SPECIAL SPECIFICATION

2139

Mechanical Construction for Moveable Bridge Rehabilitation

1. Description. This Item shall consist of furnishing all materials, equipment, labor and incidentals necessary for the construction of a Mechanical Operating System for Moveable Bridge Rehabilitation with fully operational mechanical components as specified in the Mechanical Technical Specifications included as a part of this Special Specification.

2. Materials and Construction Methods. All materials furnished and all construction methods utilized shall be in accordance with the plans, TxDOT Standard Specifications for Construction and Maintenance of Highways, Streets and Bridges and the attached Mechanical Technical Specifications included as a part of this Special Specification.

3. Measurement. This item will be measured by the each for the various mechanical components of the type specified in the Mechanical Technical Specifications and by the lump sum for the overall mechanical construction for moveable bridge rehabilitation complete in place.

4. Payment. The work performed and material furnished in accordance with this Item and measured as provided for under “Measurement” will be paid for as follows:

   Payment for each of the mechanical components necessary to complete the overall mechanical construction will be made at the unit bid price by the each for the types of components as follows:

   Main Drive System and Balance Wheel Assembly   EA
   Center Pivot Bearing    EA
   Center and End Wedge Assemblies    EA
   Centering Device      EA
   Span Balancing        EA
   Functional Testing   EA

   Payment for the overall mechanical construction necessary to install and operate the moveable bridge system and corresponding mechanical components will be made at the lump sum bid for “Mechanical Construction for Moveable Bridge Rehabilitation.”

   This price shall be full compensation for furnishing all labor, materials, supplies, equipment and incidentals necessary to remove and dispose of existing non salvageable materials, and to furnish, install, and test the new materials and
mechanical assemblies described and specified in the plans and Mechanical Technical Specification.

SH87

NB BRIDGE OVER COW BAYOU

MECHANICAL TECHNICAL SPECIFICATIONS

MECHANICAL CONSTRUCTION FOR MOVABLE BRIDGE REHABILITATION

Prepared by:
URS Corporation
1950 North Stemmons Freeway
Suite 6000
Dallas, Texas 75207

Engineer of Record:

Jim Phillips, P.E.
Texas P.E. No. 104360

Date:
Pages 2 - 27
# TABLE OF CONTENTS

## 2139.A MECHANICAL CONSTRUCTION FOR MOVABLE BRIDGE REHABILITATION

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Description</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>Materials</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>Equipment</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>Construction</td>
<td>12</td>
</tr>
</tbody>
</table>

## 2139.B MAIN DRIVE SYSTEM

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Description</td>
<td>19</td>
</tr>
<tr>
<td>2</td>
<td>Materials</td>
<td>19</td>
</tr>
<tr>
<td>3</td>
<td>Construction</td>
<td>19</td>
</tr>
</tbody>
</table>

## 2139.C CENTER PIVOT BEARING

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Description</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>Materials</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>Construction</td>
<td>20</td>
</tr>
</tbody>
</table>

## 2139.D END AND CENTER WEDGE ASSEMBLIES

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Description</td>
<td>22</td>
</tr>
<tr>
<td>2</td>
<td>Materials</td>
<td>22</td>
</tr>
<tr>
<td>3</td>
<td>Construction</td>
<td>22</td>
</tr>
</tbody>
</table>

## 2139.E CENTERING DEVICE

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Description</td>
<td>24</td>
</tr>
<tr>
<td>2</td>
<td>Materials</td>
<td>24</td>
</tr>
<tr>
<td>3</td>
<td>Construction</td>
<td>24</td>
</tr>
</tbody>
</table>

## 2139.F SPAN BALANCING

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Description</td>
<td>25</td>
</tr>
<tr>
<td>2</td>
<td>Materials</td>
<td>25</td>
</tr>
<tr>
<td>3</td>
<td>Construction</td>
<td>25</td>
</tr>
</tbody>
</table>

## 2139.G FUNCTIONAL TESTING

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Description</td>
<td>27</td>
</tr>
<tr>
<td>2</td>
<td>Materials</td>
<td>27</td>
</tr>
<tr>
<td>3</td>
<td>Construction</td>
<td>27</td>
</tr>
</tbody>
</table>
2139.A  MECHANICAL CONSTRUCTION FOR MOVABLE BRIDGE REHABILITATION

1. Description
   A. General. It is the intention of this Mechanical Technical Specification and Plans to call for finished work, tested and ready for operation. Unless otherwise specified, all manufactured items, fabrications, components, pieces, assemblies and appurtenances that are to be removed, salvaged, rehabilitated, furnished new, installed, or reinstalled under this Special Specification and shown on the plans is included in the Bid Item for “Mechanical Construction for Movable Bridge Rehabilitation.”

