SPECIAL SPECIFICATION

4048
Prestressed Ground Anchors

1. Description. This Item shall govern for the installation of post-tensioned ground anchors in place, with grouting as required in accordance with the plans and with these specifications. The ground anchors shall provide the load carrying capacities as required in the anchors that will develop the load as required in the plans and the approved working drawings in accordance with testing requirements of this specification.

The Contractor shall have the option of furnishing any type of post-tensioning system meeting the requirements of these specifications. The Contractor may also propose the use of proprietary systems which do not conform to all provisions of this specification, if the concept is approved by the Engineer. The system selected shall provide the magnitude and distribution of design prestressing force and minimum ultimate strength required by the plans without exceeding allowable temporary stresses. All design procedures, coefficients and allowable stresses shall be in accordance with the latest Standard AASHTO Specifications for Highway Bridges.

2. Materials. Materials required for use under this item shall conform to the following:

<table>
<thead>
<tr>
<th>Structural Steel</th>
<th>Item 441, 442</th>
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<tbody>
<tr>
<td>Prestressing Steel</td>
<td>Item 426</td>
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<tr>
<td>Hydraulic Cement Concrete</td>
<td>Item 421</td>
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</table>

Prestressing steel shall conform to one of the following types:

Seven wire strand conforming to ASTM Designation: A416; or, high-tensile strength alloy bars conforming to the requirements of ASTM Designation: A722.

Bars with greater minimum ultimate strength, but otherwise produced and tested in accordance with ASTM Designation: A722, may be used provided they have no properties which make them less satisfactory than the specified material. Wire or strand with greater ultimate strength but otherwise produced and tested in accordance with ASTM Designation: A416 and or A421, and the requirements of this specification, will be permitted provided the physical properties as outlined in the applicable specification are shown in the shop drawings and provided they have no properties which make them less satisfactory than the specified material.

Each ground anchor tendon shall be a single bar or a group of strands having common end anchorage used to apply a prestressing force to a structural member. The tendons shall be coated (unbonded) except that portion which is established as the anchorage length. The tendons shall be coated a minimum of 15 feet. The anchorage length shall be bare and
completely free of grease or other contaminants. The anchorage length shall be a minimum of 10 feet long in rock and 15 feet long in soil.

End anchorages and tendon couplers shall develop at least 100 percent of the required ultimate strength of the tendon with a minimum elongation of 2 percent.

Material for coating unbonded tendons shall be a non-volatile, low friction mineral oil base grease, with a rust preventing additive having a relatively uniform viscosity under temperature ranges of 20 F to 120 F. A protective sheathing shall be provided around the tendon throughout the coated length consisting of .04” (1 mm) minimum thickness polyethylene or polyvinyl chloride tubing capable of maintaining the tendon tightly bundled and containing the lubricant.

Grout for ground anchors shall be a neat cement or sand cement mixture, with a 7 day compressive strength of 3500 psi. Grout strengths shall be determined by testing 2 inch cubes in accordance with Test Method TEX-307-D or 3 inch diameter by 6 inch high cylinders in accordance with Test Method TEX-418-A. Grout strength shall be determined by testing the initial grout batch. Additional testing will be necessary if the grout mixture is modified or as required by the Engineer. If allowed by the Engineer, test results from previous projects using an identical grout mix may be accepted.

In lieu of cement grout, an epoxy or polyester resin grout may be used to grout anchors in rock. The resin grout shall be used in accordance with the manufacturer’s recommendations.

All tendons shall be identified by heat number, or reel number in the case of seven wire strand, and tagged for identification. Anchorage assemblies shall be identified in a like manner. At the request of the Engineer, the Contractor shall furnish specimens for test purposes in accordance with Test Method TEX-710-I. Mill test reports shall be provided to the Engineer for tendons used in permanent anchors.

Testing of complete tendons for compliance with the requirements of this specification will be at the Contractor’s expenses, and the results certified in writing to the Engineer. In addition the Contractor shall furnish, for testing, one specimen of each size of prestressing tendon with end fittings attached at each end for ultimate strength tests only.

