity epoxy material designed for pressure injection into cracks in existing concrete to restore the structural integrity. The epoxy shall be capable of bonding to damp surfaces.

(5) Epoxy Coating (Type X). This is a high-solids epoxy coating used for waterproofing columns, caps, etc. This material is designated for application by brush or roller, but can also be applied by airless spray with the addition of a maximum of five (5) percent toluene solvent with the approval of the Engineer.

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575.4. **Packaging, Labeling and Storage.** The components shall be packaged according to mixing ratio in suitable, well-sealed containers. The containers shall be clearly labeled as to the type material and the ratio of the components to be mixed by volume. Any special instructions regarding mixing and application shall be included. The label shall show resin or hardener component, the brand name, name of the manufacturer, lot or batch number, date of packaging and the quantity contained therein. Caution warnings regarding contact of the epoxy with skin and eyes shall be included on the labels. The epoxy components must be stored at temperatures between 16 °C and 38 °C. Any material which shows
evidence of crystallization, lumps, skinning, extreme thickening or settling of pigments which can not be readily redispersed with normal agitation shall not be used.

575.5. **Construction Methods.** Mixing and application of epoxy materials shall be as specified herein.

(1) Mixing. Prior to use, each component shall be stirred to redisperse any settling or separation of the fillers and liquid portions. The components shall then be immediately placed in the proper reservoir, when used in automatic mixing and dispensing equipment. For application by other means, the components must be properly proportioned and mixed until a uniform color and appearance are obtained. No addition of solvents will be allowed unless indicated by the manufacturer or approved by the Engineer.

(2) Application and Surface Preparation. Requirements for application and preparation of the surface upon which the epoxy is to be applied shall be in accordance with the applicable specification.

575.6. **Measurement and Payment.** The work performed, materials furnished, and all labor, tools, equipment and incidentals necessary to complete the work under this Item will not be measured or paid for directly, but will be considered subsidiary to the various bid items of the contract.

ITEM 580

PROJECT MAINTENANCE

580.1. **Description.** This Item shall govern for mowing, litter pickup and sweeping by the Contractor within the limits of the project for

the duration of the project at the frequency as shown on the plans or as directed by the Engineer.

580.2. **Equipment.**

(1) **Mowing.** The equipment used for mowing shall consist of approved mowing units capable of mowing on slopes without unduly marring finished slope surfaces or injuring existing growth. The minimum cutting width shall not be less than 1.5 meters, unless otherwise approved by the Engineer.

(2) **Litter Pickup.** The equipment used for litter pickup shall be approved by the Engineer.

(3) **Sweeping.** Unless otherwise approved or directed by the Engineer, street-sweeping vehicles shall be equipped with a gutter broom capable of dislodging crusted debris from the road surface, a water tank with proper spray assemblies for dust control, a pickup mechanism capable of removing debris from the roadway and a dirt hopper with sufficient capacity to allow the operation to progress with minimum interference when sweeping under traffic. These vehicles shall be equipped with flashing arrow boards as approved by the Engineer. Other types of cleaning and sweeping equipment, as well as hand labor, shall be provided where deemed necessary and as directed and approved by the Engineer.

580.3. **Construction Methods.**

(1) **Mowing.** The Contractor shall mow all areas of existing vegetation and vegetation that has been placed by the Contractor during the project as directed by the Engineer. The mowing height shall be 150 millimeters unless otherwise shown on the plans. Portions of sod or grass that are injured during mowing operations shall be repaired in a manner acceptable to the Engineer at the Contractor's expense.

(2) **Litter Pickup.** The Contractor shall collect and dispose of all litter deposited by the traveling public including cans, bottles, paper, plastic items, metal scraps, lumber, etc. from within the project right of way to the satisfaction of and/or as directed by the Engineer. All litter collected by the Contractor shall become the property of the Contractor for proper disposal and shall not be dumped or stockpiled on State property.

(3) **Sweeping.** The Contractor shall sweep the traffic carrying facilities to remove, collect and dispose of all debris, which includes dirt,

mud, oil, grass clippings, broken glass, etc. and other such objects foreign to the roadway surface, to the satisfaction of and/or as directed by the Engineer. All debris collected by the Contractor shall become the property of the Contractor for proper disposal and shall not be dumped or stockpiled on State property. All sweeping of traffic carrying facilities shall be performed during off-peak-traffic hours or at night and/or as directed by the Engineer. Sweeping of traffic carrying facilities constructed and opened to traffic shall be performed only after these facilities have been previously cleaned by the Contractor as a part of preparing the facility for its initial opening to traffic.

580.4. **Measurement.**

(1) **Mowing.** Mowing will be measured by the number of hours for each mowing unit performing the mowing operation or by the cycle or portion of cycle. Measurement by the cycle or portion of cycle will include all mowing units used in the work.

(2) **Litter Pickup.** Litter pickup will be measured by the number of hours that each person performs the litter pickup operation or by the cycle or portion of cycle. Measurement by the cycle or portion of cycle will include all litter pickup necessary to complete the cycle. No measurement for payment will be made under this Item for the hauling or disposing of collected litter.

(3) **Sweeping.** Sweeping will be measured by the number of hours for each sweeping vehicle performing the sweeping operation or by the cycle or portion of cycle. Measurement by the cycle or portion of cycle will include all sweeping necessary to complete the cycle. No measurement for payment will be made under this Item for the hauling or disposing of the collected debris.

580.5. **Payment.** Final cleanup operations will not be included for Payment under this Item.

(1) **Mowing.** The work performed for mowing and measured as provided under "Measurement" will be paid for at the unit price bid for "Project Maintenance (Mowing)". This price shall be full compensation for furnishing and operating all equipment and for all labor, tools and incidentals necessary to complete the work.

(2) **Litter Pickup.** The work performed for litter pickup and measured as provided under "Measurement" will be paid for at the unit

price bid for "Project Maintenance (Litter Pickup)". This price shall be full compensation for collecting, hauling and disposing of litter and for all labor, tools, equipment and incidentals necessary to complete the work.

(3) Sweeping. The work performed for the sweeping and measured as provided under "Measurement" will be paid for at the unit price bid for "Project Maintenance (Sweeping)". This price shall be full compensation for furnishing and operating all equipment, for the collecting, hauling and disposing of debris and for all labor, tools and incidentals necessary to complete the work.

ITEM *585*

RIDE QUALITY FOR PAVEMENT SURFACES

585.1. **Description.** This Item shall govern the evaluation of ride quality for pavement surfaces.

585.2. **General.** The finished surface of the pavement shall be smooth and true to the established line, grade and cross section. Surface Test Type A shall be used on all pavement surfaces including intermediate layers. When shown on the plans, Surface Test Type B shall apply longitudinally along the finished riding surface of all travel lanes, including service roads, unless specific areas are excluded or other areas are designated for Surface Test Type B. The transverse slope of the finished riding surface will be tested in accordance with Surface Test Type A.

585.3. **Testing Procedures.** The surface finish shall be tested in accordance with the requirements below.

(1) Surface Test Type A. The surface or layer shall be tested with a 3.048 meter straightedge at locations selected by the Engineer.

(2) Surface Test Type B. The surface shall be tested using a profilograph in accordance with the requirements of Test Method Tex-1000-S.

Unless otherwise shown on the plans, a profilograph meeting the requirements of Test Method Tex-1000-S shall be furnished and maintained by the Contractor. The equipment calibration shall be verified by the Engineer in accordance with Test Method Tex-1000-S prior to its use on the project. Unless otherwise shown on the plans, the Contractor shall propel the profilograph under the direction of the Engineer. The results of the

profilograph test will be evaluated by the Engineer in accordance with Test Method Tex-1000-S. A properly calibrated automated profilograph will be allowed for asphaltic concrete pavements. The filter setting will be specified by the Engineer.

(a) Scope. Testing will be limited to those pavement surfaces having a construction length of 0.1609 kilometer or more.

Pavement with horizontal curves having a centerline radius of curvature less than 304.8 meters and the superelevation transition to such curves will not be profiled. Pavement within 4.57 meters of a transverse joint which separates the pavement from an existing pavement not placed by this project, a bridge structure or an approach slab will not be subjected to this test. These areas shall be evaluated using the 3.048 meter straightedge as outlined above under Surface Test Type A.

(b) Pavement Profiles. Pavement profiles will commence 4.57 meters into the previous placement and will be taken along both of the approximate wheel paths of each travel lane or as directed by the Engineer. The profile location will normally lie 0.609 meters from and parallel to the approximate location of the pavement lane lines. The profile index used for evaluating each 0.1609 kilometer section of each travel lane to determine its payment bonus or deduction shall be the average of these two (2) profiles. The profilograph may be used to identify the limits of an out-of-tolerance surface variation.

(c) Initial Paving Operation. During the initial paving operations, the pavement surface will be tested with the profilograph as soon as possible without damaging the pavement surface. The purpose of this testing is to aid the Contractor and the Engineer in evaluating the paving methods and equipment. When the paving methods and paving equipment do not result in a pay deduction, the Contractor may proceed with the paving operation.

When this initial paving operation results in a pay deduction, the Contractor shall make corrections in the paving operation as approved by the Engineer before proceeding.

There will be no pay adjustment for the first day's operation.

(d) Daily Average Pay Adjustment. The daily average pay adjustment is obtained by averaging the pay adjustments of all 0.1609 kilometer sections of pavement placed during each day's paving.

When the daily average pay adjustment for any day results in a pay deduction, the Contractor shall evaluate the paving operation.

When two consecutive daily average pay adjustments result in pay deduction, the Contractor shall take corrective action in the paving operation.

When three consecutive daily average pay adjustments result in pay deduction, operation shall cease until test results, or other information indicate to the satisfaction of the Engineer that the next material to be placed will not result in a daily average pay deduction.

585.4. **Pavement Evaluation and Corrections.**

(1) Surface Test Type A. The variation of the surface from the testing edge of the straightedge shall not exceed 3.175 millimeters between any two (2) contacts, when measured longitudinally or transversely. All irregularities exceeding the specified tolerance shall be corrected as approved by the Engineer at the Contractor's expense. Following correction, the area shall be retested to verify compliance with this Item.

(2) Surface Test Type B. After the pavement surface has been tested, all areas having deviations in excess of 7.62 millimeters in 7.62 meters or less shall be corrected unless otherwise directed by the Engineer. Following correction, the area shall be retested to verify compliance with this Item.

After correction of all individual deviations, any 0.1609 kilometer section having an initial profile index of 15 or more shall be corrected to produce a pay adjustment of zero dollars or greater. On those 0.1609 kilometer pavement sections where corrections are necessary, the corrected pavement section shall be reprofiled to verify that corrections have produced the required improvements.

When the pay adjustment results in a pay deduction on any 0.1609 kilometer section, the Contractor may elect to accept the pay deduction on that 0.1609 kilometer section in lieu of taking corrective actions to reduce the profile index. The Contractor will not be allowed to make modifications on any pavement section having a pay adjustment of zero or greater if the modifications are made for the sole purpose of increasing the bonus payment for that section.

All corrective work shall be at the Contractor's expense.

585.5

(a) Portland Cement Concrete Pavement.

All corrections shall be made using equipment approved by the Engineer or by removing and replacing the pavement. The use of bush hammers or other impact devices will not be permitted.

The Contractor shall demonstrate that any proposed corrective work will produce results satisfactory to the Engineer.

When corrections are completed, the Contractor shall re-establish a transverse texture pattern by grooving the concrete to meet the surface finishing requirements. This work shall be at the Contractor's expense.

All corrective work shall be completed prior to determinations of pavement thickness.

(b) Asphaltic Concrete Pavement.

The Contractor shall demonstrate that any proposed corrective work will produce results satisfactory to the Engineer.

585.5. **Pay Adjustment.** The pay adjustment for ride quality will be determined as follows:

(1) Surface Test Type A. No pay adjustment will be made when Surface Test Type A is used.

(2) Surface Test Type B. Pay adjustments will be made in accordance with the following schedule:

Pay Adjustment Schedule For Ride Quality

Profile Index per each 0.1609 Kilometer Section	Posted Speed > 45 mph Pay Adjustment	Posted Speed ≤ 45 mph Pay Adjustment
2.0 or less	+$ 90	+$ 90
2.1 thru 3.0	+$ 70	+$ 70
3.1 thru 4.0	+$ 50	+$ 50
4.1 thru 5.0	+$ 35	+$ 35
5.1 thru 6.0	$ 0	+$ 20
6.1 thru 9.0	-$ 35	$ 0
9.1 thru 11.0	-$ 50	-$ 20
11.1 thru 12.0	-$ 70	-$ 50
12.1 thru 13.0	-$105	-$105
13.1 thru 14.0	-$140	-$140
14.1 thru 15.0	-$175	-$175
Over 15.0	Corrective work required	Corrective work required

No bonus will be paid for pavement sections which were originally constructed under this contract with a pay deduction. There will be no pay adjustments for the sections where the Contractor took corrective action.

(a) Asphaltic Concrete Pavement. The pay adjustment for asphaltic concrete pavement applies only to the final riding surface placed for each 0.1609 kilometer section constructed under Item 340, "Hot Mix Asphaltic Concrete Pavement", Item 334, "Hot Mix-Cold Laid Asphaltic Concrete Pavement", Item 332, "Limestone Rock Asphalt Pavement (Class B)", and Item 330, "Limestone Rock Asphalt Pavement (Class A)", unless otherwise shown on the plans. A pay adjustment will be calculated in dollars for each 0.1609 kilometer section of the lane represented by the profilograph.

The pay adjustment will be determined for each day's production.

(b) Portland Cement Concrete Pavement. The bonus or deduction for portland cement concrete pavement will be based on the unit bid price and the plan depth shown. A bonus or deduction will be calculated in dollars and cents for each 0.1609 kilometer long section of the lane represented by the profilograph.

The bonus or deduction will be determined for each day's production.

585.6. **Measurement and Payment.** The work performed, materials furnished and all labor, tools, equipment and incidentals necessary to complete the work under this Item will not be measured or paid for directly, but will be considered subsidiary to the various bid items of the contract.

The bonus or deduction as described under "Pay Adjustment" will be paid or deducted separately.

PART II, CONSTRUCTION DETAILS

DIVISION VI
LIGHTING AND SIGNING

ITEM 610

ROADWAY ILLUMINATION ASSEMBLIES

610.1. Description. This Item shall govern for furnishing and installing the various types of roadway illumination assemblies shown on the plans.

The term "roadway illumination assembly" as used herein shall constitute the complete assemblage of poles, mast arms, parts, equipment and miscellaneous components, except foundations, erected as shown on the plans and in accordance with these specifications, forming a complete and independent lighting unit.

610.2. General. All materials furnished by the Contractor under this Item shall be new and in accordance with the NEC.

All materials and construction methods shall be in accordance with the details shown on the plans, the requirements of this Item and the pertinent requirements of the following Items:

Item 441, "Steel Structures"
Item 442, "Metal for Structures"
Item 445, "Galvanizing"
Item 449, "Anchor Bolts"
Item 616, "Performance Testing of Lighting Systems"
Item 620, "Electrical Conductors"

The Contractor shall furnish six (6) sets of shop drawings of the complete assembly in accordance with Item 441, "Steel Structures", except that the drawings shall be submitted to the Engineer at the project address. Prior to beginning fabrication, two (2) copies of the completed material identification form shall be furnished to the Engineer in accordance with Item 441, "Steel Structures".

610.3. Sampling. Sampling of luminaires, lamps and ballasts will be in accordance with Texas Test Method Tex-714-I.

610.4 to 610.6

610.4. Construction Methods. Roadway illumination assemblies shall be fabricated and installed in accordance with the details and dimensions shown on the plans or as approved in writing by the Engineer.

Roadway illumination assemblies shall be located as shown on the plans, except that the Engineer may shift the assembly locations, within design guidelines, where necessary to secure a more desirable location or to avoid conflict with utilities. Unless otherwise shown on the plans, the Contractor shall stake and the Engineer will verify all roadway illumination assembly locations.

Erection of poles and luminaires located near any overhead or underground utilities shall be accomplished using established industry and utility safety practices. The Contractor shall consult with the appropriate utility company prior to beginning such work.

The careful erection and aligning of the roadway illumination assemblies shall be considered an essential feature of the installation of the assemblies.

Any steel part or member on which galvanizing has been damaged shall be repaired in accordance with Item 445, "Galvanizing".

Installed roadway illumination assemblies shall be tested in accordance with Item 616, "Performance Testing of Lighting Systems".

610.5. Measurement. This Item will be measured as each roadway illumination assembly complete in place.

610.6. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Roadway Illumination Assemblies" of the various types specified. This price shall be full compensation for furnishing, installing and testing all luminaires, ballasts, poles, lamps, anchor bolts, anchor plates (when required), internal conductors and connections; and for all labor, tools, equipment and incidentals necessary to complete the work, except as shown below.

Foundations for roadway illumination assemblies will be paid for under Item 656, "Foundations for Signs, Traffic Signals and Roadway Illumination Assemblies".

611.1 to 611.3

ITEM 611

REMOVING ROADWAY ILLUMINATION ASSEMBLIES

611.1. Description. This Item shall govern for removing the various types of roadway illumination assemblies shown on the plans.

611.2. Materials. All electrical materials furnished and installed under this Item shall be new and in accordance with the NEC.

611.3. Construction Methods. Removal of assemblies located near any overhead or underground utilities shall be accomplished using established industry and utility safety practices. The Contractor shall consult with the appropriate utility company prior to beginning such work.

The illumination assemblies shall be removed in such a manner as to prevent scarring or marring of poles or mast arms. After removal of the illumination assemblies, the Contractor shall remove the transformer bases (where applicable), luminaires and mast arms from the pole shafts. Nuts, bolts and washers shall be retained with the pole shaft. Pole shafts, mast arms and all assembly hardware shall remain the property of the State and shall be stockpiled at a designated location within the limits of the project. All other parts shall become the property of the Contractor and shall be removed from the right-of-way to a site approved by the Engineer.

Unless otherwise shown on the plans, transformer bases removed shall be sufficiently destroyed to prevent reuse.

Conductors to be abandoned shall be disconnected from the power source and removed, as much as is practical, from the conduit or duct. All protruding conduits or ducts shall be cut off 150 millimeters below finish grade. Unless otherwise shown on the plans, abandoned conduits or ducts need not be removed.

When shown on the plans, duct cable, conductors and conduits to be reused shall be reconnected. Components damaged due to Contractor's operations shall be replaced by the Contractor at the Contractor's expense in accordance with applicable specifications. All splices, where permitted or required, shall be made in ground boxes or as shown on the plans.

Unless otherwise shown on the plans, existing concrete foundations that are to be abandoned shall be removed to 0.5 meter below finish grade. The remaining hole shall be repaired by backfilling with material equal in composition and density to the surrounding area, and by replacing any surfacing, such as asphalt pavement or concrete riprap, with like material to equivalent condition. Unless otherwise shown on the plans, bridge lighting brackets need not be removed.

611.4. Measurement. This Item will be measured as each roadway illumination assembly removed.

611.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Removing Roadway Illumination Assemblies" of the various types specified. This price shall be full compensation for removing, salvaging, disassembling and stockpiling the lighting assemblies; for salvaging and relocating the existing conduit and conductors; for removing existing foundations, backfilling and surface placement; for splicing existing conductors; and for all labor, tools, equipment and incidentals necessary to complete the work, except as shown below.

New ground boxes will be paid for under Item 624, "Ground Boxes".

ITEM 612

RELOCATING ROADWAY ILLUMINATION ASSEMBLIES

612.1. Description. This Item shall govern for relocating the various types of roadway illumination assemblies shown on the plans.

The term "roadway illumination assembly" as used herein shall constitute the complete assemblage of poles, mast arms, parts, equipment and miscellaneous components, except foundations, erected as shown on the plans and in accordance with these specifications, forming a complete and independent lighting unit.

612.2. General. All materials furnished by the Contractor under this Item shall be new and in accordance with the NEC.

All materials and construction methods shall be in accordance with the details shown on the plans, the requirements of this Item and the pertinent requirements of the following Items:

Item 445, "Galvanizing"
Item 610, "Roadway Illumination Assemblies"
Item 616, "Performance Testing of Lighting Systems"
Item 620, "Electrical Conductors"

612.3. Construction Methods. Removal and erection of assemblies located near any overhead or underground utilities shall be accomplished using established industry and utility safety practices. The Contractor shall consult with the appropriate utility company prior to beginning such work.

The illumination assemblies shall be removed in such a manner as to prevent scarring or marring of poles or mast arms. Components damaged due to Contractor's operations shall be replaced by the Contractor at the Contractor's expense in accordance with applicable specifications.

The Contractor shall repair any existing galvanizing damage and any galvanizing damage incurred in the removal of the poles in accordance with Item 445, "Galvanizing".

Conductors to be abandoned shall be disconnected from the power source and removed, as much as is practical, from the conduit or duct. All protruding conduit or duct shall be cut off 150 millimeters below finish grade. Unless otherwise shown on the plans, abandoned conduit or duct need not be removed.

When shown on the plans, conductors and conduit to be reused shall be reconnected. Damage to conductors or conduit due to Contractor's operations shall be replaced by the Contractor at the Contractor's expense in accordance with applicable specifications. All splices, where permitted or required, shall be made in ground boxes or as shown on the plans.

Roadway illumination assemblies shall be reinstalled at locations shown on the plans, except that the Engineer may shift the assembly locations, within design guidelines, where necessary to secure a more desirable location or to avoid conflict with utilities. Unless otherwise shown on the plans, the Contractor shall stake and the Engineer will verify all roadway illumination assembly locations.

Unless otherwise shown on the plans, existing concrete foundations that are to be abandoned shall be removed to 0.5 meter below finish grade. The remaining hole shall be repaired by backfilling with material equal in composition and density to the surrounding area, and by replacing any surfacing, such as asphalt pavement or concrete riprap, with like material to equivalent condition. Unless otherwise shown on the plans, bridge lighting brackets need not be removed.

Careful erection and aligning of the relocated roadway illumination assemblies shall be considered an essential feature of the installation of the assemblies.

The Contractor shall furnish and install new conductors that are internal to the roadway illumination assemblies, new fused and un-fused connectors, and new lamps for installation at the relocated site.

Where poles with transformer bases are being relocated, the Contractor shall furnish and install new transformer bases. Transformer bases shall meet AASHTO breakaway requirements and all other requirements shown on the plans.

Unless otherwise shown on the plans, transformer bases removed shall be sufficiently destroyed to prevent reuse.

Unless otherwise shown on the plans, the existing materials removed and not scheduled for reuse shall become property of the Contractor and shall be removed from the limits of the project to a location approved by the Engineer.

Relocated roadway illumination assemblies shall be tested in accordance with Item 616, "Performance Testing of Lighting Systems".

612.4. Measurement. This Item will be measured as each roadway illumination assembly removed and reinstalled, complete in place.

612.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Relocating Roadway Illumination Assemblies" of the various types specified. This price shall be full compensation for salvaging and relocating the existing conduit, duct cable and conductor; for removing existing foundations, backfilling and surface placement; for removing, erecting and connecting illumination assemblies,

for furnishing and installing new anchor bolts, transformer bases (when required), lamps, conductors and connectors; and for all labor, tools, equipment and incidentals necessary to complete the work except as shown below.

New foundations will be paid for under Item 656, "Foundations For Signs, Traffic Signals and Roadway Illumination Assemblies".

New conduit will be paid for under Item 618, "Conduit".

New duct cable will be paid for under Item 622, "Duct Cable".

New conductors, except the conductor internal to the poles, will be paid for under Item 620, "Electrical Conductors".

ITEM 613

HIGH MAST ILLUMINATION POLES

613.1. Description. This Item shall govern for designing, fabricating, furnishing and erecting high mast illumination poles of the design wind speed and heights as shown on the plans.

613.2. General. All materials and construction methods shall conform to the requirements of this Item and the pertinent requirements of the following Items:

Item 416, "Drilled Shaft Foundations"
Item 432, "Riprap"
Item 441, "Steel Structures"
Item 442, "Metal for Structures"
Item 445, "Galvanizing"
Item 449, "Anchor Bolts"
Item 614, "High Mast Illumination Assemblies"
Item 618, "Conduit"
Item 624, "Ground Boxes"

613.3. Standard Pole Designs. Shop drawings shall not be required or submitted for high mast illumination poles fabricated in accordance with this Item and the details shown on the plans.

Any deviation from the plans will require submission of shop drawings of the complete pole structure, including anchor bolts, in accordance with Item 441, "Steel Structures". Deviations which affect the basic structural behavior of the pole will be considered as optional pole designs.

613.4. Optional Pole Designs. Optional pole designs shall be subject to the following requirements and shall meet all other requirements of this Item.

Optional pole designs shall conform to the AASHTO STANDARD SPECIFICATIONS FOR STRUCTURAL SUPPORTS FOR HIGHWAY SIGNS, LUMINAIRES AND TRAFFIC SIGNALS.

Two (2) sets of complete design calculations shall be submitted for approval prior to submission of shop drawings. Computer printouts for design calculations will not be acceptable unless accompanied by sufficient documentation which demonstrates methods used.

Unless otherwise shown on the plans, the design calculations and six (6) sets of shop drawings shall be submitted to the Director of Design, Texas Department of Transportation, 125 East 11th St., Austin, Texas 78701-2483.

The applied design loads at the top of the poles shall be as given in the following table. These values include the gust multiplier and the drag and height coefficients.

Pole Height (meter)	Basic Design Wind Speed			
	129 km/h		161 km/h	
	Vert (kN)	Horiz (kN)	Vert (kN)	Horiz (kN)
30.50	8.0	10.0	8.0	15.6
38.10	8.0	10.0	8.0	15.6
45.70	8.0	10.7	8.0	16.7
53.35	8.0	10.7	8.0	16.7

Additional design loads on the pole shaft shall include shaft dead load and appropriate wind drag and height coefficients with the standard wind gust multiplier.

The maximum design yield strength for anchor bolts shall be 380 megapascals.

The maximum design yield strength for ASTM A 572 materials shall be 345 megapascals.

The top pole diameter and the top attachment plate shall be as shown on the plans. The bottom of the pole shall be compatible with the foundation details shown on the plans. The design shall be such that the standard mounting ring and lowering mechanism can be used without modification.

The spacing, size and number of anchor bolts may be changed. The anchor bolt circle shall be such that the bottom template does not conflict with foundation reinforcement.

The minimum nominal splice length of pole shaft sections shall be 1.5 multiplied by the average pole diameter at the splice to the nearest 25 millimeters. The average diameter shall be taken at the interface between the sections at half splice length.

Approval to eliminate the ground sleeve or to significantly modify the access hole ring shall require testing a full scale specimen of the base section. The specimen shall be supported at the base plate on double nutted anchor bolts. The specimen shall be loaded to produce maximum compression on the access hole ring. The test results shall clearly demonstrate that the specimen can develop the factored moment capacity (1.38 load factor multiplied by 1.4 wind factor multiplied by Fb) which is approximately the full plastic bending capacity.

613.5. Materials. Metal used shall conform to Item 442, "Metal for Structures", except for measurement and payment, and the additional requirements as follows:

Pole Shafts	ASTM A 588, A 572 Grade 345 (1), or A 607 Grade 345 Class 2 (2)

Ground Sleeves	ASTM A 588, A 572 Grade 345 (1), A 607 Grade 345 Class 2 (2), or A 633 Grade C (1)
Base Plates (4)	ASTM A 588, A 572 Grade 345 (1), A 633 Grade C(1), or A36MOD345 (3)
Access Hole Rings	ASTM A 588, A 572 Grade 345 (1), A 633 Grade C(1), or A36MOD345 (3)
Miscellaneous Steel	ASTM A 36 or equal

(1) ASTM A 572 and A 633 materials may have higher yield strengths but shall not have less elongation than the grade indicated.

(2) ASTM A 607 is acceptable to a maximum thickness of 12.7 millimeters.

(3) A36MOD345 is a special designation for a modified ASTM A 36 material with a higher specified yield strength and meeting the additional requirements described in Item 442, "Metal for Structures".

(4) An ultrasonic examination in accordance with either ASTM A 578 Level II or ASTM A 435 shall be conducted for all material used for base plates.

All the above steel, greater than 12.7 millimeters thick, except miscellaneous steel, shall conform to the longitudinal Charpy V-notch requirements of ASTM A 572, Group 1, in accordance with Article 442.3.

The silicon content of all steel shall be controlled to ensure high quality galvanizing and to avoid discoloration.

Unless otherwise shown on the plans, anchor bolts shall be alloy steel or medium-strength, mild steel as described in Item 449, "Anchor Bolts".

All materials furnished by the Contractor shall be new.

613.6. Fabrication. Fabrication and welding shall be in accordance with Item 441, "Steel Structures", the ANSI/AWS STRUCTURAL

WELDING CODE D1.1, the details shown on the plans and the requirements of this Item.

All pole shaft sections shall be match-marked as shown on the plans.

Conformance to the plans and/or other approved drawings does not relieve the Contractor of the responsibility for providing proper fit of components.

Fabrication Tolerances:

Part	Dimension	Tolerance (millimeters)
Pole Shafts	Length (unassembled sections),	± 25
	Shaft thickness (1)	+ 3.0, - 0.50
	I.D. of outside slip fitting	+ 3.2, - 1.6
	O.D. of inside slip fitting	+ 0.8, - 3.2
	Difference between flats or ida	± 6.4
	Straightness	3.2 in 3.0 m
	Attachment locations	± 25
Assembled Pole Shafts	Perpendicular to base plate	3.2 in 610
	Shaft centered on base plate	± 6.4
	Twist in shaft (2)	4 deg in 30.5 m
	Position of winch channel	± 6.4
Base Plates	Overall	± 6.4
	Thickness	+ 6.4, - 1.6
	Deviation from flat	4.8 in 610
	Spacing between holes	± 4.8
	Bolt hole size	± 1.6
Anchor Bolt Templates	Outside diameter	± 3.2
	Inside diameter	± 6.4
	Thickness	+ 6.4, - 0.8
	Spacing between holes	± 1.6
	Bolt hole size	± 1.6

Anchor Length		± 13
Bolts	Threaded Length	± 13
	Galvanized Length	- 6.4
Misc.	Bolt hole spacing	± 1.6

(1) Shaft thicknesses in excess of + 0.5 millimeter over the nominal thicknesses may require adjustments of the pole diameters. Changes in splice lengths may also be necessary.

(2) Individual pole sections with excessive twist will be acceptable, provided the assembled match-marked sections maintain the top of the pole within the twist tolerance.

Circumferential welds will be permitted only at the top attachment and base plates. Longitudinal seam welds that will be in contact with an outer or inner section at a slip joint splice shall be ground or otherwise smoothed to the same radius as other shaft corners for the length of the splice plus a minimum of 150 millimeters. Seam welds of the remainder of the exterior of the pole sections shall be within acceptable weld profiles. Longitudinal seam welds in outer sections at splices and at base plates shall have 100 percent penetration for 1.5 pole diameters plus a minimum of 150 millimeters. All other longitudinal seam welds for pole sections shall have 85 percent minimum penetration. Welding of longitudinal seams shall be done in a manner that will minimize acid entrapment during later galvanizing.

The fabricated pole sections and associated parts shall be hot-dip galvanized in accordance with Item 445, "Galvanizing". Any holes in steel parts or members that may be permitted by the plans or by the Engineer shall be punched or drilled before the parts or members are galvanized. Any steel part or member on which galvanizing has been damaged in assembly, transit or erection and any steel part or member welded after galvanizing shall be repaired in accordance with Item 445, "Galvanizing".

613.7. Construction Methods. High mast illumination poles shall be located as shown on the plans, except that the Engineer may shift the poles, within design guidelines, where necessary to secure a more desirable location or to avoid conflict with utilities. Unless otherwise shown on the plans, the Contractor shall stake and the Engineer will verify all pole locations.

Erection of poles near any overhead or underground utilities shall be accomplished using established industry and utility safety practices. The Contractor shall consult with the appropriate utility company prior to beginning such work.

Foundations shall be constructed in accordance with Item 416, "Drilled Shaft Foundations", and the details shown on the plans.

Anchor bolts shall be placed in the foundation so that there are always two (2) bolts on the reference line as shown on the plans.

Riprap around pole foundations shall be in accordance with Item 432, "Riprap", and the details shown on the plans.