   Dimensions given on the Plans are nominal and intended for guidance. Make note of any variations from nominal dimensions on the Shop Drawings or provide written notice to the Engineer.

   Where additional information is required or changes must be made; prepare working, erection, and Shop Drawings and submit to the Department as specified.

   B. Scope of Work: The scope of work for this Item includes the following tasks:

   1. General Mechanical Construction for Moveable Bridge Rehabilitation. Furnish all materials, equipment, labor and incidentals necessary for the construction of a Mechanical Operating System for moveable bridge rehabilitation in accordance with the plans and as described in this Special Specification.

   2. Main Drive System. Clean and lubricate the open gear sets, disassemble, clean and lubricate the bearing bushings of the main drive system. Clean the interior of the primary reducer, repair or replace the oil pump which lubricates the upper bearing and gearing within the primary reducer and add a desiccant type breather to the speed reducer. Fill the speed reducer with oil prior to operation. Do not operate the span prior to repairing the oil pump and filling the speed reducer with oil.

   3. Balance Wheel Assembly. Flush the existing grease from the balance wheel assemblies with solvent and re-lubricate the bushing with grease.

   4. Center Pivot Bearing. Remove and replace the center pivot bearing upper convex bronze disc with similar size and lubrication paths as existing. Inspect the lower concave steel disc for pitting and wear, replace if scored or damaged. Shim the center pivot bearing, re-install housing and add external oil reservoir to housing.

   5. Center Wedge Assembly. Remove the center wedge machinery, including shafts, bearings, crank arms and operating machinery. Furnish and install new linear actuator and new crank arm assembly, including new link arm. Clean and adjust the wedge assemblies.

   6. End Wedge Assembly. Remove the end wedge machinery, including shafts, bearings, crank arms and operating machinery. Furnish and install new linear actuator and new crank arm assembly, including new link arm. Clean and adjust the wedge assemblies.

   7. Centering Device. Furnish and install new centering device for the movable span, as shown in the plans.

   8. Span Balancing. Remove existing balance blocks, add and adjust span balance as specified herein.

   9. Painting of Machinery. Shop paint machinery as described herein. Final field coat machinery per the structural specification requirements. The work performed, materials furnished, equipment, labor, tools and incidentals for this task will not be measured or paid for directly, but will be subsidiary to the various bid items of the Contract.

   10. Functional Testing. Perform functional testing of the span after completion of the mechanical and electrical work. Provide operations and maintenance manuals and training for TxDOT maintenance crew for operation of the movable span. See Special Specification 2138 for Electrical Construction for Moveable Bridge Rehabilitation” for additional details and information.

   C. References. Except where additional references are listed in the individual articles, conform to the applicable sections of the following codes and standards:
D. Submittals

1. **General.** Provide a separate submittal package for each sub item unless otherwise indicated in this Article. Label each submittal package to indicate the Project Name, Sub Item number, Section number and Article number as listed in these Technical Special Provisions. Label data sheets for individual components such as linear actuators, bearings, etc. with the identification numbers shown in the Plans and the technical special provision.

Submit all mechanical submittal items in an individual separate three-ring loose-leaf binder or binders suitable for letter size sheets with opening/closing mechanism. Provide a separate individual ring binder or binders for each set of submittal items. Include binder title sheet as first page having names of job and contractor with second page as table of contents listing each submittal item in same sequence as specified.

Piece-by-piece submission of individual components will not be acceptable. Submit all components of a pay item at the same time. Submittal approval shall be on an "all or none" basis.

Provide complete re-submittals even if some items on the original submittals may not have been marked deficient. Provide sufficient time in project schedule to allow for the possibility of repetitious submittals without creating delays to the project. The Department shall not bear any responsibilities for delays caused by repetitious submittals.

2. **Shop Drawings.** Shop drawings shall detail and accurately dimension all parts including limits of accuracy and tolerances required for machining, surface finishes and allowances for fits. When required, provide fits and finishes for machinery and related parts in accordance with Article 599.4-A. Assembly drawings shall include dimensions from certified prints for all items including those supplied under other payment items such as motors and brakes.

3. **Manufacturer’s Literature.** Submit catalog cuts and detailed Manufacturer's literature for all components not detailed in the Shop Drawings. Clearly mark such items with the item number corresponding to the mark shown on the assembly drawing and the full and complete part number, extended to completely define the part including all optional or custom features. If the same cut sheet is used to define more than one item, submit multiple copies.