The specimen shall be 5 feet in clear length measured between ends of fittings. If the results of the test indicate the necessity of check tests, additional specimens shall be furnished without cost. For prestressing systems previously tested and approved on Department projects, compete tendon samples need not be furnished, provided there is no change in the material, design, or details previously approved. Shop drawings or prestressing details shall identify the project, on which approval was obtained, otherwise sampling will be necessary.

For prefabricated ground anchor assemblies, the Contractor shall notify the Materials and Tests Engineer 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.

3. **Packaging, Storing and Handling.** All prestressing steel shall be protected against physical damage and corrosion from the time of manufacture to grouting or encasing in concrete.
Rust on prestressing steel which can be removed by light rubbing is acceptable. Streaks or spots, which may remain after rust removal are acceptable if no pitting is present. Tight mill scale is acceptable but loose mill scale shall be removed.

Prefabricated ground anchor assemblies shall be protected from moisture by taping, wrapping or by other acceptable means.

4. **Equipment.** The Contractor shall furnish suitable equipment to drill the holes to the diameter, depth and line as specified herein and/or on the approved working drawings.

The Contractor shall furnish suitable hydraulic jacks for stressing the tendons. These jacks shall be equipped with gauges graduated to read directly to one percent of the total load applied, and calibrated to measure accurately the stress induced in the steel.

The jacks shall have a stroke of adequate length so that the stressing, including temporary overstress, can be done in one movement. They shall be equipped with proper ports or windows for adequate visual examination and measurement of tendon movement. They shall also be capable of slow release of stress to allow relaxation from overstress to the proper seating force.

The Contractor shall furnish a grout mixer and pump of sufficient capacity to properly place grout in the quantities required.

5. **Working Drawings.** Sufficiently in advance of the installation of ground anchors, the Contractor shall submit working drawings for the anchors. The details shall contain all necessary information for construction including:

   (1) **Prestressing Details.** These drawings shall show details of type, size, number of units per ground anchor, ground anchor diameter, inclination, forces applied per anchor, end anchorage systems, grouting and venting ports, grouting procedure, acceptable elongation, temporary overstress and other information necessary to properly complete the work.

   Details shall show the method of support for ground anchors to insure that proper location in the center of the hole can be maintained.

   (2) **Anchor Layout.** These drawings shall show the layout of all anchors and design forces relative to the proposed wall.

The working drawings shall be submitted on standard 22 inch by 34 inch sheets. These drawings shall show the layout of all anchors and design forces relative to the proposed wall.

Six sets of drawings shall be submitted to the Engineer.

6. **Construction.**

   (1) **General.** 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. Stressing systems shall be recalibrated when required by the Engineer.
(2) **Drilling.** The hole shall be drilled not more than +/- 3 degrees from the line specified on the approved working drawings.

(3) **Grouting.** Before placing the tendon, the hole shall be cleared of all debris. The tendon shall be inserted in the hole and supports shall insure that the tendon is centered in the hole with no more than 1” of sag between supports. A grouting pipe shall be provided that will allow placement of the grout from the bottom of the hole. Before pumping of grout begins, the grout tubes shall be checked to insure that they are clear. When the tendon is grouted through the center of a hollow auger, no grout tube or centralizers will be required as long as grout pressure is maintained during auger withdraw.

The anchors shall be grouted immediately after being placed in the hole. Grout shall be pumped from the bottom of the hole toward the top continuously under pressure until grout is within approximately one foot of the top of the hole. The hole shall be grouted full length in one stage with clearance provided between the grout and tendon anchorage.

If the grout level in the hole cannot be maintained, the tendon shall be withdrawn and the hole redrilled after a minimum of 24 hours have passed.

The following data concerning the grouting shall be recorded:

<table>
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<tr>
<th>Water-cement ratio</th>
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<tr>
<td>Types of additives</td>
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<td>Types of cement</td>
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<td>Volume of grout</td>
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</table>

(4) **Post-Tensioning.** Post-tensioning shall not begin until concrete in associated structural members has reached the design strength specified.