Anchor bolts and templates shall be rigidly held in position during concrete placement. The top template may be removed after the concrete has achieved initial set.

Conduit shall be held in place with the bar attached to the upper template and shall be capped prior to placing concrete. Conduit shall be reamed to remove burrs and sharp edges. Bell ends or bushings shall be installed on the conduit.

Poles shall be assembled on blocking using a minimum of two hydraulic rams at the splices. The free end of the section being assembled shall be supported by hoist equipment. All assembly force shall be applied by the hydraulic rams which shall be of sufficient capacity to properly draw the sections together with little or no remaining gaps. Splices shall be assembled to a minimum of 90 percent or a maximum of 110 percent of the planned lap. Splices which do not meet lap tolerances will require approval by the Engineer in writing.

Threads of anchor bolts shall be coated with pipe joint compound prior to installation of nuts when erecting pole.

Poles shall have an erection tolerance of 300 millimeters from vertical. During erection of the pole the Contractor shall use sufficient temporary slings, chains or wire rope to prevent unintentional separation of the pole sections.

Lower anchor bolt nuts shall be retightened against the base plate after the upper nuts are tight. A slug wrench and sledge is recommended for tightening nuts.

After the pole has been plumbed and all nuts are tight, each anchor bolt nut shall be tack welded in two (2) places to its washer and each washer shall be tack welded to the base plate in two (2) places. No welding is to be made to the bolt. Galvanizing in tack weld areas shall be repaired using zinc-rich paint in accordance with Item 445, "Galvanizing". The exposed upper threads of the anchor bolts shall be cleaned of pipe joint compound and coated with zinc-rich paint to seal the bolt thread-nut joint.

No grout shall be placed between the base plate and the foundation.

613.8. Measurement. This Item will be measured as each high mast illumination pole complete in place.

613.9. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "High Mast Illumination Poles" of the various wind designs and heights specified. This price shall be full compensation for furnishing, fabricating, galvanizing, assembling and erecting the pole upon a foundation; for furnishing and placing anchor bolts, nuts, washers and templates; for furnishing and placing conduit, ground rods and wiring as shown on the plans; and for all other materials, labor, tools, equipment or incidentals necessary to complete the work, except as shown below.

Drilled shaft foundations will be paid for under Item 416, "Drilled Shaft Foundations".

Riprap will be paid for under Item 432, "Riprap".

Ground boxes will be paid for under Item 624, "Ground Boxes".

Illumination assemblies will be paid for under Item 614, "High Mast Illumination Assemblies".

ITEM 614

HIGH MAST ILLUMINATION ASSEMBLIES

614.1. Description. This Item shall govern for furnishing and installing the various types of high mast illumination assemblies shown on the plans.

The term "assembly" as used herein shall constitute the complete assemblage of parts, equipment and miscellaneous components, except foundations and pole shafts, erected as shown on the plans and in accordance with these specifications, forming a complete and independent lighting unit.

614.2. Materials. All materials furnished by the Contractor shall be new and in accordance with the details shown on the plans.

The Contractor shall furnish six (6) sets of shop drawings of the complete assembly in accordance with Item 441, "Steel Structures", except that the drawings shall be submitted to the Director of Traffic Operations, Texas Department of Transportation, 125 East 11th Street, Austin, Texas, 78701-2483, unless otherwise shown on the plans. Prior to beginning fabrication, two (2) copies of the completed material identification form shall be furnished to the Engineer in accordance with Item 441, "Steel Structures".

The Contractor shall also make brochure submittals on the following: lighting units, ballasts, wire rope and clips, wire rope terminals, fuses, electrical cable, electrical fittings (receptacles, caps, connector bodies), cable grips, drill motor, winch and transformers. Six (6) sets of brochures shall be submitted for approval at the same time and in the same manner as the shop drawings.

614.3. Sampling. Sampling of luminaires, lamps and ballasts will be in accordance with Test Method Tex-714-I.

614.4. Construction Methods. High mast illumination assemblies shall be fabricated and installed in accordance with the details shown on the plans.

Galvanizing shall be in accordance with Item 445, "Galvanizing". After galvanizing, the floodlight mounting ring and ring support assembly shall be shop-assembled and matchmarked.

Installed high mast illumination assemblies shall be tested in accordance

with Item 616, "Performance Testing of Lighting Systems".

614.5. Measurement. This Item will be measured as each high mast illumination assembly complete in place.

614.6. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "High Mast Illumination Assemblies" of the various types specified. This price shall be full compensation for furnishing, installing, aiming and testing all rings, ring support assemblies, lighting units, ballasts, lamps, obstruction lights, hoisting assemblies, power drive assemblies, transformers, electrical equipment, electrical cord, junction boxes and enclosures; and for all labor, tools, equipment and incidentals necessary to complete the work, except as shown below.

Poles for high mast illumination assemblies will be paid for under Item 613, "High Mast Illumination Poles".

Foundations for high mast illumination assemblies will be paid for under Item 416, "Drilled Shaft Foundations".

ITEM 616

PERFORMANCE TESTING OF LIGHTING SYSTEMS

616.1. Description. This Item shall govern for performance testing of lighting systems. Lighting systems to be tested are roadway lighting, high mast lighting and sign lighting.

The term "lighting system" as used herein shall be all electrical and lighting components including service pole and the luminaires powered from that service pole.

616.2. General. Performance testing of a lighting system is for the purpose of relieving the Contractor of maintenance of the system.

The Contractor will be relieved of the responsibility for maintenance of the lighting system in accordance with Article 7.12. after a successful 14-day test period.

Materials which were damaged or which failed prior to acceptance of maintenance shall be replaced by the Contractor at the Contractor's expense.

When revisions or additions to an existing lighting system are required, the Contractor will not be held responsible for failure of existing equipment or damage to existing material unless such failure or damage is caused by the Contractor.

The Contractor will not be required to pay for electrical energy consumed by the lighting system.

616.3. Testing Method. After satisfactory completion of tests required by Items 618, "Conduit"; 620, "Electrical Conductors; and 622, "Duct Cable", when required; and all components have been properly installed, the lighting system shall be placed in operation for a 14-day test period. The 14-day test period will consist of 48 hours steady-burn and 12 days cycling by the photocell or other control device. Damaged illumination assemblies, except those damaged by the Contractor, and minor failures of lamps, ballasts and photocells will not be cause for modifying or restarting the performance test.

616.4. Measurement and Payment. The work performed, materials furnished, and all labor, tools, equipment and incidentals necessary to complete the work under this Item will not be measured or paid for directly, but will be considered subsidiary to the various bid items of the contract.

ITEM 618

CONDUIT

618.1. Description. This Item shall govern for furnishing and placing conduit of the various types and sizes shown on the plans.

618.2. Materials. All conduit and materials furnished by the Contractor shall be new, be UL-listed, and meet NEMA and NEC requirements.

Unless otherwise shown on the plans, junction boxes, expansion joints and conduit fittings shall be fabricated from a material similar to the connecting conduit.

618.3

Rigid metal conduit (RMC) shall be steel, hot-dipped galvanized inside

and outside. When tested in accordance with ASTM A 90, zinc coating of rigid metal conduit shall be a minimum of 0.45 kilograms per square meter inside and out. Electrical metallic tubing (EMT) and intermediate metal conduit (IMC) shall be steel, galvanized on the outside and protected on the inside with a suitable corrosion-resistant material. Fittings shall be rain-tight. Set screw and pressure cast fittings will not be permitted. Steel compression fittings will be allowed. Polyvinyl chloride conduit (PVC) shall meet the requirements of NEMA Standard TC-2, UL 651, and the NEC. Unless otherwise shown on the plans, PVC conduit shall be Schedule 40. Flexible conduit shall be liquid-tight.

618.3. Construction Methods. Conduit shall be placed in accordance with the lines, grades, details and dimensions shown on the plans or as otherwise approved by the Engineer. Unless otherwise shown on the plans underground conduit shall be installed a minimum of 460 millimeters deep. Installation of conduit shall be in accordance with the requirements of the NEC. Conduit placed for concrete encasement shall be secured and supported in such a manner that the alignment will not be disturbed during placement of the concrete. No concrete shall be placed until all of the conduit ends are capped and all box openings closed.

All conduit ends shall be reamed to remove burrs and sharp edges. Where conduit is threaded in the field, a standard conduit cutting die with a 19 millimeters taper per 305 millimeters shall be used. All conduit placed on structures shall be fastened with conduit straps or hangers as shown on the plans. Conduit shall be fastened within one (1) meter of each box or fitting and at other locations shown on the plans. Unless otherwise shown on the plans, all metal conduit clamps shall be of the galvanized malleable type. Clamps for 50 millimeter diameter or larger conduit shall be of the two (2) hole type.

All PVC conduit terminations shall be fitted with bushings or bell ends. All metal conduit terminations shall be fitted with a grounding type bushing except that conduit used for duct cable casing that does not terminate in a ground box and is not exposed at any point, and conduit terminating in threaded bossed fittings need not have a bushing.

When shown on the plans, conduit locations shall be marked.

Prior to installation of conductors or final acceptance, a spherical template having a diameter of not less than 75 percent of the inside diameter of the conduit shall be drawn through the conduit to insure that the conduit

is free from obstruction. The ends of all empty conduit placed for future use shall be fitted with caps.

Trench excavation and backfilling shall be as shown on the plans and in accordance with Item 400, "Excavation and Backfill for Structures", except for measurement and payment. Where existing surfacing is removed for placing conduit, repair shall be made by backfilling with material equal in composition and density to the surrounding areas and by replacing any removed surfacing, such as asphalt pavement or concrete riprap, with like material to equivalent condition.

Jacking and boring shall be as shown on the plans and in accordance with Item 476, "Jacking, Boring or Tunneling Pipe", except for measurement and payment.

618.4. Measurement. This Item will be measured by the meter of conduit.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

618.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Conduit" of the various types and sizes specified. This price shall be full compensation for furnishing and installing conduit; for jacking, boring, excavating, furnishing and placing backfill, replacing pavement structure, sod, riprap, curbs or other surface; for marking location of conduit (when required); for furnishing and installing all fittings, junction boxes, and expansion joints; and for all labor, tools, equipment and incidentals necessary to complete the work, except as shown below.

Flexible conduit will not be paid for directly, but will be subsidiary to the various bid items of the contract. Unless otherwise shown on the plans, no payment will be allowed under this Item for conduit used on electrical services or in foundations.

ITEM 620

ELECTRICAL CONDUCTORS

620.1. Description. This Item shall govern for the furnishing and placing of all electrical conductors, except conductors specifically covered by other items in the contract.

620.2. Materials. Electrical conductors shall be annealed copper of the size and type shown on the plans. All insulated conductors shall meet the requirements of ASTM B 3 or B 8, NEC and shall be listed by UL. Unless otherwise shown on the plans, all insulated conductors shall be rated for 600 volts and shall be approved for wet locations. All insulated conductors shall be stranded and shall be marked in accordance with UL and NEC requirements. All materials furnished by the Contractor shall be new.

Unless otherwise shown on the plans, bare conductors size AWG No. 8 and larger shall be stranded. For bare conductors, the Contractor shall certify that the conductors meet ASTM B 3 or B 8 requirements.

Neutral conductors shall be insulated and shall be white except that neutral conductors AWG No. 8 and larger may be black with white tape marking at every accessible location. White insulation or marking shall not be used for any other conductor except control wiring specifically shown on the plans.

Grounding conductors may be bare or insulated. Insulated grounding conductors shall be green except that insulated grounding conductors AWG No. 8 and larger may be black with green tape marking at every accessible location. Green insulation or marking shall not be used for any other conductor except control wiring specifically shown on the plans.

620.3. Construction Methods. Conductor splicing will be permitted only in junction boxes, ground boxes, transformer bases and in poles and structures at the handholes unless otherwise shown on the plans. Splices shall be as shown on the plans. Conductors shall be installed in accordance with the NEC.

The Contractor shall make insulation resistance tests on the conductors prior to making final connections. Each continuous run of insulated conductor shall have a minimum D.C. resistance of five (5) megohm when tested at 1000 volts D.C. All or part of the conductor system may be tested by the Engineer. Conductors exhibiting an insulation resistance of less than five (5) megohm shall be replaced by the Contractor at the Contractor's expense. The tests shall be witnessed by the Engineer.

620.4. Measurement. This Item will be measured by the meter of each single conductor.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

620.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Electrical Conductors" of the various types and sizes specified. This price shall be full compensation for furnishing, installing and testing electrical conductors; and for all labor, tools, equipment and incidentals necessary to complete the work, except as shown below.

(1) Conductors used in connecting the components of service poles will be paid for under Item 628, "Electrical Services".

(2) Conductors inside roadway illumination assemblies will be paid for under Item 610, "Roadway Illumination Assemblies".

(3) Conductors used for internal wiring of equipment will not be paid for directly but shall be subsidiary to the various Items of the contract.

ITEM 622

DUCT CABLE

622.1. Description. This Item shall govern for furnishing and placing duct cable of the various types and sizes shown on the plans.

The term "duct cable" as used herein shall consist of a complete assembly of conductors enclosed in a high density polyethylene duct.

622.2. Materials. Conductors in duct cable shall be in accordance with the material requirements of Item 620, "Electrical Conductors". Unless otherwise shown on the plans, the Contractor shall size duct in accordance with the NEC conduit fill requirements for the number of conductors shown on the plans. All materials furnished by the Contractor shall be new.

The duct shall be compounded from high density polyethylene meeting the requirements of ASTM D 1248, weather resistant-black, Type III.

The duct wall thickness shall meet the requirements of NEMA TC-2 for EPC-40-PE (Schedule 40) and shall meet the crushing resistance requirements of Article 3.03 of NEMA TC-2.

The duct shall be extruded directly over the paralleled conductors during manufacture of the duct cable. Duct cable assemblies exhibiting evidence of conductors having been pulled into the duct after the duct is manufactured will be rejected. Each length of duct shall be clearly and durably marked at least every 3.0 meters with the material designation, nominal size of the duct and with the name and/or trademark of the manufacturer. Duct shall also be marked at 0.6 meter intervals with sequential numbers indicating length of cable on reel, with zero mark at inner end.

Cable testing less than 50 megohms insulation resistance at 1000 volts while still on the reel will not be acceptable.

The complete assembly shall be packaged on reels having sufficient diameter to prevent permanent set or damage. Each reel shall be clearly and durably marked to show the voltage rating, type of insulation, number of conductors, conductor size, length, duct size and the name and/or trademark of the manufacturer.

Prior to installation, the Contractor shall furnish written certification to the Engineer that all duct cable complies with the requirements of this Item and as shown on the plans.

622.3. Construction Methods. The duct cable shall be placed by open trench methods at the depth shown on the plans, except at locations

where the duct cable is to be installed in conduit. The trench shall be backfilled and compacted in accordance with Item 400, "Excavation and Backfill for Structures", except for measurement and payment. Where existing surfacing is removed for placing duct cable, repair shall be made by backfilling with material

equal in composition and density to the surrounding area and by replacing any removed surfacing, such as asphalt pavement or concrete riprap, with like material to equivalent condition.

The duct shall not be spliced. Bends shall be formed with large radii to provide free movement of conductors. After the duct cable has been installed, the Contractor shall demonstrate to the satisfaction of the Engineer that the conductors can be freely moved. Duct cable that has been kinked or in which the conductors cannot be freely moved shall be replaced by the Contractor at the Contractor's expense.

Conductor splicing and insulation testing shall be made in accordance with Item 620, "Electrical Conductors", except for measurement and payment.

622.4. Measurement. This Item will be measured by the meter of duct cable.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

622.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Duct Cable" of the various types and sizes specified. This price shall be full compensation for furnishing and installing all duct cable; for pulling through conduit; for excavating and backfilling the trenches; for replacing riprap, pavement structure, topsoil, sod or other surface; for testing insulation resistance; and for all labor, tools, equipment and incidentals necessary to complete the work.

ITEM 624

GROUND BOXES

624.1. Description. This Item shall govern for constructing, furnishing and installing ground boxes of the various types and sizes shown on the plans complete with lids.

624.2. Materials. All materials furnished by the Contractor shall be new. Materials shall be as shown on the plans and as follows:

Precast concrete ground boxes, cast-in-place concrete ground boxes and aprons shall conform to the material and construction method requirements of Item 421, "Portland Cement Concrete", and Item 440, "Reinforcing Steel".

Precast polymer concrete ground boxes shall be fabricated with reinforced polymer concrete composed of borosilicate glass fiber, catalyzed polyester resin and aggregate.

Precast ground boxes shall be capable of withstanding a 6800 kilograms load applied over a 250 millimeters by 250 millimeters area in the center of the lid while the box is free standing, or other loading as shown on the plans.

624.3. Construction Methods. Installation of the ground boxes shall be in conformance with the details shown on the plans. When shown on the plans, a concrete apron shall be provided.

624.4. Measurement. This Item will be measured as each ground box complete in place.

624.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Ground Boxes" of the various types and sizes specified. This price shall be full compensation for excavating and backfilling; for constructing, furnishing and installing the ground boxes and concrete aprons when required; for concrete and reinforcing steel; and for all labor, tools, equipment and incidentals necessary to complete the work.

ITEM 625

ZINC-COATED STEEL WIRE STRAND

625.1. Description. This Item shall govern for furnishing and installing zinc-coated steel wire strand of the various diameters as shown on the plans.

625.2. Materials. Zinc-coated steel wire strand shall conform to the requirements of ASTM A 475, Utilities Grade or better, Class A coating, which include, but are not limited to, the following dimensions and properties.

Nominal Diameter of Strand (millimeter)	Wires per Strand (No.)	Nominal Diameter of Coated Wires (millimeter)	Approx. Mass per 304.8 meter (kilogram)	Minimum Breaking Strength (kilonewton)	Minimum Zinc Coating Wt. Class A (g/m^2)
4.76	7	1.65	36	10.676	152.6
6.35	7	2.03	55	21.129	183.1
7.14	7	2.36	74	20.462	213.6
7.94	7	2.77	102	26.689	244.1
9.52	7	3.05	124	51.155	259.4
11.11	7	3.68	181	80.068	274.6
12.70	7	4.19	234	111.206	274.6

The zinc coating shall be free from drips, runs, sharp points, voids and damage.

Samples for establishing conformity may be taken by the Engineer from each roll of each diameter of strand. Strands failing to meet the requirements of this Item shall be replaced by the Contractor at the Contractor's expense.

All materials furnished by the Contractor shall be new.

625.3. Construction Methods. Strands shall be installed as shown on the plans. Strand splices will not be permitted.

625.4 to 627.1

When used as a messenger cable or span wire, the strand shall be grounded to earth ground at each pole. Resistance from the strand to the ground rod shall be less than one (1) ohm.

625.4. Measurement and Payment. The work performed, materials furnished and all labor, tools, equipment and incidentals necessary to complete

the work under this Item will not be measured or paid for directly, but will be considered subsidiary to the various bid items of the contract.

ITEM 627

TREATED TIMBER POLES

627.1. Description. This Item shall govern for furnishing and installing treated timber poles of the various types and lengths as shown on the plans.

627.2. Materials. All materials furnished by the Contractor shall be new. Timber poles shall be treated southern pine and shall be in accordance with ANSI 05.1, "Specifications and Dimensions for Wood Poles", and the additional requirements of this Item.

Unless otherwise shown on the plans, treated timber poles for electrical services shall be ANSI Class 5 and poles for all other uses shall be ANSI Class 2.

Tops and butts of poles shall be free from pith holes. The depth of a trimmed scar shall not be greater than 25 millimeters or 1/10 the pole diameter at that location, whichever is smaller.

Any deviation from straightness shall not exceed 50 millimeters in a 1.5 meter (or less) section. A pole may have sweep in one (1) plane and one (1) direction (single sweep) provided a straight line joining the midpoint of the pole at the butt and the midpoint of the pole at the top does not at any intermediate point pass through the external surface of the pole. Poles with sweep in two (2) planes (double sweep) will not be accepted.

Timber poles with more than one (1) complete twist of spiral grain will not be accepted.

Butt slivering due to felling will be permitted if the distance from the outside circumference is not less than 1/4 of the butt diameter and the height is not more than 0.3 meter.

Preservative treatment shall be in accordance with AWPA C4. Minimum net retention of preservative, measured by gauge or mass, shall be as follows:

TREATMENT	RETENTION
Creosote (AWPA P1)	160 kg per m^3
Pentachlorophenol (AWPA P8 & P9)	9.6 kg per m^3
ACA/CCA (AWPA P5)	9.6 kg per m^3

627.3. Inspection. Inspectors representing the Department shall have access to all parts of facilities used in the conditioning and treating of forest products. The supplier shall provide the necessary assistance for the proper inspection of the materials being furnished. For projects requiring 10 or less timber poles, the poles may be accepted from a local supplier if an acceptable certificate of treatment is furnished and the poles are properly marked.

627.4. Markings. All poles shall be marked by branding as follows:

PTC	Supplier's code or trademark (for example, Pole Treating Company)
F-63	Plant location and year of treatment (for example, Forestville, 1963)
SPC	Species and preservative code (for example, southern pine, creosote)
5-10.5	Class-length (for example, Class 5, 10.5 meter pole)

The bottom of the brand shall be placed squarely on the face of the pole three (3) meters (plus or minus 50 millimeters) from the butt.

627.5. Construction Methods. Installation of poles located near any overhead or underground utilities shall be accomplished using

established industry and utility safety practices. The Contractor shall consult with the appropriate utility company prior to beginning such work.

Unless otherwise shown on the plans, minimum pole setting depth shall be as follows:

Pole Length (meter)	Min. Setting Depth (meter)
7.5 or less	1.4
8-9	1.5
9.5-10.5	1.7
11-12	1.8
12.5-13.5	2.0
14-15	2.1

Timber poles shall be installed at locations shown on the plans or as directed by the Engineer in writing. Holes for setting poles shall be a minimum of 1.5 diameters of the pole butt. Unless otherwise shown on the plans, poles shall be set plumb. Holes shall be backfilled by thoroughly tamping in 150 millimeter lifts. After tamping to grade, additional backfill material shall be placed in a 150 millimeter high cone around the pole to allow for settling.

Where existing surfacing is removed for placing foundations, repair shall be made by backfilling with material equal in composition and density to the surrounding area and by replacing any removed surfacing, such as asphalt pavement or concrete riprap, with like material to equivalent condition.

627.6. Measurement and Payment. The work performed, materials furnished and all labor, tools, equipment and incidentals necessary to complete the work under this Item will not be measured or paid for directly, but will be considered subsidiary to the various bid items of the contract.

ITEM 628

ELECTRICAL SERVICES

628.1. Description. This Item shall govern for furnishing and installing complete and independent points of electrical service of the various types shown on the plans.

628.2. General. All materials and construction methods shall

conform to the details shown on the plans, the requirements of this Item and to the pertinent requirements of the following Items:

Item 441, "Steel Structures"
Item 445, "Galvanizing"
Item 449, "Anchor Bolts"
Item 618, "Conduit"
Item 620, "Electrical Conductors"
Item 627, "Treated Timber Poles"
Item 656, "Foundations for Signs, Traffic Signals and Roadway Illumination Assemblies"

628.3. Materials. All materials furnished, assembled, fabricated and installed under this Item shall be in accordance with the details shown on the plans. Unless otherwise shown on the plans, all materials shall be new and shall comply with the requirements of the NEC, UL and NEMA.

628.4. Construction Methods. The electrical services shall be assembled and placed in accordance with the details and dimensions shown on the plans or as directed in writing by the Engineer. Electrical equipment shall be installed in accordance with the NEC and local utility company requirements.

628.5. Measurement. This Item will be measured as each electrical service complete in place.

628.6. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Electrical Services" of the various types specified. This price shall be full compensation for paying all fees, permits, and other costs; for making arrangements with the utility company for all work and materials provided by the utility company; for furnishing, installing and connecting all components including poles, service supports foundations, anchor bolts, riprap, enclosures, switches, breakers, conduit, fittings, conductor, brackets, bolts, hangers, and hardware; and for all labor, tools, equipment and incidentals necessary to complete the work, except as shown below.

Costs for utility owned power line extensions will be paid for by the State under Force Account work.

ITEM 629

REMOVING SERVICE POLES

629.1. Description. This Item shall govern for the removal of service poles as shown on the plans.

629.2. Materials. All electrical materials furnished and installed under this Item shall be new and in accordance with the NEC.

629.3. Construction Methods. Prior to the removal of the service poles, any existing electrical service shall be disconnected and isolated in accordance with appropriate utility company requirements. The Contractor shall consult with the appropriate utility company prior to beginning such work.

Removal of service poles near any overhead utilities shall be accomplished using established industry and utility safety practices.

Unless otherwise shown on the plans, existing service poles shall be removed to 0.6 meter below finish grade or completely removed. The remaining hole shall be repaired by backfilling with material equal in composition and density to the surrounding area, and by replacing any surfacing such as asphalt pavement or concrete riprap with like material to equivalent condition.

Conductors to be abandoned shall be disconnected from the power source and removed, as much as is practical, from the conduit or duct. All protruding conduit or duct shall be cut off 150 millimeters below finish grade. Unless otherwise shown on the plans, abandoned conduit or duct need not be removed.

When shown on the plans, duct cable, conductors and conduit to be reused shall be reconnected. Components damaged due to Contractor's operations shall be replaced by the Contractor at the Contractor's expense in accordance with applicable specifications. All splices, where permitted or required, shall be made in ground boxes or as shown on the plans.

All materials removed under this Item and not designated for reuse or retention by the State shall become the property of the Contractor and shall be removed from the right-of-way to a site approved by the Engineer.

629.4. Measurement. This Item will be measured as each service pole removed.

629.5. Payment. The work performed in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Removing Service Poles". This price shall be full compensation for coordinating with utility company to disconnect and isolate the electrical service; for removing the service poles; for backfilling holes and for all labor, tools, equipment and incidentals necessary to complete the work.

ITEM 634

PLYWOOD SIGNS (TYPE A)

634.1. Description. This Item shall govern for furnishing, fabricating and erecting roadside reflectorized plywood signs of the various types and sizes as shown on the plans.

634.2. Materials.

(1) Sign Blanks. Sign blank substrates shall be in accordance with Departmental Materials Specification D-9-7100.

Sign blanks shall be single panel or multi-panel construction as shown on the plans. Unless otherwise shown on the plans, the thickness of the plywood sheet shall be 16 millimeters.

(2) Sign Face Reflectorization. Sign faces shall be reflectorized with flat surface reflective sheeting and shall be the colors and types shown on the plans. The reflective sheeting shall be from the same manufacturer for all signs of the same color and sheeting type. Sheeting shall be in accordance with Departmental Materials Specification D-9-8300.

(3) Sign Messages. Sign messages shall be the sizes, types and colors shown on the plans. The sign message material for all signs of the same sheeting type and color shall be from the same manufacturer.

(a) Screened messages shall have clean sharp edges. Messages and backgrounds shall have no runs, sags or voids and shall exhibit uniform color and reflectivity. Screen inks shall conform to Departmental Materials Specification D-9-8300.

(b) Reflectorized removable legend shall conform to Departmental Materials Specification D-9-8400.

(c) Reflectorized sheeting legend shall be made from materials conforming to Departmental Materials Specification D-9-8300. Unless otherwise shown on the plans, legend material shall be the same sheeting type as the sign face.

(d) Non-reflectorized sheeting legend shall be made from materials conforming to Departmental Materials Specification D-9-8320.

(e) Aluminum signs required as part of a message shall conform with the plans and with Item 636, "Aluminum Signs (Type A)".

(4) Hardware. All bolts, nuts, washers, lock washers, screws and other sign assembly hardware shall be galvanized steel, stainless steel or dichromate sealed aluminum, in conformance with Departmental Materials Specification D-9-7120. When dissimilar metals are used, the metals shall be so selected or insulated to prevent corrosion.

634.3. Sampling. Sampling will be in accordance with Test Method Tex-726-I.

634.4. Fabrication.

(1) Working Drawings. Prior to fabrication, the Contractor shall submit to the Engineer for approval six (6) sets of working drawings for signs requiring the use of removable legend. When two (2) or more signs are of identical design, working drawings for only one (1) of the signs need be submitted. Working drawings shall conform to the details shown on the plans. The working drawings shall show the details of the panels, wind beams, stiffeners, joint backing plates, splices, fasteners, brackets, sign support connections and methods of attaching messages. The working drawings shall show letter types and sizes, interline spacing and message arrangements.

(2) Sign Blanks. Sign blanks shall be the sizes and shapes shown on the plans. Unless otherwise shown on the plans, no panel on multi-panel signs shall have a face dimension less than 450 millimeters. Signs 1200 by 2400 millimeters or smaller in either dimension shall be of one (1) piece construction.

Sign face surface variation shall not exceed five (5) millimeters per 0.5 meter except that surface misalignment between panels in multi-panel signs shall not exceed two (2) millimeters at any point. Gaps between panels shall not exceed three (3) millimeters.

(3) Sheeting Application. Sheeting shall be applied to sign blanks in conformance with the recommended procedures of the manufacturer of the sheeting. For multi-panel signs, reflective sheeting on adjacent panels shall be matched carefully to provide uniform color, appearance and reflectivity.

When splicing of sheeting is necessary, the number of splices shall be held to a minimum. Splices shall be a minimum six (6) millimeters lap. The minimum dimension for any one (1) piece of sheeting shall be 0.3 meter. Signs screened with transparent screen inks shall not be spliced.

(4) Attachment Hardware. Prior to erection of the signs, all attachment hardware visible on the sign faces shall be painted similar in color to the immediately adjacent sign face.

634.5. Storage and Handling. Completed sign blanks and completed signs shall be shipped, handled and stored in such a manner that corners, edges and faces are not damaged. Any damage to the sign faces which is not visible, when viewed at a distance of 15 meters as outlined in the Department's MANUAL OF INSPECTION: HIGHWAY SIGNS, will be acceptable. Unacceptable sign panels shall be replaced by the Contractor at the Contractor's expense.

Finished signs shall be stored off the ground in a vertical position and protected from the weather until erected.

634.6. Decals. Sign identification decals shall be coded and applied in accordance with Item 643, "Sign Identification Decals".

634.7 Cleaning. Completed signs shall be washed with a biodegradable cleaning solution acceptable to the manufacturers of the sheeting and screen ink to remove all grease, oil, dirt, smears, streaks, finger marks and other foreign material prior to shop inspection and again prior to final inspection after erection.

634.8. Measurement. This Item will be measured by the square meter of sign face.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

634.9. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Plywood Signs (Type A)" of the types and sizes specified. This price shall be full compensation for furnishing sign panels; for fabrication of the panels; for any treatment of sign panels that might be required prior to application of the background materials; for application of the background materials and messages to the sign panels; for furnishing and fabricating frames, wind beams, stiffeners and/or required joint backing strips; for furnishing all bolts, rivets, screws, fasteners, clamps, brackets and sign support connections; for assembling and erecting the signs; for washing and cleaning the signs; and for all other materials, labor, tools, equipment and incidentals necessary to complete the work.

ITEM 636

ALUMINUM SIGNS (TYPE A)

636.1. Description. This Item shall govern for furnishing, fabricating and erecting single piece reflectorized sheet aluminum signs of the various types and sizes as shown on the plans.

636.2. Materials.

(1) Sign Blanks. Sign blank substrates shall conform with Departmental Materials Specification D-9-7110 and shall be of the sizes and thicknesses shown on the plans.

(2) Sign Face Reflectorization. Sign faces shall be reflectorized with flat surface reflective sheeting and shall be the colors and types shown on the plans. The reflective sheeting shall be from the same manufacturer for all signs of the same color and sheeting type. Sheeting shall be in accordance with Departmental Materials Specification D-9-8300.

(3) Sign Messages. Sign messages shall be the sizes, types and colors shown on the plans. The sign message material for all signs of the same sheeting type and color shall be from the same manufacturer.

(a) Screened messages shall have clean sharp edges. Messages and backgrounds shall have no runs, sags or voids and shall exhibit uniform color and reflectivity. Screen inks shall conform to Departmental Materials Specification D-9-8300.

(b) Reflectorized sheeting legend shall be made from materials conforming to Departmental Materials Specification D-9-8300. Unless otherwise shown on the plans, legend material shall be the same sheeting type as the sign face.

(c) Non-reflectorized sheeting legend shall be made from materials conforming to Departmental Materials Specification D-9-8320.