4. **Material Certifications.** Submit material certifications for all materials specified to require material testing within the Plans and Specifications or within a referenced material specification (e.g. ASTM, ANSI, or others). Material certifications are to accompany materials when delivered to the project site.

5. **Procedures.** In addition to required detailed Shop Drawings, submit to the Engineer, for review, various procedures described in this technical special provision. The procedures shall be thorough and shall be supplemented by sketches, calculations, details, catalog cuts, photographs, etc. as required to demonstrate that the specified requirements can be met.

6. **As Built Drawings.** At the completion of the project, provide complete as-built drawings as well as operations and maintenance instructions. Use the marked up working drawings to prepare the as built drawings. Provide the working drawings markups for checking purposes.

7. **Operations Manual.** Operations and maintenance manuals shall be a compilation of the manufacturers’ catalog data, installation, and maintenance instructions.

E. **General Construction Requirements for Movable Span.** Construct in accordance with the requirements defined in this technical special provision and in the Plans and the provisions of the AASHTO Movable Bridge Specifications.

Dimensions between machined surfaces shall have a tolerance of ± 0.010 in. and machined surfaces shall have a flatness tolerance of 0.040 in.

All machinery shall be set, aligned and verified by experienced millwrights. Millwrights shall have a minimum 10 years of experience in setting and aligning heavy machinery. Submit to the Engineer for review the qualifications of the proposed millwrights.
F. Notification of Shop Work. Provide advance notification to the Engineer for all shop work and shop testing for which this technical special provision requires, or indicates that it is the intent of the Department, to provide a representative to observe or witness such activities. Provide a minimum of 30 days advance notice of such work.

G. Protection for Shipment. Coat all finished metal surfaces, not to be painted, as soon as practical after machining with a temporary protective coating that prevents oxidation prior to shipment and wipe clean before installation. Completely protect machinery parts from weather, dirt and foreign materials during manufacture and store indoors while awaiting erection. Exposed shaft journals shall be greased or coated with the oxidation preventative coating, wrapped in oil-soaked burlap and securely timber lagged for shipment. Any solvent used to clean a journal prior to assembly must be completely removed from the shaft and bearing prior to assembly. Assembled units – including bearings, lockbar operators and other devices having finished mounting surfaces shall have those surfaces thoroughly coated with a temporary protective coating that prevents oxidation and shall be skidded or crated for protection during handling, shipment and storage.

Bag and crate mounting hardware and other small parts for shipment. Label bags with all contents. Provide tags, recording the part number, secured to each part with wire or plastic ties prior to shipment. Any coating removed for the purpose of installation or erection of equipment shall be reapplied as soon as practical until it is removed for the application of paint or installation into a lubricated assembly.

H. Handling. Protect equipment from damage from mishandling, dropping, or impact. Do not install damaged equipment. Damaged equipment will not be accepted.

I. Protection of Equipment. During construction, protect all equipment from damage as a result of construction operations and contamination from dust and debris. Prior to installation, equipment shall be stored in an enclosed room. Should any equipment become contaminated, immediately clean the equipment, relubricate, and protect from further contamination. The bridge shall not be operated and no enclosed equipment opened during any period in which construction operations can contaminate the equipment.

J. Guarantee. The complete mechanical installation shall be free of defects in materials and workmanship for a period of one year from the date of final acceptance.

2. Materials

A. Material Compatibility. Provide products which are compatible with other products of the mechanical work and with other work requiring interface with the mechanical work, including mechanical/electrical connections and control devices.

B. Nameplates. Provide each piece of mechanical equipment and apparatus with a permanent, stainless steel nameplate on which is engraved the name of the Manufacturer, the catalog or model number, and the rating or capacity of the equipment or apparatus with lettering a minimum of 0.125 inch high and 0.015 inch deep. Nameplates on all proprietary elements must be readable, clean, and free of all paint before acceptance of the machinery.

C. Substitutions. Specification of a Manufacturer's part number, product, and/or name is for the purpose of defining quality, configuration, rating and arrangement of parts. Part numbers shown in the Contract Documents are not necessarily complete numbers and they are not intended to describe details of the component beyond those that are required. Be aware that Manufacturers may change product names and part numbers without advance notification. Select and provide manufactured products that meet the requirements and intent as shown in the Contract Documents. Provide complete, current part numbers for all proposed equipment and verify that the part as designated is appropriate for the intended function.

D. Shop Inspection and Testing. Provide 2 week notice to the Department prior to the beginning of work at foundries, forge and machine shops so that inspection may be arranged. Provide free access to all premises where preparation, manufacture, testing of raw materials, materials in process and assembly is conducted.
Such inspections are to facilitate work and avoid errors. It is understood that inspection by the Department does not relieve the Contractor of the responsibility for compliance with requirements of the Contract Documents or for replacing defective materials and workmanship.