Suitable means shall be provided for measuring the movement of the anchor head to the nearest 0.001 inch.

The sequence of post-tensioning shall prevent overstressing the structural member and shall be indicated on the prestressing details.

The prestressing details submitted by the Contractor shall reflect the following general tensioning procedure modified as required for each particular installation, unless otherwise required by the plans.

(a) The tendons will be tensioned in the sequence designated in the Prestressing Details.

(b) Initial tensioning to take the slack out of the tendons will be at 10 percent of the maximum tensioning load unless otherwise shown on the approved Prestressing Details.

(c) After the initial tensioning, an independent reference shall be set up to measure anchor movement. The movement measured between the maximum proof load and lock-off load shall be within the following limits:
1) Minimum movement shall be determined based on elastic elongation calculated using 80 percent of the unbonded length.

2) Maximum movement shall be determined based on the elastic elongation calculated using the entire unbonded length plus 50 percent of the bonded length.

If the movement measured is not within the above specified limits, the anchor shall be rejected and a replacement anchor installed.

(d) Proof loading of every anchor of not less than 133 percent of its design load shall be made. During the proof loading operation, the prestressing force shall not be more than 80 percent of the guaranteed ultimate strength of the prestressing steel. The duration of the proof loading shall be 2 minutes. If the anchor movement exceeds 0.02 inch in 2 minutes, proceed as described in the performance test section with the load held for a total of 60 minutes. The prestressing force shall be transferred (locked-off) at a level of between 10 and 70 percent of its guaranteed ultimate tensile strength as required to provide the design loads shown on the plans.

(e) Performance testing of 5 percent or a minimum of 3 anchors, whichever is greater, shall be performed in accordance with the following procedures.

The performance test shall be made by incrementally loading and unloading the anchor in accordance with the following schedule. All loads except the maximum test load need only be held long enough to obtain the movement reading.

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<tr>
<th>Performance Test Schedule</th>
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<tbody>
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<td>AL</td>
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<tr>
<td>0.25 DL</td>
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<tr>
<td>AL</td>
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<td>0.25 DL</td>
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<tr>
<td>AL</td>
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<td>0.50 DL</td>
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<td>0.75 DL</td>
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<tr>
<td>AL</td>
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<td>0.50 DL</td>
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<tr>
<td>0.75 DL</td>
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<td>1.00 DL</td>
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AL – alignment
DL – design load

The maximum testload shall be held for 10 minutes. The anchor movement with respect to a fixed reference shall be recorded at 1, 2, 3, 4, 5, and 10 minutes. If the movement between 1 minute and 10 minutes exceeds 0.04 inch, the test shall be continued for an additional 50 minutes. If the test is extended, the movement shall
be recorded at 15, 20, 30, and 60 minutes. Time will be measured from when the pump is started after the 1.20 DL load increment.

(f) Lift off tests shall be performed 48 hours after initial tensioning on the first three permanent anchors installed at each wall location prior to final grouting. The lift off load shall be within 10 percent of the lock off load.

(g) Final grouting of the anchor plate area as indicated in the plans shall be performed within 3 days after tensioning and lift off tests for a soil anchor are complete.

Ground anchors will be considered acceptable if the anchor movement in any testing does not exceed 0.08 inch per log cycle of time. The anchor movements must also fall within the limits stated in Section “c” above.

Anchors which fail to attain the maximum test load required as stated above may be incorporated into the wall at a load capacity equal to one half their failure load. The failure load shall be the load indicated by the pressure gauge 10 minutes after failure has occurred. Additional anchors shall then be installed to replace or supplement the failed anchor. Any additional anchors required or changes in the original anchor design shall be at the Contractor’s expense and shall not be cause for a change in contract prices.

7. **Measurement and Payment:** No direct measurement or payments will be made for the work to be done or the equipment and materials to be furnished under this item, but shall be considered subsidiary to the item “Retaining Walls” as required by the plans and the contract.