(4) Hardware. All bolts, nuts, washers, lock washers, screws and other sign assembly hardware shall be galvanized steel, stainless steel or dichromate sealed aluminum, in conformance to Departmental Materials Specification D-9-7120. When dissimilar metals are used, the metals shall be so selected or insulated to prevent corrosion.

636.3. Sampling. Sampling will be in accordance with Test Method Tex-726-I.

636.4. Fabrication.

(1) Sign Blanks. Sign blanks shall be the sizes and shapes shown on the plans, free of buckles, warps, burrs, dents, cockles and other defects resulting from fabrication. Sign face surface variation shall not exceed five (5) millimeters per 0.5 meter.

All fabrication of sign blanks, including cutting and drilling or punching of holes, shall be completed prior to cleaning, degreasing and application of the reflective sheeting. Following cleaning, the blanks shall not come in contact with grease, oils or contaminants prior to application of the reflective sheeting.

(2) Sheeting Application. Sheeting shall be applied to sign blanks in conformance with the recommended procedures of the manufacturer of the sheeting. When splicing of sheeting is necessary, the number of splices shall be held to a minimum. Splices shall be a minimum six (6) millimeters lap. The minimum dimension for any one (1) piece of sheeting material shall be 0.3 meter. Signs screened with transparent screen inks shall not be spliced.

(3) Attachment Hardware. Prior to erection of the signs, all attachment hardware visible on the sign faces shall be painted similar in color to the immediately adjacent sign face.

636.5. Storage and Handling. Completed sign blanks and completed signs shall be shipped, handled and stored in such a manner that corners, edges and faces are not damaged. Any damage to the sign faces which is not visible, when viewed at a distance of 15 meters as outlined in the Department's MANUAL OF INSPECTION: HIGHWAY SIGNS, will be acceptable. Unacceptable signs shall be replaced by the Contractor at the Contractor's expense. Finished signs shall be stored off the ground in a vertical position and protected from the weather until erected.

636.6. Decals. Sign identification decals shall be coded and applied in accordance with Item 643, "Sign Identification Decals".

636.7. Cleaning. Completed signs shall be washed with a biodegradable cleaning solution acceptable to the manufacturers of the sheeting and screen ink to remove all grease, oil, dirt, smears, streaks, finger marks and other foreign material prior to shop inspection and again prior to final inspection after erection.

636.8. Measurement. This Item will be measured by the square meter of sign face.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

636.9. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Aluminum Signs (Type A)" of the types and sizes specified. This price shall be full compensation for furnishing sign blanks; for fabrication of the sign blanks; for any treatment of sign blanks that might be required prior to application of the background materials; for application of the background materials and messages to the sign blanks; for screening messages as shown on the plans; for furnishing all bolts, rivets, screws, fasteners, clamps, brackets and sign support connections; for assembling and erecting the signs; for washing and cleaning the signs; and for all other materials, labor, tools, equipment and incidentals necessary to complete the work.

ITEM 637

ALUMINUM SIGNS (TYPE G)

637.1 Description. This Item shall govern for furnishing, fabricating and erecting roadside reflectorized extruded aluminum signs of the various types and sizes shown on the plans.

637.2. Materials.

(1) Sign Blanks. Sign blank substrates shall be extruded aluminum and shall conform to the requirements of Departmental Materials Specification D-9-7110.

(2) Sign Face Reflectorization. Sign faces shall be reflectorized with flat surface reflective sheeting and shall be the colors and types shown on the plans. The reflective sheeting shall be from the same manufacturer for all signs of the same color and sheeting type. Sheeting shall be in accordance with Departmental Materials Specification D-9-8300.

(3) Sign Messages. Sign messages shall be the sizes, types and colors shown on the plans. The sign message material for all signs of the same sheeting type and color shall be from the same manufacturer.

(a) Reflectorized removable legend shall conform with Departmental Materials Specification D-9-8400.

(b) Reflectorized sheeting legend shall be made from materials conforming to Departmental Materials Specification D-9-8300. Unless otherwise shown on the plans, legend materials shall be the same sheeting type as the sign face.

(c) Non-reflectorized sheeting legend shall be made from materials conforming to Departmental Materials Specification D-9-8320.

(d) Aluminum signs required as part of a message shall conform with the plans and with Item 636, "Aluminum Signs (Type A)".

(4) Hardware. All bolts, nuts, washers, lock washers, screws and other sign assembly hardware shall be galvanized steel, stainless steel, or dichromate sealed aluminum, in conformance with Departmental Materials Specification D-9-7120. When dissimilar metals are used, the metals shall be so selected or insulated to prevent corrosion.

637.3. Fabrication.

(1) Working Drawings. Prior to fabrication, the Contractor shall submit to the Engineer for approval six (6) sets of working drawings for each extruded aluminum sign. When two (2) or more signs are of identical design, working drawings for only one (1) of the signs need be submitted. Working drawings shall conform to details shown on the plans. The working drawings shall show the details of the panels, wind beams, stiffeners, splices, fasteners, brackets, sign support connections and methods of attaching messages.

The working drawings shall show letter types and sizes, interline spacing and message arrangements. Accompanying the working drawings, the Contractor shall submit the following: the extrusion manufacturer's name, the extrusion number and a dimensional cross section of the panel.

(2) Panel Preparation. All preparation of substrates used in making the signs, including cutting and drilling or punching of holes, except holes for attaching removable reflectorized legend, shall be completed prior to cleaning, degreasing and application of the reflective sheeting.

(3) Sign Blanks. Sign blanks shall be the sizes and shapes shown on the plans.

(4) Surface Preparation. Surface preparation of the face side of the background substrate and application of the sheeting shall be as recommended by the sheeting manufacturer. The outside surface of aluminum extrusion flanges shall be cleaned and prepared in the same manner as the sign panel face.

(5) Sign Assembly. The sign shall be assembled in accordance with the details shown on the plans. Sign surface variation shall not exceed five (5) milllimeters per 0.5 meter, except that surface misalignment between adjacent panels shall not exceed two (2) millimeters at any point.

637.4. Storage and Handling. Completed sign blanks and completed signs shall be shipped, handled and stored in such a manner that corners, edges and faces are not damaged. Any damage to the sign faces which is not visible, when viewed at a distance of 15 meters as outlined in the Department's MANUAL OF INSPECTION: HIGHWAY SIGNS, will be acceptable. Unacceptable signs shall be replaced by the Contractor at the Contractor's expense. Finished signs shall be stored off the ground in a vertical position and protected from the weather until erected.

637.5. Decals. Sign identification decals shall be coded and applied in accordance with Item 643, "Sign Identification Decals".

637.6. Cleaning. Completed signs shall be washed with a biodegradable cleaning solution acceptable to the manufacturer of the sheeting to remove all grease, oil, dirt, smears, streaks, finger marks, and other foreign material prior to shop inspection and again prior to final inspection after erection.

637.7. Measurement. This Item will be measured by the square meter of sign face.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

637.8. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Aluminum Signs (Type G)" of the types and sizes specified. This price shall be full compensation for furnishing sign panels; for fabrication of the panels; for any treatment of sign panels that might be required prior to application of the background materials; for application of the background materials and messages to the sign panels; for furnishing and fabricating frames, wind beams, stiffeners and/or required joint backing strips; for furnishing all bolts, rivets, screws, fasteners, clamps, brackets and sign support connections; for assembling and erecting the signs; for washing and cleaning the signs; and for all other materials, labor, tools, equipment and incidentals necessary to complete the work.

ITEM 639

REVISING GUIDE SIGN MESSAGES

639.1. Description. This Item shall govern for revising existing overhead and roadside guide sign messages of the various types as shown on the plans.

639.2. Materials. New reflectorized removable legend shall conform to Departmental Materials Specification D-9-8400.

New supplemental sheet aluminum panels, when shown on the plans, shall conform to Item 636, "Aluminum Signs (Type A)".

New supplemental plywood panels, when shown on the plans, shall conform to Item 634, "Plywood Signs (Type A)".

639.3. Working Drawings. Prior to beginning work, the Contractor shall furnish to the Engineer for approval six (6) sets of working drawings for signs to be modified. When two (2) or more signs are of identical design, working drawings for only one (1) of the signs need be

submitted. The working drawings shall show the details of attaching messages to the sign face. In addition, the working drawings shall show letter types and sizes, interline spacing and message arrangement in sufficient detail to verify conformance with the plans.

639.4. Construction Methods. Existing messages to be revised and/or new messages to be furnished by the Contractor shall be spaced and installed as shown on the plans.

Care shall be taken to prevent any damage to the various sign components. Any portion of the sign assembly, including messages, damaged during revision operations shall be replaced by the Contractor at the Contractor's expense in accordance with the applicable specification.

Any existing message components that are removed and are not designated on the plans to be reused shall become the property of the Contractor.

639.5. Cleaning. After the message has been revised, the entire sign shall be washed with a biodegradable cleaning solution to remove all dirt, grease, oil smears, streaks, finger marks and other foreign materials.

639.6. Measurement. This Item will be measured as each guide sign revised, complete in place. Signs consisting of a parent sign and supplemental panels attached to the parent sign shall be considered as one (1) sign.

639.7. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Revising Guide Sign Messages" of the various types specified. This price shall be full compensation for removing and/or replacing existing messages; for furnishing and installing necessary new messages; and for all other materials, labor, tools, equipment and incidentals necessary to complete the work.

ITEM 642

ALUMINUM SIGNS (TYPE O)

642.1. Description. This Item shall govern for furnishing, fabricating and erecting overhead extruded aluminum guide signs as shown on the plans.

642.2. Materials.

(1) Sign Blanks. Sign blank substrates shall be extruded aluminum and shall be in accordance with Departmental Materials Specification D-9-7110.

(2) Sign Backgrounds.

(a) Non-reflective. Unless otherwise shown on the plans, the Contractor shall utilize either Class A, B, C or D non-reflective background material conforming to Departmental Materials Specification D-9-8500. The non-reflective background material on all overhead aluminum guide signs for any one (1) project shall be of the same manufacturer and class for each color.

(b) Reflective. Sign backgrounds shall be reflectorized with flat surface reflective sheeting and shall be the colors and sheeting types shown on the plans. The reflective sheeting shall be from the same manufacturer for all signs of the same color and sheeting type. Sheeting shall be in accordance with Departmental Materials Specification D-9-8300.

(3) Sign Messages. The sign messages shall be of the sizes, types and colors shown on the plans.

Reflectorized removable legend shall be in accordance with Departmental Materials Specification D-9-8400.

Aluminum signs required as part of a message shall be as shown on the plans and in accordance with Item 636, "Aluminum Signs (Type A)".

(4) Hardware. All bolts, nuts, washers, lock washers, screws and other sign assembly hardware shall be galvanized steel, stainless steel or dichromate sealed aluminum in accordance with Departmental Materials

Specification D-9-7120. When dissimilar metals are used, the metals shall be so selected or insulated to prevent corrosion.

642.3. **Fabrication.**

(1) **Working Drawings.** Prior to fabrication, the Contractor shall submit to the Engineer for approval six (6) sets of working drawings for each overhead aluminum guide sign. When two (2) or more signs are of identical design, working drawings for only one (1) of the signs need be submitted. Working drawings shall conform to the details shown on the plans. The working drawings shall show the details of the panels, wind beams, stiffeners, splices, fasteners, brackets, sign support connections and methods of attaching messages.

The working drawings shall show letter types and sizes, interline spacing and message arrangements. Accompanying the working drawings, he Contractor shall submit the following: the extrusion manufacturer's name, the extrusion number and a dimensional cross section of the panel.

(2) **Panel Preparation.** All preparation of substrates used in making the signs, including cutting and drilling or punching of holes, except holes for attaching reflectorized removable legend, shall be completed prior to cleaning, degreasing and application of background materials.

(3) **Sign Blanks.** Sign blanks shall be the sizes and shapes shown on the plans.

(4) **Surface Preparation.** Surface preparation of the face side of the sign substrate and application of background materials shall be as recommended by the material manufacturer. The outside surface of aluminum extrusion flanges shall be cleaned and prepared in the same manner as the sign panel face.

(5) **Background Material Application.** Polyvinyl fluoride film (Class A), acrylic polymer film (Class B) and reflectorized sheeting shall be applied to the face side and a minimum of 15 millimeters of the outside surface of the aluminum extrusion flanges.

Thermosetting polyester coatings (Class C) and polyvinylidene fluoride plastic thermosetting coatings (Class D) shall be applied to the face side and outside surfaces of extrusion flanges.

The applied coatings, films and sheetings shall be uniform throughout and free of blemishes, blisters, pinholes, cracks, sags and crazing.

(6) The sign shall be assembled and erected in accordance with the details shown on the plans. Sign surface variation shall not exceed five (5) millimeters per 0.5 meter, except that surface misalignment between adjacent panels shall not exceed two (2) millimeters.

642.4. Storage and Handling. Completed sign blanks and completed signs shall be shipped, handled and stored in such a manner that corners, edges and faces are not damaged. Any damage to the sign faces which is not visible when viewed at a distance of 15 meters as outlined in the Department's MANUAL OF INSPECTION: HIGHWAY SIGNS will be acceptable. Unacceptable signs or sign panels shall be replaced by the Contractor at the Contractor's expense. Finished signs shall be stored off the ground in a vertical position and protected from the weather until erected.

642.5. Cleaning. Completed signs shall be washed with a biodegradable cleaning solution acceptable to the manufacturer of the background materials to remove all grease, oil, dirt, smears, streaks, finger marks and other foreign material prior to shop inspection and again prior to final inspection after erection.

642.6. Measurement. This Item will be measured by the square meter of sign face.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

642.7. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Aluminum Signs (Type O)". This price shall be full compensation for furnishing sign panels; for fabrication of the panels; for any treatment of sign panels that might be required prior to application of the background materials; for application of the background materials and messages to the sign panels; for furnishing and fabricating frames, wind beams, stiffeners and/or required joint backing strips; for furnishing all bolts, rivets, screws, fasteners, clamps, brackets

and sign support connections; for assembling and erecting the signs; for washing and cleaning the signs; and for all other materials, labor, tools, equipment and incidentals necessary to complete the work.

ITEM 643

SIGN IDENTIFICATION DECALS

643.1. Description. This Item shall govern for furnishing and installing sign identification decals.

643.2. General. The non-reflectorized plastic film decal shall be 75 millimeters square, white in color and shall be marked to display the face design as shown below. The face marking shall not deteriorate prior to the design life of the film material. The decal shall be free from ragged edges, streaks, blisters, foreign matter or other surface imperfections.

TxDOT											
C	**FABRICATION**										T
J	F	M	A	M	J	J	A	S	O	N	D
199		200		201		202		203		204	
		0	1	2	3	4	5	6	7	8	9
SHEETING MFR											
A	B	C	D	E	F	G	H	J	K	L	M
INSTALLATION DATE											
DAY			0	1	2	3					
		0	1	2	3	4	5	6	7	8	9
J	F	M	A	M	J	J	A	S	O	N	D
199		200		201		202		203		204	
		0	1	2	3	4	5	6	7	8	9

SHEETING MFR

A - NIKKALITE
B - AMERICAN DECAL (ADCOLITE)
C - SCOTCHLITE
D - FASIGN
E -
F - STIMSONITE
G - KIWALITE
H - REFLEXITE
J -
K -
L -
M -

643.3. Sampling and Testing. Sampling will be in accordance with Test Method Tex-720-I. Test panels shall consist of a 165 millimeter square piece of the plastic film applied to a clean and degreased 150 millimeter square aluminum panel, trimmed evenly at the edge of the panel, and aged for 48 hours at 21 °C to 32 °C.

643.4. Material Requirements.

(1) Film Characteristics. Film thickness shall be a minimum of 0.08 millimeter and a maximum of 0.1 millimeter.

The film shall be flexible and shall conform to contoured surfaces.

The film shall have an initial 60 degree gloss value of 35 (minimum) when tested in accordance with ASTM D 523.

The film shall not support fungus growth.

The material shall not exhibit more than 0.4 millimeter shrinkage in any direction from the edge of the test panel when subjected to a temperature of 60 °C for 48 hours and shall retain adhesion to the panel after one week at that temperature.

Completed decals shall exhibit no discoloring, cracking, crazing, blistering, delamination, peeling, chalking or loss of adhesion when subjected to 1200 hours exposure in a Type E Weather-O-Meter utilizing an 18-102 cyclic gear (18 minutes of sunshine and rain and 102 minutes of sunshine).

643.5

(2) Adhesive. The film shall be precoated with a pressure-sensitive adhesive allowing positioning of the decal without bonding to clean surfaces at temperatures up to 38 °C. Bonding is to occur only after pressure is applied.

The adhesive shall form a durable bond to smooth, clean, corrosion and weather resistant surfaces. Adhesive shall be of uniform thickness, non-corrosive to metal surfaces and shall have no staining effect on the film.

The adhesive shall adhere securely at temperatures from -34 °C to 93 °C such that the decal cannot be removed in one (1) piece.

The adhesive side of the film shall be covered by a treated paper liner which shall be scored approximately in the center and shall be removable at the time of decal application without soaking in water or other solvents.

643.5. Construction Methods. When the sign is fabricated, the decal shall be coded as follows:

For signs fabricated by a commercial sign fabricator - Punch out "C" in upper left corner.

For signs fabricated by the Texas Department of Criminal Justice - Punch out "T" in upper right corner.

Punch out the month the sign is fabricated in the first row under "FABRICATION"; e.g., "S" for September.

Punch out the first three (3) digits of the year in the second row under "FABRICATION"; e.g., "199" for 1990 through 1999.

Punch out the fourth digit of the year in the third row under "FABRICATION"; e.g., "0" for 1990.

Under "SHEETING MFR": Punch out the designation corresponding to the sheeting manufacturer.

After the decal has been coded by the sign fabricator, the decal shall be affixed to the sign back in the lower left hand corner such that the sign support will not block view of the decal.

643.6 to 644.2

The Contractor shall code the decals when installing the signs as follows:

Scratch out the first digit of the day installed in the first row under "INSTALLATION DATE"; "0" for dates 1 through 9; e.g., "0" for third day of the month.

Scratch out the second digit of the day installed in the second row under "INSTALLATION DATE"; e.g., "1" for first, eleventh, twenty-first, and thirty-first day of the month.

Scratch out the month in the third row under "INSTALLATION DATE"; e.g., "S" for September.

Scratch out the first three (3) digits of the year in the fourth row under "INSTALLATION DATE"; e.g., "199" for 1990 through 1999.

Scratch out the fourth digit of the year in the fifth row under "INSTALLATION DATE"; e.g., "0" for 1990.

643.6. Measurement and Payment. The work performed, materials furnished and all labor, tools, equipment and incidentals necessary to complete the work under this Item will not be measured or paid for directly, but will be considered subsidiary to the various bid items of the contract.

ITEM 644

SMALL ROADSIDE SIGN ASSEMBLIES

644.1. Description. This Item shall govern for furnishing, fabricating and erecting small roadside sign assemblies of the various types as shown on the plans.

The sign assembly shall consist of the sign(s), sign support(s), foundation(s) and associated mounting hardware.

644.2. General. All materials and construction methods shall conform to the details shown on the plans and the pertinent requirements of the following Items:

644.3 to 646.2

Item 421, "Portland Cement Concrete"
Item 440, "Reinforcing Steel"
Item 634, "Plywood Signs (Type A)"
Item 636, "Aluminum Signs (Type A)"
Item 646, "Small Roadside Sign Supports"

Item 656, "Foundations for Signs, Traffic Signals and Roadway Illumination Assemblies"

644.3. Measurement. This Item will be measured as each small roadside sign assembly complete in place.

644.4. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Small Roadside Sign Assemblies" of the various types specified. This price shall be full compensation for furnishing, fabricating, galvanizing and erecting the supports; for constructing concrete foundations where required; for furnishing complete signs including sign connections and all hardware; for attaching the signs to the supports; for washing and cleaning the signs; and for all other materials, labor, tools, equipment and incidentals necessary to complete the work.

ITEM 646

SMALL ROADSIDE SIGN SUPPORTS

646.1. Description. This Item shall govern for furnishing, fabricating, and erecting steel supports used for small roadside sign supports of the various types and sizes as shown on the plans.

646.2. General. All materials and construction methods shall conform to the details shown on the plans, the requirements of this Item and the pertinent requirements of the following Items:

Item 441, "Steel Structures"
Item 442, "Metal for Structures"
Item 445, "Galvanizing"
Item 656, "Foundations for Signs, Traffic Signals and Roadway Illumination Assemblies"
Item 660, "Winged Channel Posts"

Material for perforated fuse plates shall be as shown on the plans and shall not have an ultimate tensile strength exceeding that shown on the plans.

All bolts, nuts, washers, lock washers, screws and other sign support hardware shall be galvanized steel, stainless steel or dichromate sealed aluminum, in conformance with Departmental Materials Specification D-9-7120. When dissimilar metals are used, the metals shall be so selected or insulated to prevent corrosion.

All materials furnished by the Contractor shall be new.

646.3. Fabrication. Fabrication and welding shall be in accordance with Item 441, "Steel Structures", the ANSI/AWS STRUCTURAL WELDING CODE D1.1, the details shown on the plans and the requirements of this Item.

Conformance to the plans and/or other approved drawings does not relieve the Contractor of the responsibility for providing proper fit of components.

The length of each post for each sign shall be verified by the Contractor before fabrication in order to meet actual field conditions and to provide the sign mounting heights shown on the plans. Any necessary field fabrication or adjustments shall be with the approval of the Engineer.

All fabricated parts shall be galvanized in accordance with Item 445, "Galvanizing". Any holes in steel parts or members that are permitted by the plans or by the Engineer shall be punched or drilled before the parts or members are galvanized. Any steel part or member on which galvanizing has been damaged in assembly, transit or erection and any steel part or member welded after galvanizing shall be repaired in accordance with Item 445, "Galvanizing".

646.4. Construction Methods. Sign supports shall be located as shown on the plans, except that the Engineer may shift the sign supports, within design guidelines, where necessary to secure a more desirable location or to avoid conflict with utilities. Unless otherwise shown on the plans, the Contractor shall stake and the Engineer will verify all sign support locations.

Stub posts shall be the type, spacing, orientation and projection shown on the plans, and shall be rigidly held in position during concrete placement.

Stub posts, in the case of driveable sign supports, shall project above finished grade as shown on the plans. In material other than rock, the posts shall be driven. A driving cap or other means that will prevent cross section dimension distortion, visible at a distance of 1.5 meters, shall be utilized in the driving of posts. Posts damaged during installation shall be removed and replaced by the Contractor at the Contractor's expense.

Construction near any underground or overhead utilities shall be accomplished using established industry and utility safety practices. The Contractor shall consult with the appropriate utility company prior to beginning such work.

Multisection sign supports consisting of stub posts, with triangular slip bases, pipe collar couplings or other splice arrangements and upper post sections may, at the Contractor's option, be cast in the concrete foundation as a unit. However, if installation is made with the upper post section attached, the support shall not be exposed to traffic until the sign panel is properly affixed.

The upper post sections shall be connected to the stub post sections by bolts or other connection devices as shown on the plans. Care shall be taken to ensure that one flat washer is positioned on top of the bolt keeper plates between the upper and lower slip base sections, and that a flat washer is positioned under the head and nut of each connection bolt. Connection bolts shall be torqued as shown on the plans.

All sign supports shall be plumb. Springing or raking of posts to secure proper alignment will not be permitted.

646.5. Measurement and Payment. The work performed, materials furnished and all labor, tools, equipment and incidentals necessary to complete the work under this Item will not be measured or paid for directly, but will be considered subsidiary to the various bid items of the contract.

ITEM 647

LARGE ROADSIDE SIGN SUPPORTS

647.1. Description. This Item shall govern for furnishing, fabricating, and erecting steel supports used for large roadside sign supports of the various types and sizes as shown on the plans.

647.2. General. All materials and construction methods shall conform to the details shown on the plans, the requirements of this Item and the pertinent requirements of the following Items:

Item 441, "Steel Structures"
Item 442, "Metal for Structures"
Item 445, "Galvanizing"
Item 656, "Foundations for Signs, Traffic Signals and Roadway Illumination Assemblies"

Material for perforated fuse plates shall be as shown on the plans and shall not have an ultimate tensile strength exceeding that shown on the plans.

All bolts, nuts, washers, lock washers, screws and other sign support hardware shall be galvanized steel, stainless steel or dichromate sealed aluminum, in conformance with Departmental Materials Specification D-9-7120. When dissimilar metals are used, the metals shall be so selected or insulated to prevent corrosion.

All materials furnished by the Contractor shall be new.

647.3. Fabrication. Fabrication and welding shall be in accordance with Item 441, "Steel Structures", the ANSI/AWS STRUCTURAL WELDING CODE D1.1, the details shown on the plans and the requirements of this Item.

Conformance to the plans and/or other approved drawings does not relieve the Contractor of the responsibility for providing proper fit of components.

The length of each post for each sign shall be verified by the Contractor before fabrication in order to meet actual field conditions and to provide the sign mounting heights shown on the plans. Any necessary field fabrication or adjustments shall be with the approval of the Engineer.

All fabricated parts shall be galvanized in accordance with Item 445, "Galvanizing". Any holes in steel parts or members that are permitted by the plans or by the Engineer shall be punched or drilled before the parts or members are galvanized. Any steel part or member on which galvanizing has been damaged in assembly, transit or erection and any steel part or member welded after galvanizing shall be repaired in accordance with Item 445, "Galvanizing".

647.4. Construction Methods. Sign supports shall be located as shown on the plans, except that the Engineer may shift the sign supports, within design guidelines, where necessary to secure a more desirable location or to avoid conflict with utilities. Unless otherwise shown on the plans, the Contractor shall stake and the Engineer will verify all sign support locations.

Stub posts shall be the type, spacing, orientation and projection shown on the plans, and shall be rigidly held in position during concrete placement.

Construction near any underground or overhead utilities shall be accomplished using established industry and utility safety practices. The Contractor shall consult with the appropriate utility company prior to beginning such work.

Multisection sign supports consisting of stub posts with slip bases, or other splice arrangements and upper post sections may, at the Contractor's option, be cast in the concrete foundation as a unit. However, if installation is made with the upper post section attached, the support shall not be exposed to traffic until the sign panel is properly affixed.

The upper post sections shall be connected to the stub post sections by bolts or other connection devices as shown on the plans. Care shall be taken to ensure that one flat washer is positioned on top of the bolt keeper plates between the upper and lower slip base sections, and that a flat washer is positioned under the head and nut of each connection bolt. Connection bolts shall be torqued as shown on the plans.

All sign supports shall be plumb. Springing or raking of posts to secure proper alignment will not be permitted.

647.5. Measurement. This Item will be measured by the kilogram of steel sign support.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

647.6. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Large Roadside Sign Supports" of the various types and sizes specified. This price shall be full compensation for furnishing, fabricating, galvanizing, and erecting the supports and stub posts; for furnishing fuse plate and slip base connections; and for all labor, tools, equipment and incidentals necessary to complete the work, except as shown below.

Foundations for large roadside sign supports will be paid for under Item 656, "Foundations for Signs, Traffic Signals and Roadway Illumination Assemblies".

ITEM 648

REPLACING OR REFURBISHING ROADSIDE SIGNS

648.1. Description. This Item shall govern for replacing or refurbishing existing small and/or large roadside signs on existing roadside sign supports as shown on the plans.

648.2. General. All materials and construction methods shall conform to the details shown on the plans, the requirements of this Item and the pertinent requirements of the following Items:

Item 634, "Plywood Signs (Type A)"
Item 636, "Aluminum Signs (Type A)"
Item 637, "Aluminum Signs (Type G)"
Item 643, "Sign Identification Decals"

Unless otherwise shown on the plans, the Contractor shall furnish all materials. All materials furnished by the Contractor shall be new.

648.3. **Construction Methods.**

(1) **Replacing.** The existing roadside signs shall be removed from the existing supports and shall be replaced with new roadside signs, including mounting hardware, as shown on the plans.

(2) **Refurbishing.** When shown on the plans, refurbishing shall include new messages, sign panels and mounting hardware. New sign panels, button copy, reflectorized legend and/or supplemental signs shall be installed as shown on the plans.

(3) **Handling and Storage.** Existing signs or portions of signs removed shall be handled and stored in such a manner that they are not damaged. Care shall be taken to prevent any damage to the various sign assembly components. Any portion of the sign designated for reuse or salvage, including messages, damaged by the Contractor shall be replaced by the Contractor at the Contractor's expense in accordance with the applicable specification.

Any sign components that are removed and are shown on the plans to be reused or salvaged shall become the property of the State and shall be stockpiled at a designated location within the limits of the project. All other parts shall become the property of the Contractor and shall be removed from the right-of-way to a site approved by the Engineer.

(4) **Cleaning.** After the sign has been replaced or refurbished, the entire sign shall be washed with a biodegradable cleaning solution acceptable to the sheeting and screen ink manufacturers to remove all dirt, grease, oil smears, streaks, finger marks and other foreign materials.

648.4. **Measurement.** This Item will be measured as each sign replaced or refurbished complete in place or by any other unit shown on the plans.

648.5. **Payment.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Replacing Large Roadside Signs", "Replacing Small Roadside Signs", "Refurbishing Large Roadside Signs" or "Refurbishing Small Roadside Signs".

The price bid for replacing signs shall be full compensation for furnishing and installing new signs; for removal of existing signs; for modifying existing sign messages (when shown on the plans); for preparing

and cleaning; for salvaging; and for all other materials, labor, tools, equipment and incidentals necessary to complete the work.

The price bid for refurbishing signs shall be full compensation for modifying existing sign messages; for removing and replacing existing route markers, button copy, reflectorized legend and/or supplemental signs attached to the parent sign (when shown on the plans); for preparing and cleaning; for salvaging; and for all other materials, labor, tools, equipment and incidentals necessary to complete the work.

ITEM 649

REMOVING OR RELOCATING ROADSIDE SIGN ASSEMBLIES

649.1. Description. This Item shall govern for removing or relocating existing small and/or large roadside sign assemblies as shown on the plans.

649.2. General. All materials and construction methods shall conform to the details shown on the plans, the requirements of this Item and the pertinent requirements of the following Items:

Item 445, "Galvanizing"
Item 634, "Plywood Signs (Type A)"
Item 636, "Aluminum Signs (Type A)"
Item 637, "Aluminum Signs (Type G)"
Item 643, "Sign Identification Decals"
Item 646, "Small Roadside Sign Supports"
Item 647, "Large Roadside Sign Supports"
Item 656, "Foundations for Signs, Traffic Signals and Roadway Illumination Assemblies"

Unless otherwise shown on the plans, the Contractor shall furnish all materials. All materials furnished by the Contractor shall be new.

649.3. Construction Methods.

(1) Removal. Unless otherwise shown on the plans, existing con- crete foundations that are to be abandoned shall be removed to 0.6 meter below finish grade. The remaining hole shall be backfilled with material equal in composition and density to the surrounding area, and by replacing any surfacing, such as asphalt pavement or concrete riprap, with like material to equivalent condition.

649.4 to 649.5

(2) Relocation. Relocation shall include new foundations. Unless otherwise shown on the plans, the existing supports shall be reused and shortened or lengthened as required. The Contractor shall furnish and install new breakaway stub posts for signs that are to be relocated. Damaged galvanizing shall be repaired in accordance with Item 445, "Galvanizing". The supports shall be erected on new breakaway stub posts and the signs attached to the supports. Existing foundations to be abandoned shall be removed in accordance with this Item.

(3) Handling and Storage. Existing signs and supports to be relocated or salvaged shall be handled and stored in such a manner that they are not damaged. Care shall be taken to prevent any damage to the various sign assembly components. Any portion of the sign assembly designated for relocation or salvage, including messages, damaged by the Contractor shall be replaced by the Contractor at the Contractor's expense in accordance with the applicable specification.

Any sign components that are removed and are shown on the plans to be reused or salvaged shall become the property of the State and shall be stockpiled at a designated location within the limits of the project. All other parts shall become the property of the Contractor and shall be removed from the right-of-way to a site approved by the Engineer.

(4) Cleaning. After the sign has been relocated, the entire sign shall be washed with a biodegradable cleaning solution acceptable to the sheeting and screen ink manufacturers to remove all dirt, grease, oil smears, streaks, finger marks and other foreign materials.