Furnish to the Department test results of all certifications required of the Contract Documents, including copies of chemical and physical tests and certifications of compliance. Initial acceptance of materials and finished parts and assemblies will not preclude subsequent rejection if found deficient. Replacement of such deficient materials will be the responsibility of the Contractor.

E. General Material Requirements. Provide materials as specified on the Plans and in the Specifications. Wherever materials are not shown or specified, provide materials that conform to the current specifications as outlined in TABLE 1, Materials. An alternative material may be requested in writing; the request must provide complete data justifying suitability of the alternate materials and must be approved by the Engineer prior to initiating manufacture or construction.

Materials and equipment shall be essentially the standard catalogued products of manufacturers regularly engaged in production of such materials or equipment and shall be manufacturer’s latest standard design that complies with the Specification requirements. Materials and equipment shall essentially duplicate items that have been in satisfactory commercial or industrial use at least 2 years prior to bid opening. Where two units of the same class of equipment are required, these units shall be products of the same manufacturer. However, the component parts of the system need not be the products of the same manufacturer. Each major component of equipment shall have the manufacturer’s name, address, model number and serial number on a nameplate securely affixed in a conspicuous place. The nameplate of the distributing agent will not be acceptable.

<table>
<thead>
<tr>
<th>DESIGNATION</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>A27</td>
<td>Mild to Medium Strength Carbon Steel for General Applications</td>
</tr>
<tr>
<td>A29</td>
<td>General Requirements for Steel Bars, Carbon and Alloy, Hot-wrought and Cold-finished</td>
</tr>
<tr>
<td>A36</td>
<td>Structural Steel</td>
</tr>
<tr>
<td>A48</td>
<td>Gray Iron Castings</td>
</tr>
<tr>
<td>A108</td>
<td>Standard Quality Steel Bars, Carbon, Cold-finished</td>
</tr>
<tr>
<td>A148</td>
<td>High-strength Steel Castings for Structural Purposes</td>
</tr>
<tr>
<td>A193</td>
<td>Alloy-steel and Stainless Steel Bolting Materials for High Temperature Service</td>
</tr>
<tr>
<td>A240</td>
<td>Heat-resisting Chromium and Chromium-nickel Stainless Steel Plate, Sheet, and Strip for Fusion-welded Unfired Pressure Vessels</td>
</tr>
<tr>
<td>A276</td>
<td>Stainless Steel and Heat-resisting Steel Bars and Shapes</td>
</tr>
<tr>
<td>A291</td>
<td>Carbon and Alloy Steel Forgings for Pinions and Gears for Reduction Gears</td>
</tr>
<tr>
<td>A311</td>
<td>Steel Bars Carbon, Stress Relieved Cold Drawn, Subject to Mechanical Property Requirements</td>
</tr>
<tr>
<td>A325</td>
<td>High-strength Bolts for Structural Steel Joints, Including Suitable Nuts and Plain Hardened Washers</td>
</tr>
<tr>
<td>A366</td>
<td>Commercial Quality Steel, Carbon, Cold-rolled Sheet</td>
</tr>
<tr>
<td>A449</td>
<td>Quenched and Tempered Steel Bolts and Studs</td>
</tr>
<tr>
<td>A501</td>
<td>Hot-formed Welded and Seamless Carbon Steel Structural Tubing</td>
</tr>
<tr>
<td>A519</td>
<td>Seamless Carbon and Alloy Steel Mechanical Tubing</td>
</tr>
<tr>
<td>A563</td>
<td>Carbon and Alloy Steel Nuts</td>
</tr>
<tr>
<td>SPECIFICATION</td>
<td>DESCRIPTION</td>
</tr>
<tr>
<td>---------------</td>
<td>-------------</td>
</tr>
<tr>
<td>American National Standards Institute (ANSI)</td>
<td>Metric Screw Threads</td>
</tr>
<tr>
<td></td>
<td>Pipe Threads (Except Dryseal)</td>
</tr>
<tr>
<td></td>
<td>Preferred Limits and Fits for Cylindrical Parts</td>
</tr>
<tr>
<td></td>
<td>Forged Steel Fittings, Socket Welding and Threaded</td>
</tr>
<tr>
<td></td>
<td>Keys and Keyseats</td>
</tr>
<tr>
<td></td>
<td>Heavy Hex Bolts</td>
</tr>
<tr>
<td></td>
<td>Hex Nuts</td>
</tr>
<tr>
<td></td>
<td>Socket Cap, Shoulder, and Set Screws</td>
</tr>
<tr>
<td></td>
<td>Clevis Pins and Cotter Pins</td>
</tr>
<tr>
<td></td>
<td>Dowel Pins</td>
</tr>
<tr>
<td></td>
<td>Plain Washers</td>
</tr>
<tr>
<td></td>
<td>Surface Texture</td>
</tr>
<tr>
<td></td>
<td>Tooth Proportions for Coarse-pitch Involute Spur Gears</td>
</tr>
<tr>
<td>Military Specifications</td>
<td>Fittings, Lubrication</td>
</tr>
<tr>
<td></td>
<td>Commercial Hard, High Brass</td>
</tr>
</tbody>
</table>
F. Shafting and Pins. Rolled material may be used for shafting and pins up to 4 in. diameter. Use forged material for larger diameter shafts and those having integral flanges or pinions. Homogeneity of forgings is required; shafts shall be reduced to size from a single bloom or ingot at no less than red heat. The blooms or ingots shall have a cross sectional area at least three times that required after finishing. The finished product shall be free of injurious flaws such as seams, pipes or cracks. Forged shafts over 8 in. in diameter shall have a hole bored lengthwise through the center. The diameter of the hole shall be about 1/5 the diameter of the shaft.