649.4. Measurement. This Item will be measured as each roadside sign assembly removed or relocated or by any other unit as shown on the plans, complete in place.

649.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Removing Large Roadside Sign Assemblies", "Removing Small Roadside Sign Assemblies", "Relocating Large Roadside Sign Assemblies" or "Relocating Small Roadside Sign Assemblies". This price shall be full compensation for furnishing and installing new breakaway stubs, new foundations, and/or new sign supports (when required); for new sign panels (when required), removing existing signs and related materials; for modifying existing sign supports; for preparing and cleaning; for salvaging; for hauling, excavating, backfilling

and surface placement; and for all other materials, labor, tools, equipment and incidentals necessary to complete the work.

ITEM 650

OVERHEAD SIGN SUPPORTS

650.1. Description. This Item shall govern for furnishing, fabricating and erecting overhead sign supports of the various types, spans and vertical clearances as shown on the plans.

650.2. General. Overhead sign supports shall include the following types or other types as shown on the plans.

(1) Balanced Tee

(2) Bridge

(3) Cantilever

(4) Combined Bridge and Cantilever

Span lengths will be described in one (1) meter increments but shall be constructed to the lengths shown on the plans.

All materials and construction methods shall conform to the requirements of this Item and the pertinent requirements of the following Items:

Item 416, "Drilled Shaft Foundations"
Item 420, "Concrete Structures"
Item 441, "Steel Structures"
Item 442, "Metal for Structures"
Item 445, "Galvanizing"
Item 449, "Anchor Bolts"
Item 618, "Conduit"
Item 652, "Highway Sign Lighting Fixtures"
Item 654, "Sign Walkways"

650.3. Materials. All materials furnished by the Contractor shall be new.

Anchor bolts shall be alloy steel or medium-strength, mild steel as described in Item 449, "Anchor Bolts".

All brackets, clamps, bolts and other hardware used in fastening signs to overhead sign supports shall be galvanized steel, noncorroding stainless steel or dichromate sealed aluminum in accordance with Departmental Materials Specification D-9-7120. When dissimilar metals are used, the metals shall be so selected or insulated to prevent corrosion.

650.4. Fabrication. Shop drawings for overhead sign supports shall be in accordance with Item 441, "Steel Structures". Shop drawings shall include anchor bolts, sign sizes and positions, and when required, walkways and sign lights. Unless otherwise shown on the plans, shop drawings shall be submitted to the Director of Design, Texas Department of Transportation, 125 East 11th Street, Austin, Texas 78701-2483.

Drawings for only one (1) support need be submitted for two (2) or more supports of identical design and dimensions.

Fabrication and welding shall be in accordance with Item 441, "Steel Structures", the ANSI/AWS STRUCTURAL WELDING CODE D1.1, and the requirements of this Item.

Unless otherwise shown on the plans, fixture mounting channels shall be included for the installation of sign lighting fixtures.

Conformance with the plans and/or other approved drawings does not relieve the Contractor of the responsibility for providing proper fit of components.

All fabricated parts shall be galvanized in accordance with Item 445, "Galvanizing". Any holes in steel parts or members that are permitted by the plans or by the Engineer shall be punched or drilled before the parts or members are galvanized. Any steel part or member on which galvanizing has been damaged in assembly, transit or erection and any steel part or member welded after galvanizing shall be repaired in accordance with Item 445, "Galvanizing".

650.5. Construction Methods. Overhead sign support structures shall be located as shown on the plans, except that the Engineer may shift a sign support, within design guidelines, where necessary to secure a more desirable location or to avoid conflict with utilities. Unless otherwise shown on the plans, the Contractor shall stake and the Engineer will verify all overhead sign support locations.

Erection of overhead sign supports near any overhead or underground utilities shall be accomplished using established industry and utility safety practices. The Contractor shall consult with the appropriate utility company prior to beginning such work.

Concrete overhead sign support columns and/or spans shall be constructed as shown on the plans and in accordance with Item 420, "Concrete Structures" except for measurement and payment.

Foundations for overhead sign supports shall be constructed in accordance with Item 416, "Drilled Shaft Foundations", and the details shown on the plans. Anchor bolts shall be oriented as shown on the plans. The anchor bolt and template assembly shall be rigidly held in position during concrete placement. The top template may be removed after the concrete has achieved initial set.

Conduit shall be held in place with suitable bracing attached to the upper template and shall be capped prior to placing concrete. Conduit shall be reamed to remove burrs and sharp edges. Bell ends or bushings shall be installed on the conduit.

Threads of anchor bolts shall be coated with pipe joint compound prior to installation of nuts when erecting the overhead sign support.

Lower anchor bolt nuts shall be retightened against the base plate after the upper nuts are tight. A slug wrench and sledge is recommended for tightening nuts.

Springing or raking of columns, towers or anchor bolts will not be permitted.

After the overhead sign support has been plumbed and all nuts are tight, each anchor bolt nut shall be tack welded in two (2) places to its washer and each washer shall be tack welded to the base plate in two (2)

places. No welding is to be made to the bolt. Galvanizing in tack weld areas shall be repaired in accordance with Item 445, "Galvanizing". The exposed upper threads of the anchor bolts shall be cleaned of pipe joint compound and coated with zinc-rich paint to seal the bolt thread-nut joint.

No grout shall be placed between the base plate and the foundation.

650.6. Measurement. This Item will be measured as each overhead sign support complete in place.

650.7. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Overhead Sign Supports" of the various types and described span lengths specified. The described span lengths shall be the design span lengths shown on the plans rounded up to the next one (1) meter increment. This price shall be full compensation for furnishing, fabricating, galvanizing, assembling and erecting the overhead sign supports; for furnishing and placing anchor bolts, nuts, washers and templates; for concrete, reinforcing steel and construction of concrete columns and/or spans when required; for furnishing and placing conduit, ground rods and wiring as shown on the plans; and for all other materials, labor, tools, equipment and incidentals necessary to complete the work, except as shown below.

Drilled shaft foundations will be paid for under Item 416, "Drilled Shaft Foundations".

Sign walkways will be paid for under Item 654, "Sign Walkways".

Sign lights will be paid for under Item 652, "Highway Sign Lighting Fixtures".

ITEM 651

REMOVING OVERHEAD SIGN SUPPORTS

651.1. Description. This Item shall govern for removing overhead sign supports as shown on the plans.

651.2. Construction Methods. Prior to removal of the structure, any existing electrical power supply shall be disconnected and isolated.

The existing sign panels, walkways, lighting fixtures, lighting brackets, ballast boxes, and other accessories shall be removed from the existing overhead sign supports. Accessories which are to be reused or salvaged shall be stored in a manner which will prevent damage. Sign panels shall be stored off the ground in a vertical position. Any component lost or damaged due to the Contractor's operations shall be replaced by the Contractor at the Contractor's expense. The existing overhead sign support, if designated for reuse or salvage, shall be removed and stored in a manner which will prevent damage.

Unless otherwise shown on the plans, existing concrete foundations that are to be abandoned shall be removed to 0.5 meter below finish grade. The remaining hole shall be backfilled with material equal in composition and density to the surrounding area, and by replacing any surfacing, such as asphalt pavement or concrete riprap, with like material to equivalent condition.

All materials removed under this Item and not designated for reuse or retention by the State shall become the property of the Contractor and shall be removed from the right-of-way to a site approved by the Engineer.

651.3. Measurement. This Item will be measured as each sign support removed.

651.4. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Removing Overhead Sign Supports". This price shall be full compensation for removing the various overhead sign support components; for storing the components to be reused or salvaged; for backfilling and surface placement; and for furnishing all other materials, tools, equipment, labor and incidentals necessary to complete the work.

ITEM 652

HIGHWAY SIGN LIGHTING FIXTURES

652.1. Description. This Item shall govern for furnishing and installing highway sign lighting fixtures of the types shown on the plans.

652.2. Materials. All materials furnished by the Contractor under this Item shall be new and shall be in accordance with the details shown on the plans. Unless otherwise shown on the plans, the Contractor shall furnish to the Engineer six (6) sets of shop drawings or brochures of the fixtures.

652.3. Sampling. Sampling shall be in accordance with Test Method Tex-714-I.

Installed lighting fixtures shall be tested in accordance with Item 616, "Performance Testing of Lighting Systems".

652.4. Construction Methods. The lighting fixtures and associated components shall be installed in accordance with the details shown on the plans.

652.5. Measurement. This Item will be measured as each highway sign lighting fixture complete in place.

652.6. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Highway Sign Lighting Fixtures" of the various types specified. This price shall be full compensation for furnishing, installing and testing all fixtures complete with lamps, ballasts and ballast boxes; for all conduit and conductors between the fixtures and from the fixtures to the base of the tower or post supporting the sign structure; for safety switches, fixture mounting bolts, hardware and internal connections; and for furnishing all other materials, labor, tools, equipment and incidentals necessary to complete the work.

ITEM 654

SIGN WALKWAYS

654.1. Description. This Item shall govern for fabricating, furnishing and erecting sign walkways of the widths, lengths and types as shown on the plans.

654.2. General. Unless otherwise shown on the plans, sign walkways shall have handrails. Walkways with handrails are designated as

Type 1. Walkways without handrails are designated as Type 2. The width of walkway shall be as shown on the plans.

All materials and construction methods shall conform to the requirements of this Item and the pertinent requirements of the following Items:

Item 441, "Steel Structures"
Item 445, "Galvanizing"
Item 650, "Overhead Sign Supports"

654.3. Standard Designs. Sign walkways shall be of the design and type shown on the plans. Shop drawings in accordance with Item 441, "Steel Structures", will be required. Shop drawings for the sign walkways shall be submitted with the shop drawings for overhead sign supports. Shop drawings for walkways shall be submitted separately if walkways are to be placed on existing overhead sign supports. Unless otherwise shown on the plans, shop drawings shall be submitted to the Director of Design, Texas Department of Transportation, 125 East 11th Street, Austin, Texas 78701-2483.

Drawings for only one (1) sign walkway need be submitted for two (2) or more walkways of identical design, type and dimensions.

654.4. Fabrication. Fabrication and welding shall be in accordance with Item 441, "Steel Structures", the ANSI/AWS STRUCTURAL WELDING CODE D1.1 and the requirements of this Item.

Conformance to the plans and/or other approved drawings does not relieve the Contractor of the responsibility for providing proper fit of components.

All fabricated parts shall be galvanized in accordance with Item 445, "Galvanizing". Any holes in steel parts or members that are permitted by the plans or by the Engineer shall be punched or drilled before the parts or members are galvanized. Any steel part or member on which galvanizing has been damaged in assembly, transit or erection, and any steel part or member welded after galvanizing shall be repaired in accordance with Item 445, "Galvanizing".

654.5. Construction Methods. Each sign walkway shall be de- livered as a complete unit or with sub-assemblies marked for field assembly. All fittings and hardware shall either be installed or packaged in such a manner that all parts remain with their associated major components during shipment. The sign walkway shall be erected in accordance with the details shown on the plans.

654.6. Measurement. This Item will be measured by the meter of sign walkway.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

654.7. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Sign Walkways" of the types and widths specified. This price shall be full compensation for furnishing, fabricating, galvanizing, assembling and erecting the sign walkways; for furnishing and placing required handrails including connections, latches, plates, bolts, nuts and washers; and for furnishing all other materials, labor, tools, equipment and incidentals necessary to complete the work.

ITEM 656

FOUNDATIONS FOR SIGNS, TRAFFIC SIGNALS AND ROADWAY ILLUMINATION ASSEMBLIES

656.1. Description. This Item shall govern for constructing con- crete foundations for signs, traffic signals, traffic signal controllers, roadway illumination assemblies and other concrete foundations of the types and sizes as shown on the plans.

656.2. General. All materials and construction methods shall conform to the requirements of this Item and the pertinent requirements of the following Items:

Item 400, "Excavation and Backfill for Structures"
Item 416, "Drilled Shaft Foundations"

Item 420, "Concrete Structures"
Item 421, "Portland Cement Concrete"
Item 440, "Reinforcing Steel"
Item 449, "Anchor Bolts"
Item 618, "Conduit"

656.3. Materials. Concrete for foundations shall be Class A or C with the exception that Class B may be used for small roadside sign supports, traffic signal pedestal poles or traffic signal controller foundations.

Unless otherwise shown on the plans, strength of concrete shall be controlled by the flexural strength of test beams.

Reinforcing steel, when required, shall conform to the sizes and dimensions shown on the plans.

656.4. Construction Methods. Foundations shall be located as shown on the plans, except that the Engineer may shift, within design guidelines, a foundation where necessary to secure a more desirable location or to avoid conflict with utilities. Unless otherwise shown on the plans, the Contractor shall stake and the Engineer will verify all foundation locations.

Construction near any underground or overhead utilities shall be accomplished using established industry and utility safety practices. The Contractor shall consult with the appropriate utility company prior to beginning such work.

Anchor bolts shall be held in place with templates during concrete placement. Any posts, conduit or other hardware to be embedded in the foundation shall be held in place during concrete placement by templates or other suitable means approved by the Engineer. Conduit, when used, shall be capped prior to placing concrete. Conduit shall be reamed to remove burrs and sharp edges. Bell ends or bushings shall be installed on the conduit.

Top templates may be removed after the concrete has achieved initial set. Forms and other bracing, when used, shall not be removed until the concrete has cured a minimum of one curing day unless Type III cement is used in which case the concrete must cure a minimum of one-half curing day.

All parts of the concrete foundations extending above the natural or finished ground line shall be given an ordinary surface finish in accordance with Item 420, "Concrete Structures".

Unless otherwise permitted in writing by the Engineer, no structure or post shall be erected on a concrete foundation nor shall any sign be attached to a sign post embedded in concrete until the concrete has cured at least seven curing days.

Springing or raking of posts or anchor bolts to secure proper alignment will not be permitted.

All backfilling shall be completed prior to the erection of any structure on the foundation.

Where existing surfacing is removed for placing foundations, repair shall be made by backfilling with material equal in composition and density to the surrounding area and by replacing any removed surfacing, such as asphalt pavement or concrete riprap, with like material to equivalent condition.

656.5. Measurement. This Item will be measured by the meter when constructed as a drilled shaft, or by the cubic meter for other types of foundations.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

656.6. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Foundations for Large Roadside Sign Supports", "Foundations for Traffic Signals" and "Foundations for Roadway Illumination Assemblies" of the various types and sizes specified. This price shall be full compensation for excavation; for furnishing, placing, finishing and curing all concrete; for furnishing and placing reinforcing steel when required; for furnishing and placing conduit and ground rods as shown on the plans; for placing anchor bolts when required; for backfilling and replacing removed surfacing; and for all other materials, labor, tools,

equipment or incidentals necessary to complete the work, except as shown below.

Anchor bolts will not be measured or paid for directly, but will be considered subsidiary to the various bid items of the contract.

Foundations for small roadside signs will be paid for under Item 644, "Small Roadside Sign Assemblies".

ITEM 658

DELINEATOR AND OBJECT MARKER ASSEMBLIES

658.1. Description. This Item shall govern for furnishing and mounting delineator and object marker assemblies of the types and colors shown on the plans. An assembly consists of the reflector unit(s) and post or mounting bracket when required.

658.2. Materials. Delineator and object marker reflector units and/or reflectorized panels shall conform to the requirements of Departmental Materials Specification D-9-8600. Winged channel posts shall conform to the materials requirements of Item 660, "Winged Channel Posts". Flexible posts shall conform to the requirements of Departmental Materials Specification D-9-4400.

(1) Delineators and Object Markers. Delineators and object markers shall consist of reflector units or reflectorized panels of the color specified for the various types as shown on the plans.

(2) Reflector Units. All reflector units of the same type shall be of the same manufacture.

(a) Type A reflector units shall be reflective sheeting applied to a substrate.

(b) Type B reflector units shall be center-mounted acrylic-plastic.

(c) Type C reflector units shall consist of a reflector unit(s) attached to a bracket to facilitate the mounting of the delineator on concrete traffic barriers, railing or other locations as shown on the plans.

658.3. Sampling. Sampling will be in accordance with Test Methods Tex-725-I or Tex-737-I.

658.4. Construction Methods. Delineators and object marker assemblies shall be installed as shown on the plans or as directed by the Engineer.

Winged channel posts and flexible delineator posts shall be installed such that the reflector units and/or reflectorized panels will be at the height shown on the plans. Posts shall be true to line and shall be vertical.

The posts shall be driven in material other than rock. A driving cap that will prevent visible cross-section dimension distortion shall be used in the driving of posts. Posts damaged due to the Contractor's operations shall be removed and replaced by the Contractor at the Contractor's expense.

When rock is encountered at a depth less than the minimum embedment depth shown on the plans, a pilot hole shall be drilled and the post driven to the required embedment depth. The hole shall be backfilled, as necessary, with suitable material.

Reflector units for flexible post assemblies shall be installed on the post after erection.

Posts on which galvanizing has been damaged shall be repaired in accordance with Item 445, "Galvanizing".

Surface-mount flexible post assemblies shall be installed in accordance with the manufacturer's recommendations.

658.5. Measurement. This Item will be measured as each delineator or object marker assembly.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

658.6. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Delineator Assemblies" and "Object Marker Assemblies" of the various types and colors specified. This price shall be full compensation for furnishing, fabricating and mounting the delineator or object marker assemblies as shown on the plans including posts, adhesive or pads for surface mount assemblies, back plates, reflector units, fastening plates, brackets, bolts, nuts and washers; and for furnishing all labor, tools, equipment and incidentals necessary to complete the work.

ITEM 659

REMOVING DELINEATOR AND OBJECT MARKER ASSEMBLIES

659.1. Description. This Item shall govern for removing existing delineator and object marker assemblies as shown on the plans or as directed by the Engineer. Assemblies shall be considered as a post or mounting bracket, reflector unit(s) and attachment hardware.

659.2. Construction Methods. When shown on the plans, existing posts which are deemed by the Engineer to be salvageable shall be removed in such a manner that they will not be damaged and shall be stockpiled at a designated location within the project limits. Existing reflector units and attachment hardware considered salvageable need not be removed from the post by the Contractor. When approved by the Engineer, unsalvageable posts may be broken 150 millimeters below the finish grade.

Salvageable assemblies removed shall remain the property of the State. Nonsalvageable assemblies shall become the property of the Contractor and shall be removed from the right-of-way to a site approved by the Engineer.

659.3. Measurement. This Item will be measured by each delineator and object marker assembly removed.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

659.4. Payment. The work performed in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Removing Delineator and Object Marker Assemblies". This price shall be full compensation for all tools, equipment, labor and incidentals necessary to complete the work.

ITEM 660

WINGED CHANNEL POSTS

660.1. Description. This Item shall govern for furnishing and installing winged channel posts used for mounting delineators, object markers or milepost markers as shown on the plans.

660.2. Materials. The Contractor shall supply the Engineer with a mill test report which certifies that the base metal is in accordance with ASTM A 570, Grade 345 or ASTM A 499. Galvanizing shall be in accordance with Item 445, "Galvanizing". The post dimensions shall be as shown on the plans.

660.3. Construction Methods. Winged channel posts shall be installed such that the attached delineators, object, or milepost markers will be at the height shown on the plans. Posts shall be true to line and shall be vertical.

The posts shall be driven in material other than rock. A driving cap that will prevent visible cross-section dimension distortion shall be used in the driving of posts. Posts damaged, except for galvanizing damage, due to the Contractor's operations shall be removed and replaced by the Contractor at the Contractor's expense.

When rock is encountered at a depth less than the minimum embedment depth shown on the plans, a pilot hole shall be drilled and the post driven to the required embedment depth. The hole shall be backfilled, as necessary, with suitable material.

Posts on which galvanizing has been damaged shall be repaired in accordance with Item 445, "Galvanizing".

660.4. Measurement. This Item will be measured as each winged channel post.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

660.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Winged Channel Posts" of the various lengths and mass (kg/m) specified. This price shall be full compensation for furnishing all materials, labor, tools, equipment and incidentals necessary to provide the posts in place ready for the attachment of delineators, object markers or milepost markers.

ITEM 662

WORK ZONE PAVEMENT MARKINGS

662.1. Description. This Item shall govern for the placement and maintenance of work zone pavement markings, of the colors, types and sizes as shown on the plans.

662.2. General. Work zone pavement markings shall consist of guidemarks, short term markings and/or standard pavement markings. All roadways to be opened to traffic shall be marked with short term markings or standard markings, as shown on the plans, at the end of each day's operation.

When inclement weather prohibits the application of short term markings or standard markings as called for on the plans, upon approval by the Engineer, guidemarks may be considered as temporary short term markings for asphaltic surfaces. The placement of pavement markings as shown on the plans may be delayed until such time that weather permits application of pavement markings.

662.3. Materials. All non-removable markings shall be thermoplastic unless otherwise shown on the plans. Thermoplastic markings shall have a thickness of 1.5 millimeters unless otherwise shown on the plans. All non-removable work zone markings shall conform to the requirements of Item 666, "Reflectorized Pavement Markings", except for performance period, measurement and payment.

Unless otherwise shown on the plans, materials used for work zone pavement markings shall be thermoplastic, paint and beads, raised pavement markers, prefabricated pavement marking material, temporary flexible-reflective roadway marker tabs or other materials approved by the Engineer.

Thermoplastic or paint and beads shall not be used for removable markings.

Unless otherwise shown on the plans, temporary flexible-reflective roadway marker tabs shall be used as short term work zone pavement markings for surface treatments.

Unless otherwise shown on the plans, the Contractor shall have the option to use raised pavement markers to simulate standard markings in accordance with the plans. Longitudinal lines wider than 100 millimeters may be simulated by the side-by-side placement of markers to increase the apparent line width in multiples of 100 millimeters.

Unless otherwise shown on the plans, removable work zone pavement markings on final pavement surfaces shall be removable tape conforming to Departmental Materials Specification D-9-8241. When raised reflective pavement markers are required by the plans to supplement the removable pavement markings, a marker shall be applied to the top of the tape at the approximate mid-length of tape used for broken lines and at approximately six (6) meter spacings for solid lines.

Unless otherwise shown on the plans, raised pavement markers will not be allowed for words, symbols, and shapes, diagonal or transverse lines.

Unless otherwise shown on the plans, paint shall be water-based and shall be purchased on the open market. Paint shall conform to Departmental Materials Specification D-9-8200, WPT-10 or YPT-10. Beads shall be purchased on the open market and shall conform to Departmental Materials Specification D-9-8290. Thermoplastic type materials shall conform to Departmental Materials Specification D-9-8220.

When the plans call for paint to be purchased from the Department, the Contractor shall order materials to be purchased from the Department through the Engineer a minimum of 15 days before materials are needed. Not later than 10 days after completion of all material application required by the contract, the Contractor shall return all remaining undamaged and unopened containers of Department supplied materials to the District

662.4 to 662.6

warehouse and credit will be given for the original cost of the materials. The Contractor shall not use any materials purchased from the Department on any work other than Department projects.

662.4. Performance Requirements. Markings in construction areas shall remain in proper alignment and shall be distinctly visible when dry from a minimum distance of 100 meters in daylight conditions and from a minimum of 50 meters when illuminated by automobile low-beam headlights at night. Visibility distances will be determined when viewed from an automobile traveling on the roadway.

The daytime color as well as the nighttime reflected color of the markings shall be distinctly white or yellow as shown on the plans. The markings shall exhibit uniform retroreflective characteristics.

662.5. Maintenance of Markings. The Contractor shall be responsible for maintaining all work zone pavement markings for 30 calendar days after installation. Pavement markings that fail to meet the requirements of this specification for 30 calendar days from the date of installation shall be removed and replaced by the Contractor at the Contractor's expense. The 30 calendar day maintenance requirement will be required for replaced markings from the time the original markings were installed.

662.6. Construction Methods.

(1) Placement and Maintenance. The Contractor shall exercise diligence in the selection of materials and placement of work zone pavement markings. Work zone pavement markings shall be maintained, in accordance with this Item, by the Contractor and at the expense of the Contractor to the satisfaction of the Engineer.

Unless otherwise approved in writing by the Engineer, all concrete surfaces shall have standard markings in place prior to opening to traffic.

All asphaltic surfaces which are to be opened to traffic shall be marked with guidemarks immediately following placement and final rolling of any course. Guidemarks shall consist of a single temporary flexible-reflective roadway marker tab or a single temporary construction raised reflective pavement marker at 12 meter spacings.

Guidemarks shall be placed in proper alignment with the final location of future standard markings. Any guidemarks not in alignment

with standard markings shall be removed by the Contractor at the Contractor's

expense.

Standard pavement markings shall be installed in accordance with the TMUTCD and as shown on the plans.

Surfaces to receive surface treatments shall be marked in accordance with the plans. Unless otherwise shown on the plans, standard pavement markings in accordance with the TMUTCD shall be placed no sooner than three (3) days nor later than two (2) weeks after the placement of the surface treatment.

When short term markings are required by the plans, short term markings shall conform with the TMUTCD and details as shown on the plans. Unless otherwise shown on the plans, short term markings shall be removed immediately prior to placement of final pavement markings.

(2) Marking Removal. Work zone pavement markings placed by the Contractor that conflict with any succeeding work zone markings shall be removed by the Contractor at the Contractor's expense in accordance with Item 677, "Eliminating Existing Pavement Markings and Markers", except for measurement and payment.

Removable marking materials, when removed, shall leave minimal evidence of the marking having been in place.

662.7. Measurement. This Item will be measured by the meter of standard marking or short term marking, by each guidemark, by each word, shape or symbol, by each temporary flexible-reflective roadway marker tab on surface treatments or by any other unit as shown on the plans. Raised pavement markers used to simulate a stripe will be measured by the meter of simulated stripe or each raised pavement marker as shown on the plans. Where double stripes are placed, each stripe will be measured separately.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

662.8. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Work Zone Pavement Markings **666.1 to 666.2**

(Removable)", "Work Zone Pavement Markings (Non-removable)", "Work Zone Pavement Markings (Short Term)" and "Work Zone Pavement Markings

(Guidemark)" of the width, color and type shown on the plans. This price shall be full compensation for furnishing all materials, labor, tools, equipment and incidentals necessary to place, maintain and remove, when required, the markings, except as shown below.

Removal of existing markings will be paid for under Item 677, "Eliminating Existing Pavement Markings and Markers".

Final work zone pavement markings (paint and beads) which will be used within 30 calendar days after application as a sealer for Type I pavement markings will not be paid for under this Item, but will be paid for under Item 666, "Reflectorized Pavement Markings".

ITEM 666

REFLECTORIZED PAVEMENT MARKINGS

666.1. Description. This Item shall govern for furnishing and placing reflectorized pavement markings of the types, colors, shapes, sizes, widths, and thickness shown on the plans.

666.2. Materials.

(1) Type I Marking Materials. Type I markings are thermoplastic type materials that require heating to elevated temperatures for application. Type I marking materials shall conform to Departmental Materials Specification D-9-8220. Each container of Type I marking material shall be clearly marked to indicate the color, mass, type of material, manufacturer's name and the lot/batch number.

(2) Type II Marking Materials. Type II markings are paint-type materials that are applied at ambient or slightly elevated temperatures. Type II marking materials shall conform to Departmental Materials Specifications D-9-8200, YPT-10 and/or WPT-10 and D-9-8290.

(3) Source of Supply. All Type I marking materials shall be purchased on the open market.

All glass traffic beads shall be purchased on the open market.

All Type II marking material paints shall be purchased from the Department. The Contractor shall give the Engineer a minimum of 30 days notice as to where exact quantities of paint will be needed and the required dates, except for quantities of paint of 400 liters or less. This notification shall be accomplished on a standard Department form supplied by the Engineer. The paint shall be picked up by the Contractor at the location specified on the plans.

All materials purchased from the Department will be charged to the Contractor at prices shown on the plans. Reimbursement to the State will be accomplished by making deductions from the Contractor's monthly and/or final estimate for the cost of materials purchased.

Not later than 10 days after completion of all material application required by the contract, the Contractor shall return all remaining undamaged and unopened containers of Type II marking paint to the District warehouse and credit will be given for the original cost of the paint. The Contractor shall not use any materials purchased from the Department on any work other than Department projects.

666.3. Equipment Requirements. Equipment used to place pavement markings shall:

(1) Be maintained in satisfactory operating condition.

(2) Be considered in satisfactory operating condition if it has an average placement rate of 1500 meters per hour of acceptable 100-millimeter solid or broken lines over any five (5) consecutive working days.

(3) Meet or exceed the material handling at elevated temperatures requirements of the National Fire Underwriters and the Texas Railroad Commission.

(4) Be capable of placing a minimum of 12,000 meters of 100-millimeter solid or broken markings per working day.

(5) Have production capabilities similar to 100-millimeter marking equipment and shall be capable of placing linear markings up to 200 millimeters in width in a single pass when used for placing markings in widths other than 100 millimeters.

(6) Have production capabilities considered satisfactory by the Engineer when used to place markings other than solid or broken lines.

(7) Be capable of placing a center-line and no-passing barrier-line configuration consisting of one (1) broken line with two (2) solid lines at the same time to the alignment and spacing shown on the plans.

(8) Be capable of placing broken and/or continuous white line from both sides.

(9) Be capable of placing lines with clean edges and of uniform cross-section. All lines shall have a tolerance of plus or minus three (3) millimeters per 100 millimeters width.

(10) Have an automatic cut-off device with manual operating capabilities to provide clean, reasonably square marking ends to the satisfaction of the Engineer, and to provide a method of applying broken line in an approximate stripe-to-gap ratio of 1 to 3. The length of the stripe shall not be less than three (3) meters or more than 3.2 meters. The total length of any stripe-gap cycle shall not be less than 11.8 meters or more than 12.2 meters.

(11) Provide continuous mixing and agitation of the pavement marking material. The use of pans, aprons or similar appliances which the die overruns will not be permitted for longitudinal striping applications.

(12) Apply beads by an automatic bead dispenser attached to the pavement marking equipment in such a manner that the beads are dispensed uniformly and almost instantly upon the marking as the marking is being applied to the road surface. The bead dispenser shall have an automatic cut-off control, synchronized with the cut-off of the pavement marking equipment.

When Type I markings are to be placed, the Contractor shall have a hand-held thermometer on the project. The thermometer shall be capable of measuring the temperature of the pavement marking material to be placed.

666.4. Construction Methods.

(1) General. When required by the Engineer, the Contractor and the Engineer shall review the sequence of work to be followed and the estimated progress schedule.

Markings may be placed on roadways either free of traffic or open to

traffic. On roadways already open to traffic, the markings shall be placed under traffic conditions that exist with a minimum of interference to the operation of the facility. Traffic control shall be as shown on the plans or as approved by the Engineer in writing. All markings placed under open-traffic conditions shall be protected from traffic damage and disfigurement. On roadways open to traffic, with three (3) lanes of travel in one direction, all markings shall be placed from the outside lanes only, unless otherwise approved in writing by the Engineer.

Guides to mark the lateral location of pavement markings shall be established as shown on the plans or as directed by the Engineer. The Contractor shall establish the pavement marking guides and the Engineer will verify the location of the guides.

Markings shall be placed in proper alignment with the guides. The deviation rate in alignment shall not exceed 25 millimeters per 60 meters of roadway. The maximum deviation shall not exceed 50 millimeters nor shall any deviation be abrupt.

Markings shall essentially have a uniform cross-section. The density and quality of markings shall be uniform throughout their thickness. The applied markings shall have no more than five (5) percent, by area, of holes or voids and shall be free of blisters.

Markings, in place on the roadway, shall be reflectorized both internally and externally. Glass beads shall be applied to the materials at a uniform rate sufficient to achieve uniform and distinctive retroreflective characteristics when observed in accordance with Test Method Tex-828-B.

The Contractor's personnel shall be sufficiently skilled in the work of installing pavement markings.

Markings placed that are not in alignment or sequence, as shown on the plans or as stated in this specification, shall be removed by the Contractor at the Contractor's expense. Removal shall be in accordance with Item 677, "Eliminating Existing Pavement Markings and Markers", except for measurement and payment. Guides placed on the roadway for alignment purposes shall not establish a permanent marking on the roadway.

Unless otherwise shown on the plans, pavement markings may be applied by any method that will yield markings meeting the requirements of this specification.

666.4

(2) Surface Preparation. New portland-cement-concrete surfaces shall be cleaned in accordance with Item 678, "Pavement Surface Preparation for Markings" to remove curing membrane, dirt, grease, loose and/or flaking existing

construction markings and other forms of contamination.