Shafting materials shall be tested for mechanical properties and certificates shall be furnished to the Department. Finished shafts shall be free of camber and run without vibration, noise or chatter at all speeds up to and including 120 percent of design speed.

Test all cold-finished shafting for its mechanical properties, and furnish a test certificate to the Engineer.

Dowel Pins shall be American National Standard Unhardened ground Dowel Pins with 64,000 psi minimum Ultimate Shear Strength.

G. Castings. Use castings that conform to AASHTO Movable Bridge Specifications. Material grades shall be as specified or shown in the Plans.

H. Forgings. Use forgings that conform to AASHTO Movable Bridge Specifications. Material grades shall be as specified or shown in the Plans.

I. Fasteners. Fasteners used for connecting machinery parts to each other and to supporting steelwork shall be turned bolts, or turned studs where shown, that conform to the minimum specified physical requirements of high strength, ASTM A325 or ASTM A449 cut thread, washer faced, hexagonal head bolts. Provide threads for turned bolts that conform to the requirements of ASTM A325. Do not use ASTM A490 bolts. Use nuts that conform to ASTM A563 or A194, Grade DH or 2H, heavy hex series.

Bolt heads, nuts and hexagonal cap screws shall be dimensioned in accordance with ANSI B18.2. Such fasteners are to be of the heavy series.

Socket head cap screws, socket flat head cap screws and socket set screws shall conform to ANSI B18.3. Such screws shall be heat treated alloy steel. Set screws shall be of the headless, safety type and be of the coarse thread series and have cup points. Set screws shall not be used to transmit torque nor as a stop for equipment that provides stability or contributes to operation of the bridge.

Class 2 coarse thread tolerances shall be required for all fasteners or threaded connections including bolts, nuts and cap screws and rod ends, unless specified otherwise.

Provide approved type positive locks for cap screws and nuts on turned bolts. Use standard thickness nuts where double nuts are required in locations where occasional opening or adjustment is necessary. Use flat jam nuts only where space prohibits use of standard nuts. Lock washers shall be made of tempered steel and conform to regular SAE dimensions and specifications. Properly tension high strength bolts and nuts to create a self-locking effect. If wire is used for locking it shall be 316 stainless steel.

Hardened steel, plain washers conforming to ASTM F436 shall be used at the rotated end of high strength ASTM A325 or A449 bolts and always under the nut.

Stainless Steel Fasteners: Where stainless steel bolts, threaded rod or anchors are required, provide fasteners of the following materials:

- **Bolt**: ASTM A193, Grade B8M, Type 316, Class 2 stainless steel
- **Nut**: ASTM A194, Grade 8M, Heavy hex, Class 2B Fit
- **Washer**: ASTM A240, Type 316, Hardened

Miscellaneous Fasteners and Hardware: Provide miscellaneous fasteners and hardware, including cotter pins and lock wire of corrosion resistant stainless steel, with material composition of type 316. Provide minimum strength requirements where shown in the Plans.

J. Keys and Keyways. Provide keys and keyways conforming to the dimensions and tolerances for square and flat keys of ANSI B17.1, Keys and Keyseats.

Provide keys machined from steel forgings, ASTM A668, Class K.
K. **Plain Spherical Bearings.** Where required, provide plain spherical bearings of the self-aligning type that are sized to meet B-10 life (as defined by the AFBMA at which 90 percent of a group of bearings will survive the identical loading conditions) of 40,000 hours under the power requirements defined in the AASHTO Movable Bridge Specifications or shown in the Plans. All pins and attachments shall be machined to the dimensions and tolerances as specified by the Bearing Manufacturer. Provide all plain spherical bearings with a means for grease lubrication and lip seals to retain the lubrication and guard the spherical surfaces from contamination.

I. **Spherical Roller Bearings.** Where required, provide spherical Roller Bearings manufactured in accordance with AFBMA Roller Bearing Engineering Committee (RBEC). Bearings shall be of the size, type and mounting configuration shown in the Plans.

Bearing and bearing housing materials, unless otherwise specified within the plans, shall be determined by the Bearing Manufacturer in accordance with applicable specifications and the design loads shown in the Plans. The following minimum materials shall be used with higher strength materials substituted as required by analysis:

- **Bearing Housings:** Cast Steel ASTM A27, Grade 60-30
- **Cap Bolts:** High Strength Turned Bolts, ASTM A449
- **Hex Head Cap Screws:** SAE Grade 8
- **Housing Cover:** Structural Steel, ASTM A709 Grade 36
- **Bearing Retainer:** Structural Steel, ASTM A709 Grade 50

Include in bearing submittals calculations or catalog cuts verifying bearing capacity, B-10 life, cap bolt and bearing housing capacity, and recommended maintenance, installation, and lubrication procedures.

M. **Shims.** Provide shims required for leveling and alignment that are stainless steel, full depth shims, drilled for all bolts that pass through, and trimmed to the dimensions of the assembled unit. The nominal shim pack thickness shall be 1/2 in. Shim material shall be ASTM A666, type 316 stainless steel. Thin laminated brass precision thickness shims may be used for final adjustment. Sufficient thicknesses shall be provided to permit 0.005 in. variations of the shim allowance plus one full allowance shim. All shims shall be corrosion-resistant. Provide the Department with one full set of additional shims for each type of component.

N. **Epoxy Leveling Grout.** Use Epoxy Leveling Grout where required for chocking, leveling and supporting equipment. Use an Epoxy Leveling Grout that is a two component, pourable, epoxy-based grouting compound manufactured for use in severe applications. Use Epoxy Leveling Grout manufactured for use in a thickness range of 1 - 1 ½ in. or the range shown in the Plans for a particular application.

Use Epoxy Leveling Grout having the following minimum properties:

- **Minimum Compressive Modulus of Elasticity:** 1,640 ksi ASTM C-579
- **Minimum Compressive Strength:** 19 ksi ASTM C-579
- **Flexural Strength:** 4,920 psi ASTM D-580
- **Minimum Izod Impact Strength:** 3.4 in-lb/in ASTM D-256
- **Maximum Linear Shrinkage:** 0.0001 in./in ASTM D-2566
- **Minimum Tensile Strength:** 3,156 psi ASTM D-638
- **Maximum Coefficient of Linear Expansion:** 15.4 x 10^-6ºF (Temperature Range 32º - 140ºF) ASTM D-696

Store, mix, place, and finish Epoxy Leveling Grout in strict accordance with the Manufacturer's recommendations.

O. **Weldments.** Fabricate weldments for support of machinery and/or hydraulic equipment from structural steel of the type and grade specified in the Plans. Where the type and grade of steel is not specified in the Plans, fabricate weldments from ASTM A709, Grade 50 structural steel. Use of steel plate larger than that denoted in the Plans may be required to obtain the final required dimensions.

P. **Lubrication of Machinery.** Giant button head fittings, No. 1823, will be used on all bearings and other machinery (not including gear teeth) requiring grease lubrication.
Provide one permanent lubrication chart for each Bascule Leaf. The charts will identify all points at
which lubrication fittings are located and will designate the kind and frequency of lubrication required
at each point. Provide charts that are a minimum of 11 inches x 17 inches. Make charts by laser
engraving ASTM Type 316 stainless steel sheet or similar means that is weather and corrosion
resistant. Use lettering that is a minimum of 0.125 in. high. Provide stainless steel hardware and mount
one chart in the bascule pier below each Bascule Leaf in a location directed by the Engineer. Include
copies of the charts in the bridge operation and maintenance manuals.

The lubrication charts will be submitted, as drawings, for approval. The charts shall consist of:

- A schematic diagram of all machinery showing the location of lubrication fittings and other
  points of mechanical and electrical equipment that require lubrication of any kind. These
diagrams shall indicate the type of lubrication to be used at each point, the method of application
  at each point, and the frequency of lubrication at each point.