Older portland-cement-concrete surfaces and asphaltic surfaces that exhibit loose and/or flaking existing markings shall be cleaned in accordance with Item 678, "Pavement Surface Preparation for Markings", to remove all loose and flaking markings.

Pavement to which material is to be applied shall be completely dry. Pavements shall be considered dry if, on a sunny day after observation for 15 minutes, no condensation occurs on the underside of a 0.3 meter square piece of clear plastic that has been placed on the pavement and weighted on the edges.

(3) Application of Type I Markings. New portland-cement- concrete surfaces shall be further prepared for Type I markings, after cleaning, by placing a Type II marking as a sealer in accordance with this Item. When placing Type I markings in new locations on asphaltic surfaces three (3) years old or older or any portland-cement-concrete surfaces, a Type II marking shall be used as a sealer. Unless otherwise shown on the plans, existing portland-cement-concrete and asphaltic surfaces to be restriped will not require Type II markings as a sealer; existing markings may be used as a sealer in lieu of Type II markings. Type II markings shall be placed a minimum of two (2) and a maximum of 30 calendar days in advance of placing Type I markings. Type II markings which become dirty due to inclement weather or road conditions shall be cleaned by washing, brushing, compressed air or other means approved by the Engineer, prior to application of Type I markings. If washing is used, the surface of Type II markings shall become thoroughly dry before placing Type I markings. Color, location and configuration of Type II markings shall be the same as that of Type I markings.

Type I pavement marking material shall be applied within temperature limits recommended by the material manufacturer. Application of Type I pavement markings shall be done only on clean, dry pavement having a surface temperature above 10 °C. Pavement temperature shall be measured in accordance with Test Method Tex-829-B.

When Type I pavement marking application is by spray, and operations cease for five (5) minutes or more, the spray head shall be flushed by spraying pavement marking material into a pan or similar container until the pavement marking material being sprayed is at the proper temperature for application.

Unless otherwise directed by the Engineer in writing, Type I pavement marking materials shall not be placed on roadways between September 30 and March 1, subject to temperature and moisture limitations specified herein.

Unless otherwise shown on the plans, Type I marking minimum thickness shall be 1.5 millimeters for edgeline markings and 2.3 millimeters for stop-bars, legends, symbols, gore and center-line/no-passing barrier-line markings, when measured in accordance with Test Method Tex-854-B. The maximum thickness of all Type I markings shall be 4.5 millimeters.

The thickness of Type I markings at the time of placement will be measured above the plane formed by the pavement surface. The Engineer will supply a device to measure the thickness of the applied markings. The markings shall be of uniform thickness throughout their lengths and widths.

(4) Application of Type II Markings. The application of Type II marking materials shall be done only on surfaces with a minimum surface temperature of 10 °C.

The application rate for Type II marking material shall be: between 35 and 45 liters per kilometer of solid 100 millimeter line and between 70 and 90 liters per kilometer for solid 200 millimeter line except that, for new surface treatment projects the application rate shall be between 55 and 70 liters per kilometer of solid 100 millimeter line and between 90 and 110 liters per kilometer for solid 200 millimeter line.

Pavement markings for new surface treatment projects shall be applied in two (2) applications each approximately one-half the application rate. The first application shall not contain glass beads. The interval between the first and second applications shall be a minimum of one (1) hour.

When, in the case of impending inclement weather, and the Engineer directs the Contractor to apply water-based traffic paint, the markings are damaged by subsequent rain, sleet, hail, etc., the Contractor will be paid for the initial placement and the replacement markings. However, if the Contractor places the markings at his option, the Contractor is responsible for all costs associated with the replacement markings.

666.5. Performance Period for Type I Markings. Type I pavement markings shall meet all requirements of this specification for a minimum of 15 calendar days after installation. Pavement markings that fail to meet all requirements of this specification shall be removed and replaced by the Contractor at the Contractor's expense. The Contractor shall replace all pavement markings failing the requirements of this specification within 30 calendar days following notification by the Engineer of such failing. All replacement markings shall also meet all requirements of this specification for a minimum of 15 calendar days after installation.

666.6. Measurement. This Item will be measured by the meter, by each of the various words, symbols or shapes, or by any other unit as shown on the plans.

Where double stripes are placed, each stripe will be measured separately.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

Type II pavement markings requiring two (2) applications on new surface treatments will be measured as one (1) marking.

Type II pavement marking materials, when used as a sealer for Type I markings will be measured as Type II markings.

666.7. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Reflectorized Pavement Markings" of the various types, colors, shapes, sizes, widths, and thickness (Type I

markings only) specified. This price shall be full compensation for furnishing all materials; for application of pavement markings; and for all other labor, tools, equipment and incidentals necessary to complete the work, except as shown below.

Surface Preparation, when shown on the plans, will be paid for under Item 678, "Pavement Surface Preparation for Markings".

Final work zone pavement markings (paint and beads) which will be used as a sealer for Type I pavement markings will be paid for under this Item.

When replacement Type II markings are required due to damage to the original markings from rain, sleet, hail, etc., and the original markings were placed at the direction of the Engineer, the plan quantity requirements under "Measurement" do not apply to the original and replacement markings. The Contractor will be paid for the actual quantity of original and replacement markings at the unit price bid for that bid item.

ITEM 668

PREFABRICATED PAVEMENT MARKINGS

668.1. Description. This Item shall govern for furnishing and placing prefabricated pavement markings of the types, colors, shapes and sizes as shown on the plans.

668.2. Materials. Prefabricated pavement marking materials shall conform to Departmental Material Specification D-9-8240.

Materials shall be stored in a weather-proof enclosure in such a manner to prevent damage.

668.3. Sampling. Sampling will be in accordance with Test Method Tex-732-I.

668.4. Construction Methods.

(1) General. When required by the Engineer, the Contractor and the Engineer shall review the sequence of work to be followed and the estimated progress schedule. Waste generated by this work shall be removed from the job site before the end of each working day.

Guides to mark the lateral location of pavement markings shall be established as shown on the plans or as directed by the Engineer. The Contractor shall establish the pavement marking guides and the Engineer will verify the location of the guides prior to installation.

The pavement markings shall be placed in proper alignment with the guides. The deviation rate in alignment shall not exceed 25 millimeters per 60 meters of roadway. The maximum deviation shall not exceed 50 millimeters nor shall any deviation be abrupt.

(2) Seasonal Limitation. Unless otherwise directed in writing by the Engineer, pavement marking materials shall not be placed between September 30 and March 1, subject to temperature and moisture limitations specified.

(3) Dimensions. Markings shall be in accordance with the color, length, width, shape and configuration shown on the plans. The alignment and location shall be as shown on the plans or as directed by the Engineer in writing.

(4) Methods. All material placement shall be in accordance with the material manufacturer's instructions, unless otherwise directed in writing by the Engineer. In addition to the manufacturer's instructions, material placement shall be in accordance with surface condition, moisture and temperature requirements specified by this Item.

(5) Surface Preparation. Surface preparation shall be accomplished by any cleaning method approved by the Engineer that effectively removes contaminants, loose materials and conditions deleterious to proper adhesion. Surface preparation by blast cleaning will not be required unless shown on the plans. When required, blast cleaning shall be done in accordance with Item 678, "Pavement Surface Preparation for Markings". Surfaces shall be further prepared after cleaning by sealing or priming, as recommended by the manufacturer of the pavement marking material or as directed in writing by the Engineer.

Adhesive, when required, shall be of the type and quality recommended by the manufacturer of the pavement marking material. Portland cement concrete pavement surfaces shall not be cleaned by grinding.

(6) Moisture. Pavement to which material is to be applied shall be completely dry. Pavements shall be considered dry if, on a sunny day after observation for 15 minutes, no condensation occurs on the underside of a 0.3 meter square piece of clear plastic that has been placed on the pavement and weighted on the edges.

(7) Temperature. Pavement and ambient air temperature requirements recommended by the material manufacturer shall be followed. If no temperature requirements are established by the material manufacturer, material shall not be placed if the pavement temperature is below 15 °C or above 50 °C.

668.5. Performance Requirements.

(1) Adhesion. Installed pavement markings shall not lift, shift, smear, spread, flow or tear by traffic action.

(2) Appearance. Pavement markings shall present a neat, uniform appearance, free of excessive adhesive, ragged edges and irregular lines or contours.

(3) Visibility. Installed pavement markings shall have uniform and distinctive retroreflectance when observed in accordance with Test Method Tex-828-B.

(4) Observation Period. Unless otherwise shown on the plans, pavement markings shall meet all requirements of this specification for a minimum of 15 calendar days after installation. Pavement markings that fail to meet all requirements of this specification shall be removed and replaced at the expense of the Contractor. The Contractor shall replace all pavement markings failing the requirements of this specification within 30 working days following notification in writing by the Engineer. All replacement pavement markings shall also meet all performance requirements of this specification for a minimum of 15 calendar days after installation.

668.6. Measurement. This Item will be measured by the meter, by each word(s), shape or symbol or by any other unit as shown on the plans.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

668.7. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Prefabricated Pavement Markings" of the various types, colors, shapes and sizes specified. This price shall be full compensation for cleaning the pavement by any suitable means other than blast cleaning; for furnishing and placing all materials; and for all labor, tools, equipment and incidentals necessary to complete the work except, as shown below.

Surface preparation, when shown on the plans, will be paid for under Item 678, "Pavement Surface Preparation for Markings".

ITEM 672

RAISED PAVEMENT MARKERS

672.1. Description. This Item shall govern for furnishing and installing raised pavement markers of the various classes and types shown on the plans.

672.2. Materials. Raised pavement markers shall comply with the requirements of Departmental Materials Specifications as follows:

Class A, Jiggle Bar Tile D-9-4100
Class B, Pavement Markers (Reflectorized) D-9-4200
Class C, Traffic Buttons D-9-4300
Class D, Traffic Buttons (Oval) D-9-4300
Class E, Pavement Markers (All-Weather Reflectorized) D-9-4210

Raised pavement markers shall be of the following classes and types:

Class A Raised Pavement Markers (Jiggle Bar Tile). Class A raised pavement markers shall include types: I-A, I-C, II-A-A, W and Y.

Class B Raised Pavement Markers (Pavement Markers, Reflectorized). Class B raised pavement markers shall include types: I-A, I-C, I-R, II-A-A and II-C-R.

Class C and D Raised Pavement Markers (Traffic Buttons). Class C and D raised pavement markers shall include types: I-A, I-C, I-R, II-A-A, II-C-R, W and Y.

Class E Raised Pavement Markers (All-Weather Reflectorized). Class E raised pavement markers shall include types: I-A, I-C, I-R, II-A-A and II-C-R. The body color descriptions do not apply to Class E raised pavement markers.

The following are descriptions for each type of raised pavement marker:

Type I-A. Type I-A shall contain an approach face that reflects amber light. The body, other than the reflective face, shall be yellow.

Type I-C. Type I-C shall contain an approach face that reflects white light. The body, other than the reflective face, shall be white, silver-white or light gray.

Type I-R. Type I-R shall contain a trailing face that reflects red light. The body, other than the reflective face, shall be white, silver-white, light gray or may be one-half red on the side which reflects red light.

Type II-A-A. Type II-A-A shall contain two (2) reflective faces (approach and trailing) each of which shall reflect amber light. The body, other than the reflective faces, shall be yellow.

Type II-C-R. Type II-C-R shall contain two (2) reflective faces, an approach face which shall reflect white light and a trailing face which shall reflect red light. The body, other than the reflective faces, shall be white, silver-white or light gray. Optionally, the body may be one-half white,

silver-white or light gray on the side that reflects white light and one-half red on the side that reflects red light.

Type W. Type W shall have a white body and no reflective faces.

Type Y. Type Y shall have a yellow body and no reflective faces.

The reflective faces of all Type II markers shall be positioned so that the direction of reflection of one (1) face shall be directly opposite to the direction of reflection of the other face.

Bituminous adhesive shall conform to the requirements of Departmental Materials Specification D-9-6130. Epoxy adhesive shall conform to the requirements of Item 575, "Epoxy".

672.3. Sampling. Sampling will be in accordance with Test Method Tex-729-I.

672.4. Construction Methods. Each class of raised pavement marker shall be from the same manufacturer.

Surfaces to which markers are to be attached by an adhesive shall be prepared by any method approved by the Engineer to ensure that the surface is free of dirt, curing compound, grease, oil, moisture, loose or unsound pavement markings and any other material which would adversely affect the adhesive bond. Unless otherwise shown on the plans, surface preparation for installation of raised pavement markers will not be paid for directly, but shall be considered subsidiary to this Item.

Guides to mark the lateral location of pavement markings shall be established as shown on the plans or as directed by the Engineer. The Contractor shall establish the pavement marking guides and the Engineer will verify the location of the guides.

The pavement markers shall be placed in proper alignment with the guides. The deviation rate in alignment shall not exceed 25 millimeters per 60 meters of roadway. The maximum deviation shall not exceed 50 millimeters nor shall any deviation be abrupt.

Markers placed that are not in alignment or sequence, as shown on the plans or as stated in this specification, shall be removed by the Contractor at the Contractor's expense. Removal shall be in accordance with Item 677, "Eliminating Existing Pavement Markings and Markers",

except for measurement and payment. Guides placed on the roadway for alignment purposes shall not establish a permanent marking on the roadway.

Unless otherwise shown on the plans, the Contractor shall use the following adhesive materials for placement of markers:

Epoxy adhesive for Class E markers.

Bituminous adhesive for Class A, B, C and D markers on bituminous pavements.

Epoxy adhesive for Class A, B, C and D markers on portland cement concrete pavements.

Adhesive shall be applied in sufficient quantity to ensure the following:

100 percent of the bonding area of raised pavement markers shall be in contact with the adhesive.

Raised pavement markers, except for Class E, shall not be in contact with the pavement surface but shall be seated on a continuous layer of adhesive.

Unless otherwise required by this Item, adhesives shall be applied in accordance with the manufacturer's recommendations.

When bituminous adhesive is used, pavement and raised pavement marker temperature shall be at least 5 °C. The bituminous adhesive shall not be heated above 205 °C. The bituminous adhesive shall be agitated intermittently to ensure even heat distribution.

Epoxy adhesive shall be machine mixed.

Raised pavement markers shall be free of rust, scale, dirt, oil, grease, moisture or contaminants which might adversely affect the adhesive bond.

Raised pavement markers shall be placed immediately after the adhesive is applied and shall be firmly bonded to the pavement. Adhesive or any other material that impairs functional reflectivity will not be acceptable.

672.5. Measurement. This Item will be measured as each raised pavement marker.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

672.6. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Raised Pavement Markers" of classes and types specified. This price shall be full compensation for furnishing all materials, surface preparation, installation, labor, equipment, tools and incidentals necessary to complete the work.

ITEM 677

ELIMINATING EXISTING PAVEMENT MARKINGS AND MARKERS

677.1. Description. This Item shall govern for the elimination of existing pavement markings of the various types and sizes, and raised pavement markers as shown on the plans or as directed, in writing, by the Engineer.

677.2. Materials. All surface treatment material application rates shall be as directed by the Engineer. Unless otherwise shown on the plans, surface treatment materials shall conform to the requirements of Item 300, "Asphalts, Oils and Emulsions", and Item 302, "Aggregates For Surface Treatments". Testing of surface treatment materials may be waived by the Engineer. Asphalt and aggregate types and grades shall be as shown on the plans or as approved in writing by the Engineer.

677.3. Construction Methods. Elimination of existing pavement markings and markers shall be accomplished by one (1) or more of the following methods as approved by the Engineer.

(1) Markings on Asphaltic Surfaces.

(a) Placement of a surface treatment a minimum of 0.6 meter wide to cover the existing marking.

(b) Placement of a surface treatment, thin overlay or microsurfacing a minimum of one (1) lane in width in areas where directional changes of traffic are involved or other areas as directed by the Engineer. Construction methods for surface treatments shall conform to Item 316, "Surface Treatments".

(2) Markings on Concrete Surfaces. Removal by an approved burning method.

(3) Markings on Asphaltic or Concrete Surfaces. Removal by water, water-sand blasting techniques or by any other method(s) proven satisfactory to the Engineer.

(4) Markers on Asphaltic or Concrete Surfaces. Removal by any mechanical method to remove marker and adhesive.

Existing pavement markings and markers on both concrete and asphaltic surfaces shall be removed in such a manner that color and/or texture contrast of the pavement surface will be held to a minimum.

Removal of pavement markings on concrete surfaces by blast cleaning shall be in accordance with Item 678, "Pavement Surface Preparation for Markings", except for measurement and payment. Blast cleaning shall be performed in such a manner that damage to the concrete surface is held to a minimum.

When thermoplastic pavement markings or prefabricated pavement markings are encountered, the application of heat may be used to remove the bulk of the marking material prior to blast cleaning. When heat is used, care shall be taken to prevent spalling of concrete surfaces.

A burner may be used for complete removal of pavement markings. Broom removal or light blast cleaning may be used for removal of minor residue.

Damage, such as spalling, shelling, etc. greater than six (6) millimeters in depth, caused to asphaltic surfaces resulting from the removal of pavement markers shall be repaired by the application of a 0.6 meter **677.4 to 678.2**

wide surface treatment for longitudinal markers with no directional change or a minimum of one (1) lane width surface treatment in areas where directional changes of traffic are involved.

Grinding is not an acceptable method of marker or marking removal. However, equipment utilizing special milling flails are considered acceptable in the removal of markings and markers on asphalt and concrete surfaces.

677.4. Measurement. This Item will be measured by the square meter of surface treatment, thin overlay or microsurfacing (full lane width) placed; by each word, symbol or shape eliminated; by the meter of markings eliminated; or by any other unit as shown on the plans.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

677.5. Payment. The work performed and material furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Eliminating Existing Pavement Markings and Markers" of the various types specified. This price shall be full compensation for blast cleaning, mechanical cleaning and/or other cleaning methods; for all materials, tools, equipment, labor and incidentals necessary to complete the work, except as shown below.

No payment will be made for the elimination of pavement markers when pavement markers are to be removed in conjunction with the elimination of longitudinal markings.

ITEM 678

PAVEMENT SURFACE PREPARATION FOR MARKINGS

678.1. Description. This Item shall govern for surface preparation of pavement surface areas prior to placement of pavement markings or raised pavement markers.

678.2. Materials. Abrasive blasting medium, when used, shall be a quality commercial product capable of producing the specified surface cleanliness without the deposition of deleterious materials on the cleaned surface. Water used in blasting operations shall be potable.

678.3. Equipment. Equipment shall be in good condition. Air compression equipment shall utilize moisture and oil traps, in working order, of sufficient capacity to remove contaminants from blasting air and prevent the deposition of moisture, oil or other contaminants on the roadway surface.

678.4. Construction Methods. Widths, lengths and shapes of the prepared surfaces shall only be of sufficient size to include the full area of pavement markings or raised pavement markers shown on the plans.

Surface preparation of portland cement concrete surfaces shall be sufficient to remove contaminants. Damage to the roadway surface due to over-blasting shall be held to a minimum. Asphaltic pavement surfaces shall be cleaned by brushing, washing, compressed air, high pressure water or any combination thereof to remove all forms of contamination and loose materials. All other surfaces to be cleaned by blast cleaning shall be cleaned sufficiently to remove loose and flaking materials from the roadway surface.

When existing markings are encountered, they shall be cleaned sufficiently to remove all loose and flaking materials. Small spots of old markings or contaminants of up to 15 millimeters square in area may remain if the contaminant is not removed by the following test:

Firmly press a 250 millimeters long, 50 millimeters wide strip of mono-filament tape onto the surface to be tested, leaving approximately 50 millimeters free. Grasp the free end and remove the tape with a sharp pull.

Blasting pressure and technique shall be controlled to prevent damage to the pavement surface. Portland cement concrete surfaces shall not be cleaned by grinding.

678.5. Measurement. This Item will be measured by the meter of the various widths, by each of the various words, shapes or symbols, or by any other unit as shown on the plans.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

678.6. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Pavement Surface Preparation for Markings" of the various types specified. This price shall be full compensation for all materials, tools, equipment, labor and incidentals necessary to complete the work.

ITEM 680

INSTALLATION OF HIGHWAY TRAFFIC SIGNALS

680.1. Description. This Item shall govern for construction of highway traffic signal installations of the various types as shown on the plans.

680.2. General. Unless otherwise shown on the plans, electrical materials and construction methods shall conform to the NEC and additional local utility requirements.

All materials furnished by the Contractor shall be new.

All materials and construction methods shall conform to the details shown on the plans, the requirements of this Item and the pertinent requirements of the following Items:

Item 610, "Roadway Illumination Assemblies"
Item 618, "Conduit"
Item 620, "Electrical Conductors"
Item 624, "Ground Boxes"
Item 625, "Zinc-Coated Steel Wire Strand"
Item 627, "Treated Timber Poles"
Item 628, "Electrical Services"
Item 634, "Plywood Signs (Type A)"
Item 636, "Aluminum Signs (Type A)"
Item 656, "Foundations for Signs, Traffic Signals and Roadway Illumination Assemblies"
Item 682, "Vehicle and Pedestrian Signal Heads"
Item 684, "Traffic Signal Cables"
Item 686, "Traffic Signal Pole Assemblies"
Item 688, "Traffic Signal Detectors"

Controller assemblies shall conform to the requirements of the Item "Traffic Signal Controller Assembly" and the details shown on the plans.

Flasher assemblies shall conform to the requirements of the Item "Flasher Controller Assembly" and the details shown on the plans.

680.3. Sampling and Testing. Sampling and testing of traffic signal controller assemblies shall be in accordance with Test Method Tex 879-B.

680.4. Electrical Requirements.

(1) Electrical Services. The Contractor shall make all arrangements for electrical services. Materials not provided by the utility company shall be supplied and installed by the Contractor as shown on the plans. Unless otherwise shown on the plans, the electrical service shall be 120 volt, single-phase, 60 Hz AC.

The Contractor will not be required to pay for electrical energy consumed by the traffic signal installation.

(2) Conduit. Conduit and fittings shall be the sizes and types shown on the plans. The Contractor may, at the Contractor's expense, use conduit of larger size than that shown on the plans providing that the same size is used for the entire length of the conduit run. Conduit in concrete foundations shall extend 50 millimeters to 75 millimeters above the concrete. The ends of each conduit shall be sealed with silicone caulking, or other sealant approved by the Engineer, after all cables and conductors are installed.

(3) Wiring. Unless otherwise shown on the plans, conductors shall be stranded No. 12 AWG XHHW. Cables and conductors above ground shall be installed in rigid metal conduit, except for span wire suspended cables and conductors, drip loops, and electrical wiring inside signal poles. Power entrance to ground-mounted controllers shall be made through underground conduit. Each signal installation shall be wired to operate as shown on the plans.

Ends of wires to be attached to terminal posts shall be provided with properly sized self-insulated solderless terminals. These terminals shall be attached to the wires with a ratchet type compression crimping tool properly

sized to the wire. Pre-numbered identification tags of plastic or tape shall be placed around each wire adjacent to wire ends in the controller, signal heads and signal pole terminal blocks.

Splices will not be permitted except as shown on the plans, unless the Engineer approves each individual splice in writing. All allowed splices shall be water-tight.

(4) Grounding and Bonding. Unless otherwise shown on the plans, grounding and bonding shall be in accordance with the NEC. The resistance from the grounded point of any equipment to the nearest ground rod shall be less than one (1) ohm.

A continuous bare or green insulated copper wire (equipment ground) shall be installed throughout the electrical system. The equipment ground shall be connected to all metal conduit, metal signal heads, metal pedestrian push buttons, signal poles, controller housing, service pole ground, ground rods and all other metal enclosures and raceways. Unless otherwise shown on the plans, the equipment ground shall be at least the same size as the neutral feeding that equipment (heads, push buttons, controllers, etc.).

Bonding jumpers shall be copper wire and shall be minimum No. 8 AWG.

680.5. Controller Assemblies. Immediately prior to mounting the controller assembly on the foundation, a bead of silicone caulk shall be applied to seal the cabinet base. Any space between conduit entering the controller and the foundation shall be sealed with silicone caulk.

When the project is complete, the keys for the controller cabinets shall be delivered to the Engineer.

The instruction manual and wiring diagrams for all equipment in the controller cabinet, shall be placed inside the controller cabinet.

680.6. Timber Poles. Timber poles other than for electrical services, shall be ANSI Class 2.

680.7. Preservation of Sod, Shrubbery and Trees. Sod, shrubbery and trees damaged by the Contractor shall be replaced by the Contractor at the Contractor's expense.

680.8. Removal and Replacement of Curbs and Walks. The Contractor shall secure approval of the Engineer before cutting into or removing walks or curbs not shown on the plans to be removed or replaced.

After work is completed, the Contractor shall restore any curbs or walks, which have been removed, to equivalent original condition and to the satisfaction of the Engineer.

680.9. Sign Lighting. Sign lighting attached to traffic signal equipment shall be as shown on the plans.

680.10. Intersection Lighting. Luminaires on signal poles shall be as shown on the plans.

680.11. Test Period. Completed traffic signal installations shall operate continuously for a minimum of thirty days in a satisfactory manner. If any equipment furnished by the Contractor, except lamps, fails during the thirty day test period, the Contractor shall repair or replace that equipment and a new thirty day test period shall start.

The test period will be suspended when a lamp or any equipment not furnished by the Contractor fails. The test period will resume after the failed equipment has been repaired.

680.12. Measurement. This Item will be measured as each signalized intersection(s) controlled by one (1) traffic signal controller complete in place.

680.13. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Installation of Highway Traffic Signals" of the various types specified. This price shall be full compensation for furnishing, installing and testing the completed installation including controller and associated equipment, luminaires, signs and sign lights mounted on signal equipment, timber poles, mounting hardware and steel wire strand; for preservation and/or replacement of damaged sod, shrubbery and trees; for removal and replacement of curbs and walks; and for all labor, tools, equipment and incidentals necessary to complete the work, except as shown below.

Conduit will be paid for under Item 618, "Conduit".

Electrical conductors will be paid for under Item 620, "Electrical Conductors".

Ground boxes will be paid for under Item 624, "Ground Boxes".

Electrical service will be paid for under Item 628, "Electrical Services".

Foundations for traffic signals will be paid for under Item 656, "Foundations for Signs, Traffic Signals and Roadway Illumination Assemblies".

Vehicle and pedestrian signal heads will be paid for under Item 682, "Vehicle and Pedestrian Signal Heads".

Traffic signal cables will be paid for under Item 684, "Traffic Signal Cables".

Traffic signal pole assemblies will be paid for under Item 686, "Traffic Signal Pole Assemblies".

Traffic signal detectors will be paid for under Item 688, "Traffic Signal Detectors".

ITEM 681

TEMPORARY TRAFFIC SIGNALS FOR CONSTRUCTION

681.1. Description. This Item shall govern for furnishing, installing, operating, maintaining, reconfiguring and removing temporary traffic signals, as shown on the plans, for controlling traffic during construction.

681.2. General. Unless otherwise shown on the plans, materials and installation shall be in accordance with Item 680, "Installation of Highway Traffic Signals", except for measurement and payment. Any signal equipment furnished by the Department shall be picked up by the Contractor at locations shown on the plans.

(1) Operation and Maintenance. Unless otherwise shown on the plans, the Contractor shall be responsible for maintenance and operation of the temporary signal(s).

The Contractor shall identify in writing to the Engineer, the company, subcontractor or individual designated by the Contractor to perform maintenance and operation of the temporary traffic signals. Designated personnel shall be sufficiently skilled in the work, shall be available 24 hours each day and shall respond, unless otherwise shown on the plans, within a reasonable time.

The Contractor will not be required to pay for commercial electrical power consumed by the temporary signal system. When shown on the plans, back-up power shall be provided at each location at all times. The Contractor shall be responsible for cost of all other electrical power sources.

(2) Reconfiguration. Reconfiguration of temporary traffic signals shall be in accordance with the requirements of this Item and shall be as shown on the plans or as directed in writing, by the Engineer. Reconfiguration shall consist of any changes made at the same intersection including relocation of poles, controller and signal heads.

(3) Removal. All equipment installed for temporary traffic signals shall be removed as shown on the plans or as directed in writing, by the Engineer.

Unless otherwise shown on the plans, poles or other supports used for temporary traffic signals shall either be removed to 0.6 meter below finish grade or completely removed. The remaining hole shall be backfilled with material equal in composition and density to the surrounding area, and by replacing any surfacing, such as asphalt pavement or concrete riprap, with like material to equivalent condition.

Unless otherwise shown on the plans, all removed temporary signal components shall remain the property of the Contractor.

681.3. Measurement. This Item will be measured as each temporary signalized intersection.

681.4. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Temporary Traffic Signals for

Construction". This price shall be full compensation for furnishing materials as shown on the plans; for picking up and returning materials furnished by the State at the locations shown on the plans; for installation, operation, including operating costs (except for commercial power consumed by the signal), maintenance, reconfiguration and removal of the temporary traffic signal; and for all labor, tools, equipment and incidentals necessary to complete the work.

ITEM 682

VEHICLE AND PEDESTRIAN SIGNAL HEADS

682.1. Description. This Item shall govern for furnishing and installing vehicle and pedestrian signal heads of the various types and sizes shown on the plans.

682.2. Definitions.

Optical Unit--The lens, reflector, lamp, lamp receptacle and associated supporting parts in a signal section.

Signal Section--One housing case, housing door, visor and optical unit.

Signal Face--One section or an assembly of two or more sections facing one direction.

Signal Head--A uni-directional face or a multi-directional assembly of faces, including back plates and louvers, when required, attached at a common location on a support.

682.3. General. The material, design and construction of signal heads shall be in accordance with the requirements set forth in the ITE standards except as noted herein.

All signal heads shall be in accordance with the TMUTCD.

Signal sections shall be constructed of a housing case, a housing door and a visor all made of the same material. All lens shall be polycarbonate. Each signal section shall contain an optical unit and a terminal block. The signal sections shall be designed so they can be attached to each other and to mounting hardware. Assembled signal sections shall not exhibit light leakage.

682.4

Unless otherwise shown on the plans, each signal section shall be designed for operation from a power supply of 120 volt, single phase, 60 Hz AC and with incandescent lamps conforming to ITE standards. Unless otherwise shown on the plans, the Contractor shall furnish and install all traffic signal

lamps.

682.4. Materials. Signal head components shall be either aluminum or polycarbonate. Unless otherwise shown on the plans, material selection shall be the option of the Contractor. Signal heads furnished for any one project shall be of the same material and manufacturer.

All material shall be accurately formed and free from defects affecting strength and appearance.

All material furnished by the Contractor shall be new.

(1) Aluminum. Cast aluminum parts shall have a minimum tensile strength of 117 megapascals and sheet aluminum parts shall have a minimum tensile strength of 186 megapascals.

Aluminum materials shall conform to the following:

TYPE	ASTM	ALLOY
Die castings	B 85	SG100B, SG100A,
Permanent mold castings	B 108	CS72A or S5A.
Sheet	B 209	M1A.

(2) Polycarbonate. Polycarbonate materials shall be ultraviolet-stabilized and shall meet the following physical property requirements:

TEST	**REQUIRED**	**ASTM**
Specific Gravity	1.17 minimum	D 792
Vicat Softening Point, °C	152-163	D 1525
Brittleness Point, °C	Below -129	D 746
Flammability	Self-extinguishing	D 635
Tensile Strength, yield, MPa	59 minimum	D 638
Elongation at yield, percent	5.5-8.5 minimum	D 638
Shear, strength, yield, MPa	38 minimum	D 732

Izod impact strength, J/mm (notched, 3.175 mm thick)	0.8 minimum	D256
Fatigue strength, MPa at 2.5 mm cycles	6.55 minimum	D671

(3) Hardware. All bolts, nuts, washers, lock washers, screws and other assembly hardware shall be galvanized steel, stainless steel or dichromate sealed aluminum, in conformance with Departmental Materials Specification D-9-7120. When dissimilar metals are used, the metals shall be so selected or insulated to prevent corrosion.

(4) Gaskets. Gaskets in the optical unit shall be closed-cell silicone and shall withstand temperatures up to 120 °C without permanent deformation or becoming brittle. Other gaskets shall be closed-cell neoprene.

682.5. Design.

(1) Housing Case.

(a) The housing case shall be one piece and shall be of either die cast aluminum alloy, permanent mold cast aluminum alloy or molded polycarbonate.

(b) Polycarbonate housing cases shall be a minimum of 2.3 millimeters thick and shall be ribbed for strength and durability.

(c) Both ends of each housing case shall be provided with an opening of 50 millimeters in diameter to accommodate mounting brackets.

(d) Each signal section shall be capable of being rotated 360 degrees about its mounting axis and shall be capable of being locked at 5-degree intervals. Locking shall be accomplished by the engagement of serrations in adjacent signal sections and in the mounting bracket assembly. Serrations shall be integral with the signal section and designed to insure flush alignment of the perimeters of the sections. Polycarbonate sections shall have additional strengthening ribs integral with the mating sides.

(e) Provisions shall be made for the attachment of the optical unit, housing door and for the signal head mounting arrangement shown on the plans. Provisions shall be made for attaching back plates, signs and sign lights of the types shown on the plans.

(2) Housing Door.

(a) The door of each housing case shall be one piece and shall accommodate the lens shown on the plans.

(b) Polycarbonate doors shall be a minimum of 2.3 millimeters thick.

(c) A gasket shall be provided between the aluminum door and housing case.

(d) The door shall be attached to the housing case by two stainless steel hinge pins spaced to hold the door in alignment when closed. Hinge pins shall be designed to remain in place under normal use.

(e) Two stainless steel wing screws or wing nuts shall be installed on the side of the door or the side of the housing to provide for opening and closing the door without the use of tools. Wing screws or wing nuts shall have a flat bearing surface or stainless steel flat washer to prevent gouging of the housing door. The wing screws or wing nuts shall remain captive when the door is open.

(3) Visor.

(a) Unless otherwise shown on the plans, each housing door shall have a standard tunnel visor as described herein. The visor material shall have a minimum thickness of 2.5 millimeters for polycarbonate and 1.3 millimeters for aluminum. The visor shall be rigidly attached to the housing door with corrosion resistant connectors.

(b) The visor shall be easily removed and replaced without damage to the visor or the completed signal head assembly. Louvers shall be attached when shown on the plans.

(c) Unless otherwise shown on the plans, the visors for vehicle signal sections shall:

-be cylindrical.
-have a downward tilt of 2 to 8 degrees relative to the perpendicular to the plane of the housing door.
-encompass approximately 300 degrees of the lens.

-extend outward from the face of the lens a minimum of 240 millimeters for 300-millimeter diameter lens and 175 millimeters for 200-millimeter diameter lens.
-be open at the bottom.

(d) Each pedestrian signal section shall be furnished with a three- sided visor shielding the top and sides, extending out from the surface of the lens a distance of 150 to 230 millimeters.

(e) The same type visor shall be used throughout the project.

(4) **Lens for Vehicle Signal Sections.**

(a) Each lens shall be either red, yellow, yellow arrow, green, or green arrow. Masks may be used to form arrows. The lens shall be round with a nominal diameter of 200 or 300 millimeters. Lens type, color and size shall be as shown on the plans.

(b) Each lens shall be permanently marked, in an inconspicuous manner, indicating the top of the lens and the name or trademark of the manufacturer.

(5) **Lens for Pedestrian Signal Sections.**

(a) Each lens shall be square with a nominal size of 230 x 230 millimeters or 300 x 300 millimeters as shown on the plans.

(b) Unless otherwise shown on the plans, the lens shall display the words "WALK" or "DONT WALK". The letters shall be at least 75 millimeters high for 230 millimeter lens and 114 millimeters high for 300 millimeter lens.

(c) When shown on the plans, symbols shall be used. Symbols shall be a minimum of 150 millimeters high and 88 millimeters wide for 230 millimeter lens and a minimum of 230 millimeters high and 133 millimeters wide for 300 millimeter lens.

(d) Unless otherwise shown on the plans, the WALK and the DONT WALK, word or symbol, indications shall be in separate signal sections. The WALK indication shall be white. The DONT WALK indication shall be orange.

(6) **Reflector.**

(a) The reflector shall be approximately parabolic in section and reasonably free from chips, bubbles, streaks and wrinkles. The reflecting surface shall be free of flaws, scratches and defacements. The light from a 200 watt incandescent lamp shall be invisible through the reflector.

(b) The reflector shall be specular Alzak aluminum or aluminized polycarbonate.

(7) **Lamp Receptacle.**

(a) The lamp receptacle shall be of weatherproof construction. A lamp grip shall be provided to prevent the lamp from loosening by vibration. The lamp receptacle shall be rotatable for proper lamp orientation.

(b) Each lamp receptacle shall be wired with two flexible, insulated, color coded wires not smaller than No. 18 AWG.

(8) **Lamp.**

(a) Unless otherwise shown on the plans, the traffic signal lamp shall meet the following requirements.

Item	Type of Signal Section 300 mm vehicle	200 mm vehicle All pedestrian
Light center length	76.2 mm	61.9 mm
Minimum initial lumens	1650	550
Rated average life	8000 h	8000 h
Maximum wattage	150	70

(b) The glass envelope of each lamp shall be indelibly marked to show the manufacturer's identification, the rated voltage, the rated lumens, the rated average life and orientation of the lamp for proper burning position.

(9) Optical Unit.

(a) The optical unit shall meet ITE standards for light color and distribution. All parts of the optical unit shall withstand the heat generated by continuous illumination of a 70 watt lamp in an 200 or 225 millimeter signal section, and a 150 watt lamp in a 300 millimeter signal section without distortion or discoloration.

(b) The reflector, lamp receptacle and lens shall form a dust tight, water tight unit. A closed-cell silicone gasket shall be used to seal the lens to the reflector.

(c) The reflector holder and lamp receptacle holder shall be rigidly fastened in place by hinges and/or lugs for easy removal of the assembly. It shall not be necessary to remove the assembly from its supports for relamping or cleaning the reflector.

(10) Back Plate.

(a) The back plate shall be attached to vehicle signal faces when shown on the plans.

(b) Back plates shall be a minimum thickness of 1.3 millimeters for aluminum and 2.5 millimeters for polycarbonate. Unless otherwise shown on the plans, back plates shall be made of the same material as the signal housing.

(c) The back plate shall extend around the periphery of the signal face a distance of 200 millimeters for faces with 200 millimeter lens and 125 millimeters for faces with 300 millimeter lens.

(11) Terminal Block.

(a) The terminal block body shall be of one-piece molded construction using phenolic materials. The block shall consist of permanently identified electrical sections, each section consisting of two (2) three (3) millimeters or four (4) millimeters x eight (8) millimeters binding head screws and a conducting metal strip between the screws. The block shall be rated for a minimum of 20 ampere, 250 volt service and section to section breakdown voltage shall be a minimum of 1600 volts AC rms. All metal parts shall be nickel plated brass.

(b) The terminal block shall be securely mounted to the housing case in an accessible position internally in the signal section.

(c) Each vehicle signal section shall have a terminal block containing a minimum of six (6) sections.

(d) Each pedestrian signal section shall have a terminal block containing a minimum of three (3) sections.

(12) Mounting Attachments. Mounting attachments shall be as shown on the plans.

(13) Colors.

Unless otherwise shown on the plans, traffic signal heads shall be Federal Yellow No. 13538 of Federal Standard 595. Back plates, louvers and the inside of visors shall be flat black.

(a) The colorant required shall completely impregnate the polycarbonate material. The inside of polycarbonate visors shall be provided with two (2) coats of high grade flat black finish paint.

(b) All exposed metal surfaces, except for back plates, louvers and the inside of visors, of the assembled traffic signal head shall be given two (2) separately baked on coats of high grade enamel. The back plates, louvers and inside of the visors shall be provided with two (2) coats of high grade flat black finish paint.

682.6. Construction Methods.

(1) Assembly.

(a) Individual signal sections in multi-section faces shall be assembled, in accordance with manufacturer's recommendations, to form a rigid signal face.

(b) Signal heads shall be assembled and mounted as shown on the plans.

(c) Any openings in an assembled signal head shall be closed with a plug. The plug shall be of the same material and color as the head.

(2) **Wiring.**

(a) Each optical unit shall be wired to the terminal block located in that signal section by means of solderless wire connectors or binding screws and spade lugs.

(b) All sections of a multi-section signal face shall be wired to the section terminal block(s) in which the traffic signal cable is terminated. The color coding on leads from the individual optical units shall be maintained throughout the signal head except for the traffic signal cable. All connections to terminal blocks, except field wiring, shall be made using solderless wire connectors or binding screws and spade lugs. Field wiring shall be made using binding screws and spade lugs.

682.7. **Certification.** All traffic signal heads shall conform to ITE strength requirements. The Contractor shall supply written certification of compliance from the manufacturer.

682.8. **Measurement.** This Item will be measured by each vehicle signal section, by each pedestrian signal section, by each back plate and by each louver complete in place.

682.9. **Payment.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Pedestrian Signal Section", "Vehicle Signal Section", "Back Plate", or "Louver" of the various types and sizes specified. This price shall be full compensation for furnishing, assembling and installing the signal sections, back plates and louvers; for all mounting attachments; and for all labor, tools, equipment and incidentals necessary to complete the work.

ITEM 684

TRAFFIC SIGNAL CABLES

684.1. **Description.** This Item shall govern for furnishing and installing traffic signal cables of the various sizes and types as shown on the plans.

684.2. **Materials.** All cables shall consist of two (2) or more individually insulated copper conductors. The insulation shall be polyethylene and rated for 600 volts. All cables shall be polyethylene jacketed.

All materials furnished by the Contractor shall be new.

(1) Type A cable shall be suitable for installation in underground conduit or use as an aerial cable supported by a messenger. The cable shall meet all the requirements of ISMA 20-1, which includes but is not limited to the requirements specified herein for Type A cable.

(2) Type B cable shall be an integral messenger cable for use in aerial installations as traffic signal interconnect cable. The cable shall meet all the requirements of IMSA 20-3, which includes but is not limited to the requirements specified herein for Type B cable.

(3) Type C cable shall be a two (2) conductor shielded cable for use as loop detector lead-in. The cable shall meet all the requirements of IMSA 50-2, which includes but is not limited to the requirements specified herein for Type C cable.

(4) The material for cable Types A and B shall be as follows:

(a) Unless otherwise shown on the plans, each conductor shall consist of seven (7) copper strands. The size and number of the conductors shall be as shown on the plans.

(b) Color coding of conductors and sequence for cables shall be in compliance with the following table. Base color shall be the insulation color. Tracers shall be colored stripes which are part of, or firmly adhered to, the insulation surface for the full length of the conductor.

CONDUCTOR COLOR AND SEQUENCE FOR CABLES

Conductor No.	Base Color	Tracer Color
1	Black	
2	White	
3	Red	
4	Green	
5	Orange	
6	Blue	
7	White	Black
8	Red	Black
9	Green	Black
10	Orange	Black
11	Blue	Black
12	Black	White
13	Red	White
14	Green	White
15	Blue	White
16	Black	Red
17	White	Red
18	Orange	Red
19	Blue	Red
20	Red	Green
21	Orange	Green

(c) Two (2) conductor cable shall be of the round twisted type with fillers used where necessary to form a round cable.

(d) In cables having more than two (2) conductors, individual conductors shall be laid up symmetrically in layers, with fillers used when necessary, to produce a uniform assembly of conductors with a firm compact cylindrical core.

(e) Fillers shall be of a non-metallic, moisture-resistant, non-wicking material.

(f) The conductor assembly shall be covered with a wrapping of a moisture-resistant tape applied to overlap at least 10 percent of the tape width.

(g) The taped conductor assembly shall be covered with a tight fitting black polyethylene jacket that is smooth, free from holes, splits, blisters and any other imperfections.

(h) Each cable shall clearly show the name of the manufacturer and the IMSA specification number applied at approximately 0.6 meter intervals to the outer surface of the jacket by indent printing.

(5) Additional material requirements particular to Type B cable are:

(a) Cables consisting of five (5) or more conductors shall have a 6.3 millimeter nominal diameter messenger. The messenger shall be Class A galvanized Extra High Strength Steel Strand with three (3) or seven (7) wires.

(b) A solid strand messenger with 3.4 millimeter diameter may be used for cables with less than five (5) conductors.

(c) To provide corrosion protection, the messenger strand shall be coated and the interstices flooded with a rubber asphalt compound or equivalent.

(d) The integral messenger and conductors shall be enclosed in the jacket forming a cross section similar to a figure eight (8).

(6) The materials for Type C cable shall be as follows:

(a) Unless otherwise shown on the plans, No. 14 AWG insulated conductors with concentric stranding shall be provided. The insulation on one (1) of the two (2) conductors shall be black and the other shall be clear. The conductors within the cable shall have a minimum of seven (7) twists per meter.

(b) The cable shall have 100 percent shield coverage utilizing aluminum bonded to a Mylar film. The drain wire shall be in continuous contact with the aluminum side of the shield material and shall be two (2) AWG sizes less than the conductor. The drain wire shall be stranded tinned copper.

(c) The jacket shall be black polyethylene.

684.3 to 684.4

(d) Each cable shall legibly show the name of the manufacturer and the

IMSA specification number applied at approximately 0.6 meter intervals on a tape under the outer jacket.

(7) Samples for establishing conformity to IMSA and this specification may be taken by the Engineer from each roll of each size of cable. The samples shall be a minimum of one (1) meter in length. Cable failing to meet IMSA requirements and this Item will be rejected and shall be replaced by the Contractor at the Contractor's expense.

684.3. Construction Methods.

(1) Installation of the cable shall be as shown on the plans. Each cable run in underground conduit shall have an extra length of 1.5 meters coiled and left in each ground box.

(2) Splices will not be permitted except as shown on the plans, unless the Engineer approves each individual splice in writing. All allowed splices shall be watertight.

(3) Splices between Type C cable and loop detector wires shall be made only in the ground box near the loop it is servicing. Splices shall be soldered using non-corrosive solder. The drain wire of Type C cable shall be grounded to earth ground only at the controller or detector cabinet. The resistance from the drain wire to the ground rod shall be less than one (1) ohm.

(4) After installation of the cables and prior to any connection to the cables, the cables may be tested. Cable testing less than 50 megohms insulation resistance at 500 volts will be rejected.

684.4. Measurement. This Item will be measured by the meter of traffic signal cables except as shown below.

Measurement will not be made for cable inside signal heads and controllers and cable coiled in ground boxes, in pole bases and coiled on span wires.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

684.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Traffic Signal Cables" of the various types and

sizes specified. This price shall be full compensation for furnishing and installing all materials, and for all labor, tools, equipment and incidentals necessary to complete the work.

ITEM 686

TRAFFIC SIGNAL POLE ASSEMBLIES (STEEL)

686.1. Description. This Item shall govern for designing, fabricating, furnishing and erecting steel traffic signal pole assemblies of the various types and sizes as shown on the plans.

686.2. General. All materials and construction methods shall conform to the requirements of this Item and the pertinent requirements of the following Items:

Item 441, "Steel Structures"
Item 442, "Metal for Structures"
Item 445, "Galvanizing"
Item 449, "Anchor Bolts"
Item 656, "Foundations for Signs, Traffic Signals and Roadway Illumination Assemblies"

686.3. Standard Pole Designs. Shop drawings shall not be required or submitted for traffic signal pole assemblies fabricated in accordance with this Item and the details shown on the plans.

Any deviation from the plans will require submission of shop drawings of the complete assembly, including anchor bolts, in accordance with Item 441, "Steel Structures". Deviations which affect the basic structural behavior of the pole will be considered as optional pole designs.

686.4. Optional Pole Designs. Optional pole designs shall be subject to the following requirements and shall meet all other requirements of this Item.

The designs shall conform to the AASHTO STANDARD SPECIFICATIONS FOR STRUCTURAL SUPPORTS FOR HIGHWAY SIGNS, LUMINAIRES AND TRAFFIC SIGNALS.

686.5 to 686.6

Two (2) sets of complete design calculations shall be submitted for approval prior to submission of shop drawings. Computer printouts for design calculations will not be acceptable unless accompanied by sufficient other documentation which demonstrates methods used.

Unless otherwise shown on the plans, the design calculations and six (6) sets of shop drawings shall be submitted to the Director of Design, Texas Department of Transportation, 125 East 11th Street, Austin, Texas 78701-2483.

The maximum design yield strength for anchor bolts shall be 380 megapascals.

The maximum design yield strength for ASTM A 572 or A 595 materials shall be 345 megapascals.

Pole assemblies shall be compatible with the foundation details, signal heads and other attachments shown on the plans.

686.5. Anchor Bolts. Unless otherwise shown on the plans, anchor bolts shall be alloy steel or medium-strength, mild steel as described in Item 449, "Anchor Bolts".

686.6. Materials. Metal used shall conform to Item 442, "Metal for Structures", except for measurement and payment, and the additional requirements as follows:

Poles and Mast Arm Shafts	ASTM A 570 Grade 345, A 572 Grade 345, A 588, A 595 Grade A, A 607 Grade 345, or A36MOD345 (1)
Base Plates, Mast Arm Mounting Plates, or Access Hole Rings	ASTM A 36, A 572 Grade 345, A 588, A 595 Grade A (2), or A36MOD345 (1)
Luminaire Arms	ASTM A 53 Grade A or B, A 501, A 595 Grade A (2), or A 715 Grade 345
Simplex Fittings for Luminaire Arms	ASTM A 27 Grade 450-240, or A 148 Grade 550-345, or A 576 Grade 1021 (3), or A 36 (arm simplex only)

Connection or Pin Bolts	ASTM A 325 (4)
Miscellaneous Plates and Gussets	ASTM A 36 or equal

(1) A36MOD345 is a special designation for a modified ASTM A 36 material with a higher specified yield strength and having other additional

requirements as described in Item 442, "Metal for Structures".

(2) ASTM A 595 material used for other than pole and mast arm shafts need not be cold worked to ASTM A 595 requirements, but the basic material shall have 275 megapascals minimum yield strength prior to fabrication.

(3) ASTM A 576 shall be suitable for forging and shall also have minimum tensile strength of 450 megapascals, minimum yield strength of 240 megapascals, and minimum elongation of 22 percent in 50 millimeters.

(4) ASTM A 321 threaded rods may also be used for pin bolts and clamp-on mast arm connection bolts. Nuts for ASTM A 321 connection bolts shall be ASTM A 563 Grade DH heavy hex.

ASTM materials A 570, A 572, A 607, or A 715 may have higher yield strengths but shall not have less elongation than the grade indicated.

ASTM A 570 Grade 345 or ASTM A 595 Grade A materials shall also have a minimum yield strength of 345 megapascals and a minimum elongation of 18 percent in 200 millimeters or 23 percent in 50 millimeters prior to brake or tube forming operations. Material thicknesses in excess of those stipulated under ASTM A 570 will be acceptable providing the material meets all other ASTM A 570 requirements and the requirements of this Item. ASTM A 595 Grade A material shall have a minimum yield strength of 345 megapascals adjacent to base welds after fabrication.

All the above steel, greater than 12.7 millimeters thick, except simplex fittings, bolts and miscellaneous steel, shall conform to the longitudinal Charpy V-notch requirements of ASTM A 572, Group 1, in accordance with Article 442.3.

686.7

The silicon content of all steel shall be controlled to ensure high quality galvanizing and to avoid discoloration.

All materials furnished by the Contractor shall be new.

686.7. Fabrication. Fabrication and welding shall be in accordance with Item 441, "Steel Structures", the ANSI/AWS STRUCTURAL WELDING CODE D1.1, the details shown on the plans and the requirements of this Item.

Conformance to the plans and other approved drawings does not relieve the Contractor of the responsibility for providing proper fit of components.

Shafts for poles and mast arms may be round or octagonal and shall be tapered as shown on the plans. Bolted slip joints overlapping a minimum of 1.5

diameters are permissible in mast arms 12 meters and longer.

Circumferential welds, other than at the ends of the shafts, will not be allowed. The exterior of longitudinal seam welds shall be ground or otherwise smoothed to the same appearance as other shaft surfaces. Longitudinal seam welds for shaft sections shall have 60 percent minimum penetration. Longitudinal seam welds shall have 100 percent penetration when within 150 millimeters of circumferential base welds. A maximum of two (2) longitudinal seam welds may be made in shaft sections. Welding of longitudinal seams shall be done in a manner that will minimize acid entrapment during later galvanizing.

Luminaire arm connections to the pole shall be with simplex fittings. Castings for simplex fittings shall be true to pattern in form and dimensions with no sharp unfilleted angles or corners. The fittings shall have no defects affecting their strength and appearance.

Fabrication Tolerances:

Part	Dimension	Tolerance (millimeters)
Poles and Mast Arm Shafts	Length	± 25
	Thickness	+ 3.0, - 0.50
	Deviations from flats or ida	± 4.8
	Straightness	3.2 in 3.0 m
	Attachment locations	± 25

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Base and Mast Arm Mounting Plates	Overall	± 4.8
	Thickness	+ 6.4, - 0
	Deviations from flat	4.8 in 610
	Spacing between holes	± 3.2
	Bolt hole size	± 1.6
Anchor Bolts	Length	± 13
	Threaded Length	± 13
	Galvanized Length	- 6.0
Assembled Shafts	Angular Orientation (1)	1.6 in 305
	Centering	± 4.8
	Twist	3 deg in 15.2 m

(1) The angular orientation tolerance between mounting plates and between mounting plates and base plate shall be three (3) in 305.

Unless otherwise shown on the plans, mast arms shall be fabricated straight in the unloaded condition.

Fabricated sections and associated parts shall be galvanized in accordance with Item 445, "Galvanizing".

Terminal blocks, cover plates and gaskets as shown on the plans shall be in place for shipment. Terminal block hardware shall be nickel plated brass.

The design wind speed specified on the plans shall be permanently identified on the pole base plate and mast arm mounting plate surfaces and shall be visible after erection.

Each traffic signal pole assembly shall be delivered as a complete unit with fittings and hardware either installed or packaged in such a manner that all parts remain with their associated major components during shipment.

All components of a shipment shall be identified with a weatherproof tag. This tag shall identify manufacturer, contract number and date and destination of shipment.

686.8. Construction Methods. Traffic signal poles shall be located as shown on the plans, except that the Engineer may shift the poles, within design guidelines, where necessary to secure a more desirable location or

to avoid conflict with utilities. Unless otherwise shown on the plans, the Contractor shall stake and the Engineer will verify all traffic signal pole locations.

Foundations shall be constructed in accordance with Item 656, "Foundations for Signs, Traffic Signals and Roadway Illumination Assemblies".

Anchor bolts shall be oriented as shown on the plans.

Erection of poles near any overhead or underground utilities shall be accomplished using established industry and utility safety practices. The Contractor shall consult with the appropriate utility company prior to beginning such work.

Threads of anchor bolts shall be coated with pipe joint compound prior to installation of nuts when erecting the pole.

Lower anchor bolt nuts shall be retightened against the base plate after the upper nuts are tight. A slug wrench and sledge is recommended for tightening nuts.

After the traffic signal pole assembly has been plumbed and all nuts are tight, each anchor bolt nut shall be tack welded in two (2) places to its washer and

each washer shall be tack welded to the base plate in two (2) places. No welding is to be made to the bolt. Galvanizing in tack weld areas shall be repaired using zinc-rich paint in accordance with Item 445, "Galvanizing". The exposed upper threads of the anchor bolts shall be cleaned of pipe joint compound and coated with zinc-rich paint to seal the bolt thread-nut joint.

No grout shall be placed between the base plate and the foundation.

686.9. Measurement. This Item will be measured as each traffic signal pole assembly complete in place.

686.10. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Traffic Signal Pole Assemblies (Steel)" of the various types and sizes specified. This price shall be full compensation for furnishing, fabricating, galvanizing, assembling and erecting the pole upon a foundation; for furnishing and erecting required mast arms and luminaire arms; for furnishing and placing anchor bolts,

nuts, washers and templates; and for all other materials, labor, tools, equipment and incidentals necessary to complete the work, except as shown below.

Foundations will be paid for under Item 656, "Foundations for Signs, Traffic Signals and Roadway Illumination Assemblies".

ITEM 688

TRAFFIC SIGNAL DETECTORS

688.1. Description. This Item shall govern for furnishing and installing traffic signal detectors of the various sizes and types as shown on the plans.

688.2. Materials. Unless otherwise shown on the plans, vehicle detector loop wire shall be stranded copper No. 14 AWG XHHW cross-linked-thermosettting-polyethylene insulated conductor rated for 600 volts AC. Each length of wire shall show the name or trademark of the manufacturer, the insulation voltage rating, the wire diameter and insulation type. This information shall be shown at approximately 0.6 meter intervals on the insulation surface.

Flexible vinyl or polyethylene tubing for loop wire shall be 4.67 millimeters minimum I.D., 0.787 millimeter minimum wall thickness and 6.6 millimeters maximum O.D., having a smooth bore. The tubing shall not adhere to the loop wire in any way and shall be capable of resisting deterioration from oils, solvents, and temperatures up to 100 °C. The tubing shall also be abrasion resistant and remain flexible from -30 °C to 100 °C. Unless otherwise shown on the plans, tubing shall be colored orange or red.

All materials furnished by the Contractor shall be new.

Conduit, when required, shall be in accordance with Item 618, "Conduit".

Ground boxes, when required, shall be in accordance with Item 624, "Ground Boxes".

Sealant for the vehicle detector loops shall be as shown on the plans.

Materials for pedestrian detectors shall conform to the material requirements of Item 682, "Vehicle and Pedestrian Signal Heads".

Information signs for push buttons shall be made of sheet aluminum having a minimum thickness of two (2) millimeters.

688.3. Design of Pedestrian Detectors. The push button assembly shall be weather-tight and tamper-proof. The assembly shall be designed to prevent an electrical shock under any weather condition and shall have provisions for grounding in accordance with the NEC.

The housing shall be a sturdy two (2) piece unit, consisting of a base housing and a removable cover. The internal components shall provide a push button with normal open contacts and shall include all electrical and mechanical parts required for operation. The housing shall be cast aluminum. The housing or an adaptor (saddle) shall conform to the pole shape, fitting flush to ensure a rigid installation. Adaptors shall be of the same material and construction as the housing. Threaded holes for 12.7 millimeters conduit shall be provided in the housing for any necessary conduit attachment. Unused openings shall be closed with a weather-tight closure and painted to match the housing. A 19 millimeter hole with an insulating bushing shall be provided through the back of the housing.

The complete body of the housing shall conform to the paint requirements of Item 682, "Vehicle and Pedestrian Signal Heads".

The manufacturer's name or trademark shall be located on the housing.

The push button switch shall have single-pole, single-throw contacts and screw-type terminals. The switch shall have a design life of one (1) million operations (minimum).

688.4. Construction Methods.

(1) Pedestrian Detectors. The push button shall be wired to the nearest splicing point or terminal strip using stranded No. 12 AWG XHHW wire with 600 volt insulation. No splicing or terminal connection of wire leads will be permitted, except in the hand holes located in the signal pole shaft, in the signal pole base or at locations approved by the Engineer. All allowed splices shall be water-tight.

Attachment of wires to terminal posts shall be made with solderless

terminals. The terminals shall be attached to the wires with a ratchet type compression crimping tool properly sized to the wire.

A pedestrian push button sign shall be mounted near each push button as shown on the plans.

(2) Vehicle Detectors. The loop location, configuration, wire color and number of turns shall be as shown on the plans. Loops may be adjusted by the Engineer to fit field conditions.

(a) Saw Cuts. The pavement shall be cut with a concrete saw to form neat lines. Saw cuts in concrete bridge slabs shall not exceed 25 millimeter in depth. All other saw cuts shall be deep enough to provide a minimum of 25 millimeter depth of sealant over the wire. Unless otherwise shown on the plans, a separate saw cut shall be made from each loop to the edge of the pavement. The cut shall be clean and dry when the wire and sealant are placed.

(b) Conduit. Conduit shall be placed between the pavement and ground box as shown on the plans.

(c) Loop Wire Color. Unless otherwise shown on the plans, all loops in the same lane shall be the same color and shall have the following color code. Loops installed in multi-lanes will have the same color code in the order the loops are installed.

When facing the same direction that traffic flows, the color code will read from right to left for all lanes carrying traffic in that direction. If traffic moves in two directions, the color code will be repeated for the other direction of traffic.

The first loop on the right shall be white followed by black, orange, green, brown and blue.

(d) Loop Wire Installation. When shown on the plans the loop wire shall be placed in a flexible vinyl or polyethylene tubing in accordance with Article 688.2. The requirements of Section 688.4.(2)(c) do not apply to wires in tubing.

Wire from the loop to the ground box shall be twisted a minimum of 17 turns per meter. When there is only one (1) pair of wires in a saw

cut they need not be twisted while in the saw cut. Loop wire shall have no splices in the loop or in the run to the ground box.

The loop wire shall be held in place every 0.6 meter with strips of rubber, neoprene flexible tubing or polyethylene foam sealant approximately 25 millimeters in length. These strips shall be left in place and the slot filled with loop sealant.

Splices between the loop lead-in cable and loop detector wires shall be made only in the ground box near the loop it is serving. Splices shall be soldered using non-corrosive solder and shall be water-tight. The drain wire of the loop lead-in cable shall be grounded to earth ground only at the controller or detector cabinet. The resistance from the drain wire to the ground rod shall be less than one (1) ohm.

688.5. Measurement. This Item will be measured by the meter of saw cut containing loop wire and by each pedestrian push button.

This is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities is required, additional measurements or calculations will not be required.

688.6. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Vehicle Detectors" or "Pedestrian Detectors" of the various sizes and types specified. This price shall be full compensation for furnishing, installing and testing the detectors; and for all labor, tools, equipment and incidentals necessary to complete the work, except as shown below.

Ground boxes will be paid for under Item 624, "Ground Boxes".

Conduit will be paid for under Item 618, "Conduit".

Loop lead-in cable will be paid for under Item 684, "Traffic Signal Cables".

PART II, CONSTRUCTION AND MAINTENANCE DETAILS

DIVISION VII
MAINTENANCE

ITEM 700

POTHOLE REPAIR

700.1. Description. This Item shall govern for repair of potholes, spalled areas and ravelled or damaged pavement edges of various sizes in roadway surfaces.

700.2. Materials. The Department will furnish all materials unless otherwise specified. Materials, when furnished by the Department, will be located at sites designated in the **General Notes and Specification Data Sheet(s)**.

The Contractor shall not use any materials furnished by the Department on any work which is not required by and which does not constitute a part of the contract. Materials not used which were furnished by the Department shall be returned to the location from which the materials were obtained upon completion of the work.

700.3. Equipment. The Contractor shall furnish all equipment, tools and machinery necessary for the proper prosecution of the work. The equipment, tools and machinery shall be on the work site in good repair and operating condition and approved by the Engineer prior to beginning work. If at any time, the Engineer determines any equipment is defective to the point that it may affect the quality of the work, that equipment shall be immediately repaired or replaced.

700.4. Scope of Work. Pothole repair shall consist of one of the following types of work which includes potholes, spalled areas and edge repair. Unless otherwise directed by the Engineer, the Contractor shall perform pothole repair in accordance with one of the following construction methods:

(1) Standard Repair (Type A). The Contractor shall remove loose and foreign material from the area to be repaired. The tack coat shall then be applied to all surfaces of the area of the repair (tack coat may not be required for certain repair materials). The repair material shall be placed in compacted lifts not to exceed 75 millimeters per lift. The

repaired area shall be raked, graded and compacted to conform to the existing roadway surface. Compaction shall be accomplished with hand, mechanical tampers or rollers as approved by the Engineer. Approved methods of compaction shall continue until no further consolidation is apparent or as directed by the Engineer.

When repairing potholes in the pavement edge and/or ravelled pavement edges, the Contractor shall assure that the repaired pavement edge is straight and conforms to the grade and alignment of the adjacent pavement edge. The roadway surface shall be cleaned after pothole repair operations and all materials removed shall be disposed of in a manner satisfactory to the Engineer.