- A table chart listing each machinery component that requires lubrication, the minimum
  frequency of inspection, the minimum lubrication frequency, the minimum lubrication change
  frequency instructions, standards, guidelines, and a history of most recent service.

Use tubing of seamless brass pipe meeting the requirements of ASTM B43 and bronze fittings ASTM
B62 or ASTM A269 Type 304 stainless steel tube with Type 304 or 316 stainless steel fittings. Use
stainless steel or corrosion resistant hardware to secure lubrication tubing and fittings. Provide one
grease gun for each type fitting.

Proprietary units will use lubricants approved by the Manufacturer; other units shall be supplied with
the lubricants specified in the Bridge Operation and Maintenance Manual.

Immediately after the completion of fabrication, plug all grease fittings until components are installed
and regular lubrication is started.

Immediately after erection and before operation, lubricate all rotating and sliding parts and fill all gear
housings with the lubricants specified. If the manufacturer does not recommend a specific lubricant use
the following requirements to specify a lubricant:

Enclosed Gear Reducers: Enclosed gear reducers lubricant shall meet the requirements of the
American Gear Manufacturers Association (AGMA) Standard 250.04 “Lubrication of Industrial
Gear Drives.” The lubricant shall be manufactured by a reputable and knowledgeable supplier
of lubrication and shall be as recommended by the reducer manufacturer. The lubricant should
contain oxidation inhibitors, rust inhibitors, anti-foaming agents, and anti-wear additives. The
maintenance of the lubricant, method of application, and relubrication intervals shall be
recommended by both the reducer manufacturer and the lubricant manufacturer, and meet the
requirements of AGMA Standard 250.04.

Open Gears: The open gear lubricant utilized must bond strongly to gear teeth to maintain a
continuous film on bearing surfaces despite high loading and high load repetition, contain an EP
(Extreme Pressure) additive, repel water, resist throw-off and dripping, maintain consistency
over wide temperature variations, and allow for ease in application and removal. The lubricant
shall have an operating range of 0 F to 210 F and shall be considered a heavy bodied, adhesive
type open gear lubricant by its reputable lubricant manufacturer. Some adhesive lubricants are
available in a diluted form for ease of application. This type of lubricant is diluted with solvent
that quickly evaporates after application leaving behind an adhesive tacky film. If such a
lubricant is desired, the solvent must be non-flammable and the mixture must not pose any
hazard to health. The detailed specifications for open gear lubricants that will satisfy the above
requirements do vary. Lubricant to Use: Unleaded, non-diluent type, non-chlorinated open gear
grease, SUS 7,000 @ 100 F viscosity, water resistant, anti-wear/extreme pressure.

Roller Bearings: The roller bearing lubricant, the maintenance of the lubricant, method of
application, and re-lubrication intervals shall be recommended or approved by the manufacturer.

Sleeve Bearings: The lubricant chosen shall be approved for use in sleeve bearings by the
lubricant manufacturer. Recommended Lubricant: NLGI No. 2 grease with rust and oxidation
inhibiting additives, 280 Worked Penetration at 80 F, 340 F (or higher) ASTM Drop Point, SUS
900 @ 100 F, water resistant, anti-wear/extreme pressure.
Couplings: Coupling lubricant and its maintenance shall be specified by the manufacturer. The lubricant chosen shall be approved for use in gear couplings by the manufacturer.

Keep maintenance and lubrication manuals for each machinery component in the machinery room in a heavy bound binder.

Furnish the bridge with an appropriate amount of proper lubricant. Store the lubricant in steel containers at room temperature. Store, at the site, the following amounts of additional lubricant (turn over to the Department any unused lubricant):

- **Gear Reducer Oil**: 10 gal
- **Open Gear Grease**: 12 aerosol cans
- **Bearing Grease**: 12 tubes for each type of bearing

Keep the lubricant for each type of machinery component separately in clearly marked containers. Take all measures necessary to prevent lubricant contamination.

Q. **Paint for Machinery**. Paint shall be as recommended by the manufacturer for a three-part zinc-rich epoxy primer system with aliphatic polyurethane top-coat. Apply the finish coat to weldments, bearing housings, and other machinery as specified in this Specification in the shop. Apply field touch-up paint to shop applied coatings that are damaged during construction.

After completing the operating tests and acceptance of the machinery, wash with a product recommended by the paint manufacturer all accumulated oil, grease, dirt, and other foreign matter from exposed machinery surfaces, except rubbing surfaces and mating surfaces of machinery components. Give the exposed bare metal surfaces a full prime system paint and final field coat. Paint machinery surfaces with the final field coat color per TxDOT Standard Specifications for Construction and Maintenance of Highways, Streets and Bridges. Provide color swatches to the Department for approval.