(2) Saw-Cut Repair (Type B). The Contractor shall square the sides of the area to be repaired. Remove all the loose and foreign material to solid material as directed by the Engineer. The squaring of the sides shall be accomplished by saw-cutting or other methods approved by the Engineer. Areas to be repaired shall be clean and dry prior to application of the tack coat. The Contractor shall apply a tack coat to all surfaces of the area to be repaired unless otherwise directed by the Engineer. The repair material shall be placed in compacted lifts not to exceed
75 millimeters per lift. Compaction shall be accomplished with hand, mechanical tampers or rollers as approved by the Engineer. Approved methods of compaction shall continue until no further consolidation is apparent or as directed by the Engineer. Final compaction shall be obtained by the use of a flat wheel or pneumatic tired roller or as directed by the Engineer. The completed repair shall conform to the grade and profile of the adjacent roadway surface. The roadway surface shall be cleaned after pothole repair operations and all materials removed shall be disposed of in a manner satisfactory to the Engineer.

700.5. Measurement. This Item will be measured by the square meter of surface area or cubic meter of asphaltic repair material used in the accepted work. If the repairs are measured by the cubic meter, the volume of material used will be measured by one of the following methods:

(1) Method 1. The Contractor's pothole repair trucks will be measured and the volume in cubic meters shall be calculated for a legally transported load. This volume shall be displayed on the driver's side at the front of the dump bed. The Contractor's pothole repair truck shall be loaded not to exceed the legal limit, leveled off by the Contractor and then inspected by the Engineer prior to beginning work. Each additional load during the day shall be inspected before and after loading material. At the

end of the work day, the Contractor shall level off the remaining material on the truck and the Engineer will measure and calculate the volume of material used. The remaining material shall then be returned to the proper stockpile unless otherwise directed by the Engineer.

(2) Method 2. The Contractor's pothole repair trucks shall be weighed on State-approved scales and the conversion from mass to volume will be based on the unit weight of the patching material being used, as determined by the Engineer. Each additional load during the day shall be weighed before and after loading material. Weight tickets shall be required and provided to the Engineer for approval.

700.6. Payment. The work performed in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit prices bid for "Standard Repair, Type A", and/or "Saw-Cut Repair, Type B". This prices shall be full compensation for furnishing materials, when specified on the plans; for application of the tack coat; for disposal of debris; for leveling off or weighing the load for measurement; and for all labor, tools, equipment and incidentals necessary to complete the work.

ITEM 706

MOWING HIGHWAY RIGHT OF WAY

706.1. Description. This Item shall govern for mowing the highway right of way, in conformance with the details shown on the plans.

706.2. Equipment. Rotary mowers will normally be required in the mowing of all right of way. Sickle mowers may be used around bridges, culverts, sign posts, mailboxes, delineators, guardrail, etc., when approved by the Engineer. Other types of grass-cutting equipment may be used provided the equipment has been approved by the Engineer prior to use.

All rotary mowers must be equipped with either safety chains or the manufacturer's safety device to prevent damage to property caused by flying debris propelled out from under the mower. Chains shall be a minimum of eight (8) millimeters in size and links spaced side by side around the mower's front, sides and rear. When sitting on level ground, at a level cutting height of 175 millimeters, the chains shall be long enough to drag the ground. Maximum cutting widths for rigid frame rotary mowers shall be 2.75 meters. Hinged or batwing mower cutting widths shall be as approved by the Engineer. All mowers shall be kept in good operating **706.3**

condition and shall be maintained to provide a clean sharp cut of vegetation at all times. All equipment shall be approved by the Engineer. If at any time, the Engineer determines any equipment is defective to the point that it may affect the quality of the work, that equipment shall be immediately repaired or replaced.

706.3. Scope of Work.

(1) Sequence of work. The sequence of work shall be as established by the Engineer or as requested by the Contractor and approved by the Engineer.

(2) Mowing Types. Mowing shall be performed under one of the following types:

(a) Type I (Strip Mowing). The strip width as designated in the **General Notes and Specification Data Sheet(s)** and/or in the plans.

Strip mowing shall include mowing a strip of vegetation along the edge of the pavement or shoulder and from the shoulders or curbs to the right of way line adjacent to developed areas.

Strip mowing shall also include all mowing necessary to maintain adequate sight distances at intersections, private entrances, off ramps, on ramps, signs, delineators and curves.

(i) Appurtenances. Mowing will be performed around all appurtenances (signs, delineators, guardrail, culvert headwalls, etc.) that are within the designated strip width.

(ii) Medians and Outer Separations. All center medians and outer separations less than the width as designated in the **General Notes and Specification Data Sheet(s)** and/or on the plans shall be mowed full width. When the median or outer separation is greater than the specified width, a designated strip width shall be mowed along each side.

(iii) Transitions. Strip mowing shall include smooth and gradual transitions between the designated strip width and other areas that require a greater or lesser mowing width. The rate of transition shall be as designated in the **General Notes and Specification Data Sheet(s)** and/or on the plans.

(iv) Mowing Under Bridges. Strip mowing shall include mowing full width from right of way line to right of way line under bridges, in drainage channels and easements.

(b) Type II (Full Width Mowing). All unpaved areas in the entire right of way, including medians and outer separations, except those areas that are designated as non-mow and/or vegetation management areas.

(c) Type III (Spot Mowing). All areas which, in the opinion of the Engineer, need to be mowed on an emergency basis, between scheduled mowings. The Contractor shall respond to an emergency request within 24 hours of verbal notification. If an emergency request for spot mowing is for a total area less than one (1) hectare, a minimum of one (1) hectare will be paid.

(3) Hand Trimming. The Contractor shall mow as close as possible to all fixed objects exercising extreme care not to damage trees, plants, shrubs, signs, delineators or other appurtenances which are a part of the facility. Hand trimming around such objects shall be required of the Contractor, unless specified otherwise, and will be subsidiary to the mowing operation and has been included in the total working days allowed.

(4) Mowing Time Limits. Mowing will not be permitted when, in the opinion of the Engineer, soil and weather conditions are such that the right of way will be damaged. No time will be charged when, in the opinion of the Engineer, soil or weather conditions do not allow mowing.

The Type III Mowing shall begin within 24 hours after verbal notification.

(5) Non-Mow Areas. The Department will determine all non-mow and vegetation management areas.

(6) Cutting Height. Mowers shall be adjusted for a cutting height as designated in the **General Notes and Specification Data Sheets**.

(7) Wildflowers. The Contractor shall conduct all mowing operations so as to avoid clearing or removing stands of wildflowers before the seeds have matured, unless otherwise directed by the Engineer.

(8) Debris Thrown on the Roadway. The Contractor shall immediately remove and properly dispose of any debris thrown on the roadway by the mowing operation. Mowed grass will not normally be removed unless it becomes a hazard as determined by the Engineer.

706.4. Measurement. This Item will be measured by the hectare.

For Type I and II Mowing, this is a plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal of the contract plans, except as may be modified by Article 9.8. If no adjustment of quantities,is required, additional measurements or calculations will not be required.

For Type III Mowing, payment will be made for the actual area mowed and measured in the field by the Engineer except as specified under Section 706.3(2)(c).

706.5. Payment. The work performed in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit prices bid for "Type I (Strip Mowing)", "Type II (Full Width Mowing)" or "Type III (Spot Mowing)".

This price shall be full compensation for furnishing all labor, equipment, fuel, tools and incidentals necessary to complete the work.

ITEM 712

LITTER PICKUP AND DISPOSAL

712.1. Description. This Item shall govern for the pickup and disposal of litter which is discarded onto the right of way, (excluding the traveled lanes). Litter is defined as trash and/or garbage and is further described as, but not limited to, scrap metals, rags, paper, wood, plastic, glass and rubber products, including whole tires.

712.2. Supplies and Equipment.

(1) The Contractor shall furnish all litter bags, tools, hard hats, safety vests, rubber boots, gloves, transportation to and from the work area, and all other safety materials or devices necessary to perform the work in a safe and orderly manner.

(2) All vehicles used in transporting litter must be equipped so as to prevent the accumulated litter from being strewn along the roadway.

(3) Vehicles shall be equipped with highly visible omni-directional flashing amber light(s).

712.3. Scope of Work.

(1) The Contractor shall be required to pick up all litter on the right of way when directed by the Engineer. All litter collected by the Contractor becomes the property of the Contractor and shall be disposed of at a State-approved solid waste site. Bagged litter shall be picked up the same day of collection unless otherwise approved by the Engineer.

(2) The Contractor will not be responsible for removal of dead animals or large bulky or heavy items of litter, such as tree stumps, that require mechanical lifting equipment. It shall be the Contractor's responsibility to notify the Engineer of any items that require special handling.

(3) All whole tires shall be picked up and taken to the site(s) designated in the **General Notes and Specification Data Sheet(s)**.

712.4. Measurement.

(1) This Item will be measured by the hectare or cycle.

(2) A cycle is defined as the activity necessary for performing all work within the right of way and project limits, one time.

712.5. Payment. The work performed in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit prices bid for "Litter Pickup and Disposal". This price shall be full compensation for collecting, hauling and disposing of all litter, and for all labor, tools, equipment and incidentals necessary to complete the work.

Pickup and delivery of whole tires will not be paid for directly but will be considered subsidiary to this Item.

ITEM 718

CLEANING AND SWEEPING HIGHWAYS

718.1. Description. This Item shall govern for the cleaning and sweeping of highways.

718.2. Equipment. The equipment shall consist of street sweeping vehicles equipped with gutter broom(s) capable of dislodging crusted debris from road surfaces, a water tank with proper spray assemblies for dust control, a pickup mechanism capable of removing debris from the roadway and a dirt hopper with sufficient capacity to allow operation to progress with minimum interference when sweeping highways under traffic. Other types of cleaning and sweeping equipment, as well as hand labor, shall be provided where deemed necessary and approved by the Engineer.

The equipment, tools and machinery shall be on the work site in good repair and operating condition and approved by the Engineer prior to beginning work. If at any time, the Engineer determines any equipment is defective to the point that it may affect the quality of the work, that equipment shall be immediately repaired or replaced.

718.3. Scope of Work.

(1) The Contractor shall remove all debris from the designated areas to the satisfaction of the Engineer. All debris collected by the Contractor becomes the property of the Contractor and it is the Contractor's responsibility to dispose of such debris at a State-approved solid waste site.

(2) Dirt and debris on all sides of raised pavement markers shall be removed to the satisfaction of the Engineer.

(3) Cleaning and sweeping highways shall be performed under one or more of the following types:

(a) Type I. Center Median Cleaning and Sweeping: An area comprising the entire paved center median or left-hand paved shoulder and

paved gutter regardless of width, including all left-hand bridge shoulders, regardless of width, and all structures and exit ramps exiting from the left-

hand side of all main lanes, i.e., at an interchange, in both directions of travel.

(b) Type II. Outside Main Lane Cleaning and Sweeping: An area comprising the entire outside lane or right-hand paved shoulder or paved gutter regardless of width, including all right-hand bridge shoulders regardless of width, all intersecting streets and/or driveways to the right of way line or as shown on the plans and all structures in both directions of travel.

(c) Type III. Frontage Road Cleaning and Sweeping: An area comprising the entire right-hand and left-hand paved shoulder and paved gutter regardless of width, including all right-hand and left-hand shoulders on bridges regardless of width, all U-Turn lanes (both right and left sides), and all intersecting streets including underpasses and overpasses (both right and left sides), on the frontage roads in both directions of travel.

(d) Type IV. Entrance and Exit Ramp Cleaning and Sweeping: An area comprising the ramps (both right and left sides) exiting from anywhere other than the left-hand main lane in both directions of travel and entering from the frontage road in both directions of travel.

(e) Type V. Spot Sweeping: Sweeping partial areas, as required by the Engineer, due to spills or other unexpected circumstances. The Contractor shall respond to a verbal notice within the time period specified in the **General Notes and Specification Data Sheet(s)**. A minimum of one (1) lane kilometer will be paid for each request. Failure to respond to a request shall be cause for State Forces to do such work and shall be cause for default in accordance with Article 8.7 of the Standard Specifications.

(4) Included in the above described Types will be the cleaning and sweeping under and around all appurtenances to the facility.

718.4. Measurement.

(1) This Item will be measured by the highway centerline kilometer or cycle for Type I, II, III and IV. Type V (Spot Sweeping) will be measured by the lane kilometer.

(2) A cycle is defined as the activity necessary for performing the

specified cleaning and sweeping work on the specified areas, one time.

718.5. Payment. The work performed in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit prices bid for "Cleaning and Sweeping Highways" of the types specified. This price shall be full compensation for cleaning, sweeping, hauling and disposing of all debris removed from the highway right of way and for all labor, tools, equipment and incidentals necessary to complete the work.

ITEM 724

PICNIC AREAS

724.1. Description. This Item shall govern for janitorial and grounds maintenance of picnic areas.

724.2. Supplies and Equipment. Litter barrel liners will be furnished by the Department unless otherwise specified. The Contractor shall furnish all other supplies and equipment necessary to successfully perform the duties.

All vehicles used in transporting litter shall be equipped to prevent the accumulated litter from being strewn along the roadway. Unless otherwise specified, vehicles shall be equipped with highly visible omni-directional flashing amber lights.

724.3. Scope of Work. Schedules for janitorial and grounds maintenance are designated in the General Notes and Specification Data Sheet(s).

It shall be the Contractor's responsibility to report any needed repairs or vandalism that may be noticed during cleanup. This information shall be reported to the Engineer in writing or by telephone if approved by the Engineer.

(1) Janitorial Maintenance.

(a) Cleaning. Tables, benches, arbors, barbecue pits, fire boxes, drinking fountains and other outdoor appurtenances shall be cleaned as directed by the Engineer. Soiled and stained items shall be cleaned with a cleaner and/or disinfectant, approved by the Engineer, and then immediately rinsed thoroughly with clean water. The Contractor shall not apply a disinfectant to the table or

bench tops unless the surfaces can be rinsed off immediately with clean water.

All slabs, walks and driveways shall be kept free of sand, gravel, grease, leaves, spillage and/or debris.

(b) Litter Pickup and Disposal. Litter is defined as trash, wastepaper, garbage or other items discarded in the picnic area(s) and described as, but not limited to, scrap metals, paper, wood, plastic, glass products, bottle caps, ring-pull tabs, cigarette butts, feces and animal remains.

Picnic area(s) shall be cleaned of all litter within the limits shown on the plans.

All litter barrels shall be emptied and the existing liner shall be replaced with a new liner. Barrels shall be periodically cleaned as directed by the Engineer. All litter collected by the Contractor shall become the property of the Contractor and shall be disposed of at a State-approved solid waste site. Bagged litter shall be picked up and disposed of on the same day of collection unless otherwise approved by the Engineer.

(2) Grounds Maintenance. Picnic areas shall be mowed as designated on the plans. Mowing shall include edging all sidewalks, arbor units and curbs, trimming around all trees, shrubs, light poles, guard posts, delineator posts, culvert headwalls and any other appurtenances.

Grass shall be cut to an approximate height of 50 millimeters. Push-type lawn mowers or hand-held trimmers may be required around trees, arbor units and other fixtures. Tractor-driven mowers may be allowed in other areas, but must produce an appearance satisfactory to the Engineer. Extreme care shall be used around trees and other tender vegetation when using mowers or trimmers. The Contractor will be responsible for replacement of vegetation damaged due to improper or careless mowing and trimming operations. Weeds, grass and other undesirable growth shall be removed from beds of plants and shrubs as needed. In addition, trees and shrubs shall be trimmed as directed by the Engineer.

Methods and/or directions for the removal and disposal of grass clippings, tree clippings, leaves and/or pine straw shall be as shown in the General Notes and Specification Data Sheet(s).

724.4. Measurement. This Item will be measured as follows:

(1) Janitorial Maintenance will be measured by the cycle. A cycle is defined as the satisfactory completion of janitorial maintenance shown on the plans each designated time.

(2) Grounds Maintenance will be measured by the cycle or hectare. A cycle is defined as the satisfactory completion of mowing and other required grounds maintenance activities shown on the plans each designated time.

724.5. Payment. The work performed in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit prices bid for "Janitorial Maintenance" and "Grounds Maintenance". This price shall be full compensation for furnishing all labor, tools, equipment and incidentals necessary to complete the work.

ITEM 730

REST AREAS

730.1. Description. This Item shall govern for janitorial and grounds maintenance of rest areas.

730.2. General.

(1) The number and location of rest areas, the number of attendants, their duty hours and other scheduled items of work shall be as designated in the **General Notes and Specification Data Sheet(s)**. Work performed under this Item shall be done seven (7) days a week, including holidays.

(2) Attendants shall not perform grounds maintenance while responsible for janitorial maintenance unless otherwise designated in the **General Notes and Specification Data Sheet(s)**.

(3) It shall be the Contractor's responsibility to report daily any needed repairs or vandalism that may be noticed during the performance of this contract.

(4) One storage area at each rest area will be provided to the Contractor for storage of equipment and supplies. This area is to be kept in a clean and orderly condition at all times. The Department will not be responsible for the Contractor's equipment and supplies that will be in the storage area. The storage area shall be locked at all times when not occupied.

(5) "Lost and Found" items discovered at the rest area(s) are to be placed in the storage area until they may be collected by the Engineer. The Contractor shall report daily all items found in the work place to the Engineer. Items such as money, jewelry or drugs should be reported immediately to the Engineer.

(6) Attendants shall not accept tips or other gratuities. No visitors, including relatives, of the Contractor's employees will be allowed in the rest area(s) during working hours, unless they are bona fide employees of the Contractor.

(7) The Contractor shall have a minimum of one English-speaking employee on the job during duty hours. All employees shall be well-groomed and neatly dressed at all times when on duty.

(8) Attendants shall wear the Department's standard attendant uniform at all times while on the job site. These uniforms shall be purchased at the Contractor's expense from the Department.

(9) Any malfunction of any facility in the rest area(s) shall be considered as an emergency. The attendant shall notify the Engineer immediately as to the nature of the malfunction. The Department will be responsible for all major maintenance work involving the electrical system, plumbing system, utility lines, hand dryers, light fixtures, lavatory fixtures and toilets and any other major repairs deemed necessary for operation of the rest area(s).

730.3. Supplies and Equipment. Toilet tissue, hand soap, deodorants, paint, repair materials and litter barrel liners will be furnished by the Department unless otherwise specified. The Contractor shall furnish all other supplies, including water hoses and movable sprinklers, and equipment necessary to successfully perform the duties.

All cleaning agents and disinfectant supplies shall be approved by the Engineer.

All vehicles used in transporting litter shall be equipped to prevent the accumulated litter from being strewn along the roadway. Unless otherwise specified, vehicles shall be equipped with highly visible omni-directional flashing amber lights.

730.4. Scope of Work.

(1) Janitorial Maintenance.

(a) The following services shall be performed at least once **daily** (or at least once during each work shift if more than one shift per day) and then as often as needed, in accordance with the following instructions:

(i) The floors shall be cleaned with a solution of water and a cleaner. Cleaning solutions shall be thoroughly removed. The Contractor shall furnish and display "Caution Wet Floor" signs until the floor is dry. Floors shall be kept clean at all times.

(ii) All walls adjacent to rest room fixtures, all doors, woodwork and handrails shall be cleaned. Abrasive cleaning powders shall not be used to clean the walls and ceilings. Cleaning solutions shall be thoroughly removed. All other walls and ceilings shall be kept clean at all times.

(iii) All surfaces of the lavatories including metal levers, spouts and drains shall be cleaned. Cleaning solutions shall be thoroughly removed. All areas shall be wiped dry.

(iv) The inner surfaces of the urinals and toilets shall be scrubbed and the seat, rim and other surfaces of the fixtures, including the inner surface, shall then be cleaned. Exteriors and rims shall then be wiped dry. The manufacturer's recommended amount of disinfectant/deodorant shall be used and allowed to remain in toilets. All commode seats and hinge assemblies shall be sprayed with a disinfectant.

(v) Glass mirrors shall be cleaned with a glass cleaner and then wiped dry. Stainless steel mirrors shall be cleaned with a mild liquid soap and wiped dry with a soft cloth.

(vi) All rest room wastepaper units and trash receptacles shall be emptied.

(vii) Toilet tissue and hand soap dispensers shall be adequately supplied at all times. Adequate overnight supplies are to be provided at the end of each day.

(viii) All hoses, buckets and other cleaning materials shall be returned to

the storage area immediately after use.

(ix) Rest rooms may be closed to the public for a maximum of 30 minutes during each cleaning operation.

(x) The Contractor shall remove graffiti or other markings from the rest area as soon as it is found. If required, graffiti or other markings on painted surfaces that cannot be washed off, shall be painted over by the Contractor. The Contractor shall use an appropriate repair material on graffiti scratched into any surface, before applying paint. The Contractor shall furnish all brushes, rollers, etc. necessary to apply the filler and paint, and furnish and display "Caution Wet Paint" signs. The Department will furnish the repair material and paint.

(11) The rest area(s) shall be kept clean at all times and at the end of each day, or shift, left in a clean and presentable condition.

(b) Grass, trees and shrubs shall be watered during the early morning hours or as directed by the Engineer. Fertilizing, unless otherwise directed, will be performed by the Department.

(c) Drinking fountains shall be kept clean at all times. Water to the drinking fountains shall be turned off and drained, when necessary, if freezing temperatures are expected.

(d) The inside and outside of the display case shall be kept clean. The acrylic covering, such as Plexiglas, shall be cleaned with water and a mild liquid soap. Caution: Use a very soft cloth and warm soapy water only! A glass cleaner, paper towel or abrasive of any kind shall not be used to clean or polish the acrylic coverings.

(e) Tables, benches, arbors, barbecue pits, fire boxes and other outdoor appurtenances shall be kept clean as directed by the Engineer. Soiled and stained items shall be cleaned with a cleaner and/or disinfectant, approved by the Engineer, and then rinsed thoroughly with clean water. Brushes or cloths, which have been used for cleaning in rest rooms, shall not be used to clean tables or benches. The Contractor shall not apply a disinfectant to the table or bench tops unless the surfaces can be rinsed off immediately with clean water.

All slabs, walks and driveways shall be kept free of sand, gravel, grease, leaves, spillage and/or debris.

(f) Rest area(s) shall be cleaned of all litter within the limits shown on the plan layout. Litter is defined as trash, wastepaper, garbage or other **730.5**

items discarded in the rest area(s) and described as, but not limited to, scrapmetals, paper, wood, plastic, glass products, bottle caps, ring-pull tabs, cigarette butts, feces and animal remains.

All litter barrels shall be emptied daily or more often as needed and the existing liner replaced with a new liner. Barrels shall be periodically cleaned as directed by the Engineer. The contents may be temporarily stored at a site located at the rest area which is approved by the Engineer. All litter collected by the Contractor shall become the property of the Contractor and shall be disposed of at a State-approved solid waste site. Bagged litter shall be picked up and disposed of on the same day of collection unless otherwise approved by the Engineer.

(2) Grounds Maintenance. Rest area(s) shall be mowed as designated on the plans. Mowing shall include edging all sidewalks, arbor units and curbs, trimming around all buildings, trees, shrubs, light poles, guard posts, delineator posts, culvert headwalls and any other appurtenances.

Grass shall be cut to an approximate height of 50 millimeters. Push-type lawn mowers or hand-held trimmers may be required around trees, arbor units and other fixtures. Tractor-driven mowers may be allowed in other areas, but must produce an appearance satisfactory to the Engineer. Extreme care shall be used around trees and other tender vegetation when using mowers or trimmers. The Contractor will be responsible for replacement of vegetation damaged due to improper or careless mowing and trimming operations.

Weeds, grass and other undesirable growth shall be removed from beds of plants and shrubs as needed. In addition, trees and shrubs shall be trimmed as directed by the Engineer.

Methods and/or directions for the removal and disposal of grass clippings, tree clippings, leaves and/or pine straw shall be as shown in the **General Notes and Specification Data Sheet(s)**.

730.5. Measurement. This Item will be measured as follows:

(1) Janitorial Maintenance will be measured by the month. One month is defined as the satisfactory execution of janitorial maintenance for all the rest areas shown on the plans for a period of one month.

(2) Grounds Maintenance will be measured by the cycle or hectare. A cycle is defined as the satisfactory completion of mowing and other required grounds maintenance activities shown on the plans each designated time.

730.6. Payment. The work performed in accordance with this Item and measured as provided for under "Measurement" will be paid for at the unit prices bid for "Janitorial Maintenance" and "Grounds Maintenance". This price shall be full compensation for furnishing all labor, tools, equipment and incidentals necessary to complete the work.

For any day when janitorial maintenance services are not satisfactorily completed as determined by the Engineer, one day's pay shall be deducted from the Contractor's monthly payment. One day's pay will be determined by dividing the monthly bid price by 30 days.

ITEM 736

TREES, UNDERBRUSH AND SHRUBS

736.1. Description. This Item shall govern for the removal and disposal of trees, underbrush, shrubs and vines, and the pruning and trimming of trees and shrubs.

736.2. Equipment. The Contractor shall furnish all equipment, tools and machinery necessary for the proper prosecution of the work. The equipment, tools and machinery shall be on the work site in good repair and operating condition prior to beginning work. If at any time the Engineer determines any equipment is defective to the point that it may affect the quality of the work, that equipment shall be immediately repaired or replaced.

736.3. Scope of Work. The limits of work and methods of marking trees shall be as shown on the plans or as designated in the **General Notes and Specification Data Sheet(s)**. This includes areas under bridges and around culverts. Cut trees, stumps and debris will become the property of the Contractor and shall be removed from the right of way and disposed of in a manner satisfactory to the Engineer. Pruning and trimming shall conform to the horticultural practices as determined by the Engineer appropriate to the various types of trees and shrubs and special requirements of each tree and shrub.

Those trees, shrubs and other landscape features designated by the Engineer for preservation, shall be carefully protected from abuse, marring or damage.

Unless otherwise specified, all debris from pruning, trimming, removing underbrush and chips resulting from the use of a chipping machine shall not be allowed to accumulate and shall be disposed of on sites, provided by the Contractor, outside the right of way. Chips may be spread in a thin layer, inside the right of way, when authorized by the Engineer.

Any diseased and/or infected trees shall be disposed of as designated in the **General Notes and Specification Data Sheet(s)** or as directed by the Engineer.

The Contractor shall exercise caution whenever working near any utilities, such as telephone or power lines.

(1) Tree Removal. All trees of the diameter shown on the plans, shall be removed and disposed of off the right of way. All tree stumps shall be removed to a depth as shown in the **General Notes and Specification Data Sheet(s)**. Holes shall be backfilled with an acceptable material. Backfill shall be compacted and finished flush with the surrounding ground and left in a clean and neat condition.

(2) Tree Pruning and Trimming. Pruning and trimming shall be conducted in such a manner that the original symmetry of the tree is preserved. Pruning and trimming shall conform to the horticultural practices as determined by the Engineer. All dead tree limbs shall be removed. Tree limbs extending over the pavement shall be trimmed to the height shown on the plans.

(a) All cuts shall be made sufficiently close to the trunk or parent limb, without cutting into the branch collar or leaving a protruding stub.

(b) All suckers shall be removed to the height of the lowest main branch.

(c) The following steps shall be taken when removing limbs that are 50 millimeters in diameter or larger:

(i) Undercut 1/3 way through the limb 200 millimeters to 300 millimeters from the main stem.

(ii) Remove limb 100 millimeters to 150 millimeters above the first cut.

(iii) Remove stub with an even flush cut so that a trace (collar) still protrudes (approximately 13 millimeters).

(iv) Treat exposed cut with an approved dressing.

(v) If necessary to prevent damage to other limbs, the limb being removed shall not be allowed to fall free.

(d) Tools are to be disinfected with 70 percent methyl alcohol or a chlorine solution, when moving from one tree to another to prevent the spread of disease.

(3) Underbrush Removal. All underbrush, which shall include but not be limited to bushes, small trees (less than 125 millimeters in diameter) and vines growing inside the right of way line shall be removed by cutting parallel to the ground, not to exceed 25 millimeters above the ground and within 150 millimeters of the right of way or fence line, unless otherwise noted on the plans. No further work to remove the stumps will be required.

(4) Shrub Trimming. All shrubs shall be trimmed in the appropriate manner for the type shrub. All dead material shall be removed from the shrubs, as well as all limbs that are close to the ground. Remove any undesirable plants that may be in or around the shrubs. All shrubs shall be uniform in appearance at each location. The extent of the trimming will be as shown on the plans and/or as directed by the Engineer.

736.4. Measurement. This Item will be measured as follows:

(1) Tree Removal will be measured by each tree removed of the diameter specified. The diameter shall be measured one (1) meter above natural ground line.

(2) Tree Pruning and Trimming, Underbrush Removal and Shrub Trimming will be measured by the lump sum or by the kilometer, or portion of. This measurement shall include both sides of the highway right of way.

736.5. Payment. The work performed in accordance with this Item and measured as provided for under "Measurement" will be paid for at the unit prices bid for "Tree Removal" of the diameter specified, "Tree Pruning **742.1 to**

and Trimming", "Underbrush Removal" and/or "Shrub Trimming". This price shall be full compensation for furnishing all labor, tools, equipment and incidentals necessary to complete the work.

ITEM 742

STORM SEWER SYSTEM CLEANING

742.1. Description. This Item shall govern for the hydraulic cleaning and vacuum removal of all debris in inlets, culverts, storm sewer pipes, wells or sumps.

742.2. Materials. Water shall be furnished by the Contractor and shall be clean and free of foreign material as approved by the Engineer.

742.3. Equipment. The Contractor shall furnish all equipment, tools and machinery necessary for the proper prosecution of the work. The equipment, tools and machinery shall be on the work site in good repair and operating condition and approved by the Engineer prior to beginning work. If at any time, the Engineer determines any equipment is defective to the point that it may affect the quality of the work, that equipment shall be immediately repaired or replaced.

A self-contained, single unit vehicle capable of maintaining 225 liters per minute at 13,800 kilopascals of pressure with a minimum of 152 meters of hose, having a 10.5 cubic meter (minimum) dump bin and a 4900 liter (minimum) water tank and having adequate vacuum power on an approximately 200 millimeter diameter tubing to clean pump house wells up to a 16.76 meter depth will be required unless otherwise approved or directed by the Engineer.

742.4. Scope of Work. The Contractor shall remove and dispose of all debris and wash water from the designated areas to the satisfaction of the Engineer. No such debris or wash water will be allowed to be dumped or stockpiled on State property. All debris and wash water collected by the Contractor shall become the property of the Contractor and shall be disposed of at a State-approved solid waste site.

Hydraulic cleaning and vacuum removal shall be performed on the following drainage structures:

(1) **Inlet Cleaning** - The cleaning of the entire inlet whether it is a curb

inlet, catch basin or manhole.

(2) Well Cleaning - The cleaning of the entire pump well including the basket and inlet pipes.

(3) Sump Cleaning - The cleaning of the entire sump box.

(4) Storm Sewer Cleaning - The cleaning of a storm sewer pipe or culvert.

742.5. Measurement. This Item will be measured as follows:

(1) Inlet Cleaning, Well Cleaning and Sump Cleaning will be measured by the each.

(2) Storm Sewer Cleaning will be measured by the meter of hose extended into the storm sewer of the specified diameter or size.

742.6. Payment. The work performed in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit prices bid for "Inlet Cleaning", "Well Cleaning", "Sump Cleaning" and/or "Storm Sewer Cleaning". This price shall be full compensation for cleaning; for disposing of all debris and wash water; and for all labor, tools, equipment and incidentals necessary to complete the work.

ITEM 748

METAL BEAM GUARD FENCE REPAIR

748.1. Description. This Item shall govern for repairing, removing and replacing and/or upgrading rail elements, posts, terminal anchor sections and/or other appurtenances.

748.2. Materials. Unless otherwise specified, the Contractor shall furnish the concrete. The concrete for the terminal anchor posts or for the embedment of other posts in concrete, where embedment is required, shall meet the requirements for Class "A" Concrete as specified in Item 421, "Portland Cement Concrete".

If approved by the Engineer, the concrete may be mixed on the jobsite. The mix shall be three (3) parts aggregate, two (2) parts sand and one (1) part cement. Aggregate and sand shall be approved by the Engineer prior to use.

The Department will furnish all other materials. Materials furnished by the Department will be located at sites designated in the General Notes and Specification Data Sheet(s).

The Contractor shall not use any materials furnished by the Department on any work which is not required by and which does not constitute a part of the contract. Materials not used which were furnished by the Department shall be returned undamaged to the location from which the materials were obtained upon completion of the work.

Any unused or removed material deemed salvageable by the Engineer shall remain the property of the Department and shall be delivered to a designated site. Any material deemed not salvageable shall be disposed of by the Contractor at a site(s) to be provided by the Contractor outside the highway right of way. The disposal site(s) shall be approved by the Engineer.

748.3. Equipment. The Contractor shall furnish all equipment, including but not limited to oxygen, acetylene, welding rods, arc-air electrodes, equipment, tools and machinery necessary for the proper prosecution of the work. The equipment, tools and machinery shall be on the work site in good repair and operating condition prior to beginning work.

If at any time, the Engineer determines any equipment is defective to the point that it may affect the quality of the work, that equipment shall be immediately repaired or replaced.

748.4. Scope of Work. Work on this contract may not be continuous and will be accomplished at the direction of the Engineer. All metal beam guard fence removed for replacement or upgrading purposes shall be replaced during the same workday unless otherwise approved by the Engineer. The posts shall be replaced to the correct height as directed by the Engineer or in accordance with the plans.

Post holes shall be cleaned and free of any loose dirt or debris and backfilled with select material by thoroughly tamping the material in 100 millimeter layers. Unattached metal beam rail ends shall not be permitted.

All post holes drilled during a workday shall have posts completely installed or be securely covered at the close of the workday.

The Contractor shall be required to remove all damaged steel posts with base plates that are not repairable. All reusable materials will be determined at the site by the Engineer. Any damaged steel and/or timber post which has a concrete footing shall be removed and replaced as directed by the Engineer.

All salvageable rail elements shall be carefully removed in original lengths. All fittings shall be removed from the posts and the rail element. If directed by the Engineer, the posts shall be removed. Any salvageable materials damaged by the Contractor shall be replaced at the Contractor's expense.

Posts shall be set plumb and firm to the line and grade shown on the plans. The rail elements, including terminal anchor sections, shall be erected to produce a smooth, continuous rail paralleling the line and grade of the roadway surface or as shown on the plans.

The rail elements shall be joined end to end by bolts and lapped in the direction of traffic in the lane adjoining the guard fence. When designated on the plans or when the rail to be replaced is a curved rail, the rail elements shall be curved before erection. Holes for special details may be field-drilled, punched or made by other methods approved by the Engineer.

Unless otherwise directed by the Engineer, if any anchor bolts on a base post have been sheared or pulled out of the concrete foundation, they shall be replaced along with a new concrete foundation.

Terminal anchor post repair shall be limited to straightening and/or replacing the upper portion of the anchor above the concrete.

Terminal anchor post replacement and/or upgrade shall include the complete removal and replacement of damaged anchor post with foundation and/or installation of new anchor post with foundation. This includes cleaning out the existing hole and/or drilling the new hole, placing the anchor, and furnishing and placing the concrete.

The Contractor shall remove and replace damaged wood, steel blockouts and back-up plates. This work will not be paid for directly but shall be considered subsidiary and will not be measured for payment.

Repair of headlight barrier fencing shall include straightening and/or

rods, brace rods, tension wire, stretcher bars, pedestrian control cables and any other materials needed to complete the necessary repairs. Posts shall be set plumb and permanently positioned and anchorages set before fabric is placed.

Posts shall be fastened and set as required and/or as shown on the plans. After posts have been set and all cables drawn taut, the fabric shall be placed by securing one end and applying sufficient tension to the other end to remove all slack before making attachments as shown on the plans.

Barrel-mounted guard fence repair and/or upgrade shall consist of removing and replacing and/or placement of barrels, drilling the necessary mounting holes in barrels as directed by the Engineer, filling the barrels with sand as required and mounting the rail elements as shown on the plans.

Bridge end connection upgrade shall consist of installation of bridge end connections as directed by the Engineer. This shall include drilling all holes necessary for installation of the bridge end connector to the bridge parapet walls and the installation of the connector.

Removing metal beam guard fence shall consist of removing rail element, posts and backfilling holes. This Item will not apply when the guard fence is removed for the purpose of changing the alignment.

Repair of the guardrail extruder terminal system shall consist of removing and replacing the extruder, the cables, the four (4) rectangular posts and the steel sleeves as directed by the Engineer.

748.5. Measurement. This Item will be measured as follows:

(1) Repair and/or Upgrade Rail Element. Measurement will be made by the meter of rail complete in place and will be along the face of the rail in place from center to center of posts or terminal anchor posts. This includes the 7.6 meter terminal anchor rail element.

(2) Remove and Replace Timber and/or Steel Post without Concrete Foundation. Measurement will be made by the each complete in place. Only posts that are removed and replaced as directed by the Engineer will be measured for payment. Any realignment of existing posts that are reused without being removed from the hole shall be considered subsidiary and will not be measured for payment.

(3) Remove and Replace Timber and/or Steel Post with Concrete Foundation. Measurement will be made by the each complete in place.

(4) Repair Steel Post with Base Plate. Measurement will be made by the each complete in place. This includes all work performed above the concrete foundation.

(5) Repair Concrete Foundation of Steel Posts with Base Plate. Measurement will be made by the each complete in place. This includes all work required for repairing the damaged foundation.

(6) Repair of Terminal Anchor Post. Measurement will be made by the each complete in place.

(7) Replace and/or Upgrade of Terminal Anchor Post. Measurement will be made by the each complete in place.

(8) Repair Headlight Barrier Fencing. Measurement will be made by the meter of fencing, complete in place, measurement being made along a line parallel to the top of the fence in place from center to center of end posts.

(9) Remove and Replace and/or Place Barrels. Measurement will be made by the each complete in place. Installation of rail elements will be paid for under "Repair and/or Upgrade Rail Element".

(10) Bridge End Connection Upgrade. Measurement will be made by the each complete in place. Removing and replacing existing bridge end connectors will be paid for under "Repair and/or Upgrade Rail Element".

(11) Remove Undamaged Guardrail. Measurement will be made by the meter. This shall include removing the rail element, removing the guardrail post(s) as required and backfilling the holes. This bid item is only to be used when guardrail is to be removed and not replaced.

(12) Repair Guardrail Extruder Terminal System. Measurement will be made by the each complete in place. Removing and replacing the rail element will be paid for under "Repair and/or Upgrade Rail Element". Removing and replacing all other posts will be paid for under the appropriate bid items.

748.6. Payment. The work performed and the materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit prices bid for "Repair and/or Upgrade Rail Element", "Remove and Replace Timber and/or Steel Post without Concrete Foundation", "Remove and Replace Timber and/or Steel Post with Concrete Foundation", "Repair Steel Post with Base Plate", "Repair Concrete Foundation of Steel Posts with Base Plate", "Repair of Terminal Anchor Post", "Replace and/or Upgrade of Terminal Anchor Post", "Repair Headlight Barrier Fencing", "Remove and Replace and/or Place Barrels", "Bridge End Connection Upgrade", "Remove Undamaged Guardrail" and/or "Repair Guardrail Extruder Terminal System". This price shall be full compensation for furnishing all concrete, unless otherwise specified, and for all labor, tools, equipment and incidentals necessary to complete the work.

ITEM 754

STEEL BRIDGE MEMBER REPAIR

754.1. Description. This Item shall govern for the hot mechanical or flame straightening of distorted structural steel and incidental repairs.

754.2. Materials. The Contractor shall furnish all materials unless otherwise specified. Materials, if furnished by the Department, will be located at sites designated in the **General Notes and Specification Data Sheet(s)**.

The Contractor shall not use any materials furnished by the Department on any work which is not required by and which does not constitute a part of the contract.

Materials not used, which were furnished by the Department, shall be returned to the location from which they were obtained upon completion of the work.

754.3. Equipment. All equipment, including but not limited to oxygen, acetylene, welding rods, tools, rigging, scaffolding and safety equipment shall be furnished by the Contractor. If at any time, the Engineer determines any equipment is defective to the point that it may affect the quality of the work, that equipment shall be immediately repaired or replaced.

754.4. Scope of Work. The bent and distorted structural steel bridge members shall be returned to their original basic section with regard to tilt and straightness, by mechanical force applied to the heated areas or by flame straightening. The Contractor shall use a crew experienced in heat straightening structural steel. All welding must be performed by certified welders, approved by the Engineer.

Field welding shall comply with Item 448, "Structural Field Welding", and shop fabrication shall comply with Item 441, "Steel Structures". Heating procedures and temperatures shall comply with Subarticle 441.4.(7), "Straightening Bent Material".

Mechanical force applied to heated areas through the use of approved mechanical devices to force the bent and distorted metal into the desired alignment or straightness may be used. Straightening loads may be applied both by "pushing" and by "pulling". Impacting structural steel with hammers or similar devices will not be permitted. Minor dents, nicks and gouges shall be repaired by grinding the defect so as to produce an acceptable contour or shape and the ground out area shall be filled with weld metal. The repaired area shall be dressed to provide an acceptable appearance with all corners chamfered or rounded to a 1.6 millimeter radius. The Contractor may be required to straighten or replace damaged diaframs, bracing, etc. as directed by the Engineer.

If the top flange of the beam is pulled away from full contact with the bottom of the slab, this area shall be filled by compacting with an epoxy or grout mixture into the void. Methods and mixture will be as designated by the Engineer. All spalled and/or fractured concrete shall be removed down to sound material and replaced with an approved concrete mixture.

All burned and scorched paint shall be removed by hand scraping and wire brushing, leaving a feathered edge on the remaining sound paint. Unless otherwise directed by the Engineer, paint particles from the removal operation shall be contained and disposed of as outlined in the **General Notes and Specification Data Sheet(s)**. Contaminants will be shown on the plans. The steel shall be prepared and primed in accordance with Item 446, "Cleaning, Paint and Painting". Unless otherwise specified, the Contractor shall not be required to apply the appearance coat.

754.5. Measurement. This Item will be measured by the lump sum.

754.6. Payment. The work performed and the materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the lump sum price bid for "Repairing Steel Bridge Members". This price shall be full compensation for furnishing welding rods, tools, rigging, scaffolding, and safety equipment; for straightening structural steel; for repairing damaged concrete, when required; for furnishing structural steel, if required; for cleaning and painting; and for all labor, tools, equipment and incidentals necessary to complete the work.

ITEM 760

POST AND CABLE FENCE

760.1. Description. This Item shall govern for the installation and/or repair of post and cable fence.

760.2. Materials. Unless otherwise specified, the Contractor shall furnish the concrete. The concrete shall meet the requirements for Class "B" Concrete as specified in Item 421, "Portland Cement Concrete". If approved by the Engineer, the concrete may be mixed on the jobsite. The mix shall be three parts aggregate, two parts sand and one part cement. Aggregate and sand shall be approved by the Engineer prior to use.

The Department will furnish all other materials. Materials furnished by the Department, will be located at sites designated in the General Notes and Specification Data Sheet(s).

The Contractor shall not use any materials furnished by the Department on any work which is not required by, and which does not constitute a part of the contract.

Materials not used which were furnished by the Department shall be returned undamaged to the location from which the materials were obtained upon completion of the work.

Any unused or removed material deemed salvageable by the Engineer shall remain the property of the Department and shall be delivered to a site designated by the Engineer. Any material deemed not salvageable shall be disposed of by the Contractor at a site(s) to be provided by the Contractor outside the highway right of way. The disposal site(s) shall be approved by the Engineer.

760.3. Equipment. The Contractor shall furnish all equipment, tools and machinery necessary for the proper prosecution of the work. The equipment, tools and machinery shall be on the work site in good repair and operating condition prior to beginning work. If at any time, the Engineer determines any equipment is defective to the point that it may affect the quality of the work, that equipment shall be immediately repaired or replaced.

760.4. Scope of Work. The post and cable fence, including reflectors and all related items, shall be installed in accordance with the details shown on the plans or as directed by the Engineer. The posts shall be set plumb and firm to the line and grade shown on the plans. All post holes drilled during a workday shall have posts completely installed or be securely covered at the close of the workday. For new installation, the cable shall be spliced only at the pull posts unless otherwise directed by the Engineer. The cable shall be stretched to remove all sag between posts.

Pull post spacing shall normally be 72.2 meters as shown in the details, but one pull post spacing per continuous section may be lengthened or shortened to accommodate site conditions as directed by the Engineer.

All damaged anchors or posts shall be completely removed and new anchors or posts placed in the same location. Backfilling of all posts shall be thoroughly tamped in 100 millimeter layers utilizing select material as approved by the Engineer.

For any repair, one cable splice will be allowed between posts, adjacent to the post, but not more than two (2) splices in any 30.5 meters of cable.

All undamaged posts which are more than 25 millimeters out of plumb will be straightened and shall be reset plumb and firm to the line and grade as shown on the plans.

Painting of posts, fittings or hardware will not be required unless otherwise stated in the **General Notes and Specification Data Sheet(s)**.

760.5. Measurement. This Item will be measured as follows:

(1) Installation will be measured by the meter of fence, complete in place, measurement being made from center to center of pull posts for each continuous section installed.

(2) Remove and Replace Pull/Line Posts, Remove and Replace Anchors, Splice, Straightening Posts and Tightening Cable will be measured by the each.

760.6. Payment. The work performed and the materials in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit prices bid for "Installation", "Remove and Replace Pull/Line Posts", "Remove and Replace Anchors", "Splice", "Straightening Posts" and/or "Tightening Cable". This price shall be full compensation for furnishing materials, when required, and for all labor, tools, equipment and incidentals necessary to complete the work.

ITEM 766

TRAFFIC SIGNALS

766.1. Description. This Item shall govern for the inspection, adjustment, repair and replacement of various components of traffic signals.

766.2. General. The locations of the traffic signals shall be as designated in the **General Notes and Specification Data Sheet(s).**

766.3. Materials. All materials that are to become part of the final work will be furnished by the Department unless otherwise specified. A list of required materials shall be submitted to the Department at least 24 hours in advance of the requested pickup date between the hours of 8:00 AM and 4:00 PM at sites designated in the **General Notes and Specification Data Sheet(s)**.

The Contractor shall not use any materials furnished by the Department on any work which is not required by and which does not constitute a part of the contract. Materials not used shall be returned undamaged to the location from which the materials were obtained upon completion of the work.

Any unused or removed material deemed salvageable by the Engineer shall remain the property of the Department and shall be delivered to the location from which the materials were obtained upon completion of the work. Any material deemed not salvageable by the Engineer shall be disposed of by the Contractor at a site(s) to be provided by the Contractor outside the highway right of way. The disposal site(s) shall be approved by the Engineer.

766.4. Equipment. All equipment used to install the materials shall be furnished by the Contractor. If at any time, the Engineer determines any equipment is defective to the point that it may affect the quality of the work, that equipment shall be immediately repaired or replaced.

766.5. Scope of Work. The Department will furnish the Contractor with the "Routine Traffic Signal Maintenance Report". All work performed will be in accordance with the National Electric Code (NEC). The Contractor will complete this form in its entirety for each location before leaving each location.

Maintenance, repair and/or replacement shall consist of the following as directed by the Engineer:

(1) Service Poles: The Contractor will inspect the service pole for loose conduit and continuity of the ground circuit, and repair if necessary.

(2) Signal Heads: All bulbs shall be replaced. The replaced bulbs will be collected and given to the Department's inspector at the end of each day. The location from which the bulbs were removed will be clearly marked on individual containers for each location. Lenses, louvers and reflectors shall be thoroughly cleaned and/or replaced as needed. Extreme care shall be taken to assure that each replacement lens matches the exact color of the lens being removed. Cleaning solutions shall be as approved by the Engineer. All shields that are bent or missing shall be replaced.

(3) Flashing Beacon Heads: All bulbs shall be replaced. The replaced bulbs will be collected and given to the Department's inspector at the end of each day. The location from which the bulbs were removed will be clearly marked on individual containers for each location. Lenses and reflectors shall be thoroughly cleaned or replaced as needed. Extreme care shall be taken to assure that each replacement lens matches the exact color of the lens being removed. Cleaning solutions shall be as approved by the Engineer. All shields that are bent or missing shall be replaced.

(4) Pedestrian Heads: All bulbs shall be replaced. The replaced bulbs will be collected and given to the Department's inspector at the end of each day. The location from which the bulbs were removed will be clearly marked on individual containers for each location. Lenses and reflectors shall be thoroughly cleaned and/or replaced as needed. Unless otherwise directed by the Engineer, only water shall be used in cleaning lenses and reflectors on pedestrian heads.

Each head will be inspected for damage. Any damage found will be reported to the Engineer. All heads shall be checked for proper alignment and realigned if necessary.

(5) Support System: Inspect and measure the height of the heads above the roadway, and record. Where less than 5.2 meters is measured, make adjustments either to the down guy or the span attachments to achieve a minimum 5.2 meter clearance as directed by the Engineer. Inspect the eyebolt connections at the top of the pole and inspect all cable clamps for a snug fit and tighten if necessary.

Inspect the hanger pin, eyelet and span hanger in each of the span wire signals and replace as directed by the Engineer. Check the span wire for damage or rust, and record. Excessive wear shall be immediately reported to the Engineer. Thoroughly clean and paint rust spots on steel poles and mast arms as directed by the Engineer.

(6) Complete Head Replacement: Replace complete head as directed by the Engineer. This replacement will be performed concurrently with bulb replacement.

(7) Painting: Any saddle, load binder, meter loop, breaker box, head or flashing beacon that is faded or peeling paint shall be thoroughly cleaned and repainted as directed by the Engineer.

766.6. Measurement. This Item will be measured as follows:

Service Poles, Signal Heads, Flashing Beacon Heads, Pedestrians Heads, Support System, Complete Head Replacement and Painting will be measured by the each.

766.7. Payment. The work performed in accordance with this Item and measured as provided for under "Measurement" will be paid for at the unit prices bid for "Service Poles", "Signal Heads", "Flashing Beacon Heads", "Pedestrians Heads", "Support System", "Complete Head Replacement" and "Painting". This price shall be full compensation for furnishing all labor, tools, equipment and incidentals necessary to satisfactorily complete the work.

ITEM 772

ILLUMINATION

772.1. Description. This Item shall govern for the maintenance, repair and/or replacement of the various appurtenances related to existing illumination assemblies.

772.2. Licenses. Unless otherwise designated in the General Notes and Specification Data Sheet(s), the Contractor (Owner) or the Superintendent shall hold a Master Electrician's License from a city with a population of 50,000 or greater. There shall be at least one Journeyman Electrician on the project at all times while work is in progress.

A copy of the Contractor's (Owner's) or Superintendent's Licenses must be submitted prior to work beginning. The Journeyman's License must be available on the jobsite during the performance of any work.

772.3. Materials. The contractor will furnish all materials required to repair breaks and/or other shorts in electrical conductors and cable. This shall include, but not be limited to all, concrete, ground boxes, wire mesh and pipe casing.

The Department will furnish all other materials. Materials furnished by the Department will be located at sites designated in the **General Notes and Specification Data Sheet(s)**.

The Contractor shall not use any materials furnished by the Department on any work which is not required by and which does not constitute a part of the contract. Materials not used which were furnished by the Department shall be returned undamaged to the location from which the materials were obtained upon completion of the work.

Any unused or removed material deemed salvageable by the Engineer shall remain the property of the Department and shall be delivered to a designated site. Any material deemed not salvageable shall be disposed of by the Contractor on site(s) to be provided by the Contractor outside the highway right of way. The disposal site(s) shall be approved by the Engineer.

772.4. Equipment. The Contractor shall furnish all equipment, tools and machinery necessary for the proper prosecution of the work. This will

include, but is not limited to, an aerial device capable of reaching all **772.5**

overhead lights, ditching machine, boring machine, underground line, fault detectors and splicing tools.

The equipment, tools and machinery shall be on the work site in good repair and operating condition prior to beginning work. If at any, time the Engineer determines any equipment is defective to the point that it may affect the quality of the work, that equipment shall be immediately repaired or replaced.

772.5. Scope of Work. Work on this contract may not be continuous and will be accomplished at the direction of the Engineer.

The Contractor shall initially be expected to work Monday through Friday, a minimum, of eight (8) hours per day (weather permitting) until all systems have been restored to service. Upon completion of this work, the Contractor shall be required to maintain existing roadway illumination assemblies as directed by the Engineer. The contractor shall be expected to provide proper maintenance or repairs within 48 hours of such notification of malfunction. For existing conditions, it will be the Contractor's responsibility to coordinate with the power companies any power supply problems involved in providing service to the lights.

The term "duct cable" as used herein shall consist of a complete assembly of conductors enclosed in a high density polyethylene duct.

All maintenance, repair, removal and/or replacement activities located near any overhead or underground utilities shall be accomplished using established industry and utility safety practices. The contractor shall consult with the appropriate utility company prior to beginning such work.

Maintenance, repair and/or replacement shall consist of the following as directed by the engineer and shall be installed in accordance with the National Electric Code (NEC):

(1) Replacement of lamps, fuses, fuse holders and/or starter boards for pole mounted and wall pack fixtures. Replacement of lamps shall include the cleaning of the glass cover (both inside and outside) and the reflector with a cleaning solution as approved by the Engineer.

(2) Repair of electrical conductors, cables or conduits (breaks & shorts).

The contractor shall notify the Engineer when an underground break in a conductor, cable or conduit must be located. The contractor will expose the break, perform the splice, install the ground box and backfill. Backfill shall be in accordance with the construction methods of Item 400, "Excavation and Backfill for Structures".

An underground splice will include the replacement of up to one (1) meter of cable, regardless of the number of conductors. Only one splice will be considered for payment per trench. If more than one (1) meter of cable needs to be replaced the additional will be paid for under "Replace Duct Cable".

All above ground splices which are to be performed in conjunction with a bid item will be considered subsidiary to the pertinent bid item. Above ground splices not to be performed in conjunction with a bid item will include the replacement of up to one (1) meter of conductor per splice. If more than one (1) meter of conductor needs to be replaced, the additional will be paid for under "Add or Replace Conductor in Conduit".

(3) The replacement of roadway illumination assemblies shall be installed in accordance with the details and dimensions as shown in the plans or as directed by the Engineer. Complete replacement will include the base, pole, mast, luminaire (sodium or mercury vapor) and all the wiring required.

If at any time pole and/or mast are to be replaced, then the luminaire (sodium or mercury vapor) will be considered subsidiary to the pertinent bid items.

(4) The replacement of luminaires only will include high pressure sodium or mercury vapor and will be installed in accordance with the details as shown in the plans or as directed by the engineer.

(5) The installation of the foundation for roadway illumination assemblies shall be installed as shown on the plans and in accordance with the materials and construction methods outlined in Item 656, "Foundations for Signs, Traffic Signals and Roadway Illumination Assemblies".

(6) The removal of roadway illumination assemblies with single or double mast shall consist of removing existing assemblies where designated or as directed by the Engineer and in accordance with Item 611, "Removing Roadway Illumination Assemblies".

(7) The removal of an existing foundation only of a roadway illumination assembly shall be in accordance with Item 611, "Removing Roadway Illumination Assembly".

(8) The replacement of service poles shall consist of the removal of an existing service pole and the installation of the new pole and related electrical services which include the conduit, electrical control panel (photo cell, circuit breaker, wire, manual switch and electromagnetic contactor), meter base, weatherhead and pigtail (one (1) meter from weatherhead). These connections and installations shall be in accordance with the construction methods as outlined in Item 627, "Treated Timber Poles" and Item 628, "Electrical Services".

(9) The installation of ground boxes shall be in conformance with the details shown on the plans. When shown on the plans, a Class "B" Concrete riprap apron conforming to Item 421, "Portland Cement Concrete", shall be provided by the contractor. It shall be placed to line and grade as approved by the Engineer. All wiring connections required inside the ground box will be considered subsidiary to this bid item.

(10) Pavement bore operations will be required for placement of underground wiring under the roadway and shall be in accordance with the construction methods for boring as outlined in Item 476, "Jacking, Boring or Tunneling Pipe".

The depth of the bore shall be a minimum of 1.5 meters below the roadway (and a minimum of one (1) meter below the ditch flowline) surface extending three (3) meters outside the edge of the roadway. Placement of conduit for the length of the bore will be considered subsidiary to this bid item. Electrical conductors will be paid for under the bid item "Add or Replace Conductors".

(11) The installation of ground rods will include running copper ground wire to the required ground connection.

(12) Unless otherwise approved by the Engineer, the replacement of damaged or missing covers on existing transformer bases shall consist of the installation of Original Equipment Manufacturer (OEM) lids. Installation shall be as directed by the Engineer.

(13) The replacement of lamp sockets for wall mount, pole mount and

sign mount fixtures shall include the removal of the existing socket.

(14) Other miscellaneous maintenance and repair items include the following:

(a) The replacement of luminaire wall packs (sodium or mercury vapor) on poles less than six (6) meters tall, structures, rest areas and maintenance warehouses.

(b) The replacement of photo cells and/or brackets.

(c) The replacement/or installation of the following: manual switches, fused disconnect switches, electromagnetic contactors, meter bases, time clocks, breaker panels and breakers.

(d) Re-strapping conduit.

(e) The removal and/or replacement of lenses on overhead illumination.

(f) The removal and/or replacement of lenses on wall packs on structures or buildings.

(g) The replacement or installation of ballast in wall packs, wall pack lens guards, guards on illumination poles, wall pack sockets and lamp sockets on pole-mounted illumination.

(15) The repair of overhead sign lighting will include the repair of sodium, mercury vapor and florescent lighting for large signs mounted over the roadway. This may consist of replacing the ballast, lamps, florescent tubes, complete light, fuses and lamp sockets in order to properly restore the lighting to satisfactory operation. Installations shall be in accordance with the details shown on the plans or as directed by the Engineer.

(16) The maintenance of high mast illumination will include re-aiming the lights and cleaning the lenses and reflectors as directed by the Engineer.

772.6. Measurement. This Item will be measured as follows:

(1) Replace Lamp - by the each complete in place.

(2) Replace Fuse - by the each complete in place.

(3) Replace Fuse Holder - by the each complete in place.

(4) Replace Starter Board - by the each complete in place.

(5) Underground Splice - by the each complete in place.

(6) Aboveground Splice - by the each complete in place.

(7) Replace Duct Cable - by the meter of trench complete in place.

(8) Add or Replace Conductor - by the meter of conductor complete in place.

(9) Add or Replace Above Ground Conduit - by the meter complete in place. This will include the installation of all hardware necessary to attach and connect the conduit.

(10) Add or Replace Underground Conduit - by the meter complete in place. This will include excavation, placement of conduit, backfill and compaction.

(11) Replace Standard Single Mast - by the each complete in place. This will include all wiring connections and hardware connections above the foundation.

(12) Replace Standard Double Mast - by the each complete in place. This will include all wiring connections and hardware connections above the foundation.

(13) Replace/or Install Mast Arm - by the each complete in place.

(14) Replace Luminaire - by the each complete in place.

(15) Install Foundation - by the each complete in place.

(16) Replace Service Pole - by the each complete in place. This will include drilling the hole, setting the pole, mounting the weatherhead and connecting/installing all electrical services.

(17) Install Ground Box - by the each complete in place. This will include any riprap apron and required conductor connections inside the ground

box.

(18) Pavement Bore - by the meter complete in place.

(19) Install Ground Rod - by the each complete in place.

(20) Replace Transformer Base Cover - by the each complete in place.

(21) Replace Lamp Socket - by the each complete in place.

(22) Replace Luminaire Wall Pack - by the each complete in place.

(23) Replace Photo Cell/or Bracket - by the each complete in place.

(24) Replace or Install Manual Hands-on Switch - by the each complete in place.

(25) Replace or Install Fused Disconnect Switch (includes Hands-off Auto Switch) - by the each complete in place.

(26) Replace or Install Electromagnetic Contactor - by the each complete in place.

(27) Replace or Install Meter Base - by the each complete in place.

(28) Replace or Install Time Clock - by the each complete in place.

(29) Replace or Install Breaker Panel - by the each complete in place.

(30) Replace or Install Breaker - by the each complete in place.

(31) Re-strap Conduit (per strap) - by the each complete in place.

(32) Remove/or Replace Overhead Lens (this will not be used in conjunction with head replacements) - by the each complete in place.

(33) Remove/or Replace Wall Pack Lens - by the each complete in place.

(34) Replace Wall Pack Ballast - by the each complete in place.

(35) Replace or Install Wall Pack Lens Guard - by the each complete in place.

(36) Replace or Install Pole Guard - by the each complete in place.

(37) Replace Wall Pack Socket - by the each complete in place.

(38) Replace Pole Lamp Socket - by the each complete in place.

(39) Replace Overhead Sign Ballast - by the each complete in place.

(40) Replace Overhead Sign Lamp - by the each complete in place.

(41) Replace Overhead Sign Florescent Tubes - by the each complete in place.

(42) Replace Overhead Sign Light Fixtures - by the each complete in place.

(43) Replace Overhead Sign Fuse - by the each complete in place.

(44) Replace Overhead Sign Lamp Socket - by the each complete in place.

(45) Re-aim/or Clean Lens on High Mast Pole (by the each light on ring) - by the each complete in place.

772.7. Payment. The work performed and the materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit prices bid for the various designations. This price shall be full compensation for furnishing all material associated with electrical repair, concrete, and for all labor, tools, equipment and incidentals necessary to satisfactorily complete the work.

"Removing Illumination Assembly" and "Remove Illumination Foundation Only" will be paid for under Item 611, "Removing Roadway Illumination Assembly".

PART III, APPENDIX

DIVISION I
ADDITIONAL INFORMATION

CONVERSION FACTORS

Application	Metric Symbol		To Convert From	To	Multiply by Factor
	Tech Corres	Comptr Appl	Metric Unit	English Unit	
Length	mm		millimeter	inch	0.03937
	m	M	meter	foot	3.28084
	m	M	meter	yard	1.09361
	km	KM	kilometer	mile (international)	0.62137
Area	mm^2		square millimeters	square inch	0.00155
	m^2	M2	square meters	square foot	10.76422
	m^2	M2	square meters	square yard	1.19599
	ha	HA	hectare (10,000 m^2)	acre	2.47105
	km^2		square kilometers	square mile (U.S. statute)	0.38610
Volume	mL		milliliter (1 mm^3)	ounce (U.S. fluid)	0.03381
	L	L	liter (1 dm^3)	quart (U.S. liquid)	1.05669
	L	L	liter (1 dm^3)	gallon (U.S. liquid)	0.26417
	kL	KL	1,000 liter	1,000 gallon	0.26417
	m^3	M3	cubic meter	cubic foot	35.31466
	m^3	M3	cubic meter	cubic yard	1.30795
	m^3	M3	cubic meter	acre-foot	0.00081
Discharge	L/min		liter per minute	gallon per minute	0.26417
	m^3/s		cubic meter per second	cubic foot per second	35.31466
Force per unit area, pressure, stress	kPa		kilopascal	pound-force per square inch	0.14504
	Pa		pascal	pound-force per square foot	0.02089
	MPa		megapascal	kip per square inch	0.14504

	kPa		kilopascal	kip per square foot	0.02089

CONVERSION FACTORS

Application	Metric Symbol		To	To Convert From	Multiply by Factor
	Tech Corres	Comptr Appl	Metric Unit	English Unit	
Volume per Unit Time	$m^3 \cdot h$	M3H	cubic meter hour	cubic yard hour	1.30800
Force	N		newton	pound-force	0.22481
	kN		kilonewton	kip (1,000 lbf)	0.22481
Gravitational Constant	m/s^2		9.8066 meters per second squared	32.174 feet per second squared	N/A
Mass	g		gram	ounce	0.03527
	kg	KG	kilogram	pound	2.20462
	Mg	MG	megagram	ton (2000 lbs)	1.10231
Mass density	kg/m^3		kilogram per cubic meter	pound per cubic foot	0.06243
	kg/m^3		kilogram per cubic meter	pound per cubic yard ton per cubic yard	1.68556
	Mg/m^3		megagram per cubic meter		0.84278
Rate of application	L/m^2		liter per square meter	gallon per square foot	0.02431
	L/m^2		liter per square meter	gallon per square yard gallon per acre	0.22088
	L/ha		liter per hectare		0.10691
Temperature	°C		degree Celsius	Fahrenheit	$(T_c \times 1.8) + 32$
Torque	N•m		newton meter	pound-force inch	8.85075
	N•m		newton meter	pound-force foot	0.73756
	kN•m	KNM	kilonewton meter	pound-force foot	737.56212

Velocity	m/s		meter per second	feet per second	3.28084
	km/h		kilometer per hour	miles per hour	0.62137

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