R. **Spare Parts and Tools**. Provide spare parts and tools to the Department, as required in this technical special provision or in the Plans. Spare parts and tools are considered incidental to the component to which they apply and shall be paid for as such.

3. **Equipment**

   A. **Tooling and Procedure Requirements**: Install, and/or adjust all mechanical equipment and materials in accordance with the manufacturer’s recommendations including the usage of the manufacturer specified tooling.

4. **Construction**

   A. **General Requirements**. The Contractor shall be responsible for the complete construction and satisfactory operation of the movable spans. This responsibility shall include material workmanship, and erection, and the designation of parts and details which are not covered by the Plans. Provide fits and finishes for machinery and machined structural parts in accordance with TABLE 2 per ANSI B 46.1 and ANSI B 4.1. Refer to Article 465-5 for shop drawing unit requirements.

   **TABLE 2 - FITS AND FINISHES FOR MACHINERY**

<table>
<thead>
<tr>
<th>PART IDENTIFICATION</th>
<th>FIT</th>
<th>FINISH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machinery base on steel</td>
<td>-</td>
<td>250 μ&quot;</td>
</tr>
<tr>
<td>Machinery base on masonry or epoxy leveling grout</td>
<td>-</td>
<td>500 μ&quot;</td>
</tr>
<tr>
<td>Machinery parts in fixed contact</td>
<td>-</td>
<td>125 μ&quot;</td>
</tr>
<tr>
<td>Shaft journal</td>
<td>RC6</td>
<td>H9 / e8</td>
</tr>
<tr>
<td>Journal bushing</td>
<td>RC6</td>
<td>H9 / e8</td>
</tr>
<tr>
<td>Split bushing in base or cap</td>
<td>LC1</td>
<td>H6 / h5</td>
</tr>
<tr>
<td>Solid bushing in base (to ½&quot; wall)</td>
<td>FN1</td>
<td>H7 / p6</td>
</tr>
<tr>
<td>Solid bushing in base (over ½&quot; wall)</td>
<td>FN2</td>
<td>H7 / s6</td>
</tr>
<tr>
<td>Hubs on shafts (to 2&quot; bore)</td>
<td>FN2</td>
<td>H7 / s6</td>
</tr>
<tr>
<td>Component</td>
<td>Component Type</td>
<td>Finish</td>
</tr>
<tr>
<td>-----------</td>
<td>----------------</td>
<td>--------</td>
</tr>
<tr>
<td>Hubs on Shafts (over 2” bore)</td>
<td>FN2</td>
<td>H7 / s6</td>
</tr>
<tr>
<td>Hubs on Trunnions</td>
<td>FN3</td>
<td>H7 / t6</td>
</tr>
<tr>
<td>Turned bolts in finished holes</td>
<td>LC6</td>
<td>H9 / f8</td>
</tr>
<tr>
<td>Permanent Dowel Pins</td>
<td>FN4</td>
<td>H7/u6</td>
</tr>
<tr>
<td>Sliding bearings</td>
<td>LC6</td>
<td>H9 / e8</td>
</tr>
<tr>
<td>Keys and keyways</td>
<td>LC4</td>
<td>H8 / h7</td>
</tr>
<tr>
<td></td>
<td>LC11</td>
<td>H13 / --</td>
</tr>
<tr>
<td>Teeth of open spur gears</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>under 1” circular pitch</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1” to 1 ¾” circular pitch</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>over 1 ¾” circular pitch</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Center Disks</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, furnish printed copies of these recommendations to the Engineer prior to installation. Installation of the material will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.

B. **Setting of Machinery.** Utilize millwrights, experienced in installing bridge machinery, to position, install, and make final adjustments to machinery and machinery pedestals installed on concrete structures. Use appropriate means and methods in setting machinery bases and pedestals, such as leveling screws or precision jacks such that the required positioning tolerances are obtained. If steel shims are used between the concrete surface and the machinery or pedestal base, remove the shims prior to tightening anchors. Where leveling grout is shown, remove all other temporary support devices, including leveling screws, jacks, and shims, prior to tightening anchors. Position all machinery pedestals that are installed prior to aligning the supported machinery to be within the following tolerances:

- Horizontal position: ±1/32 inches
- Vertical Position: ±1/32 inches
- Level (top of machined surface): ± 0.005 inches / foot
- Orientation (parallel to Plan centerline): ±0.5 degrees

C. **Erection and Testing.** Erect and assemble machinery in accordance with part numbers and match marks. Adjust all parts for precise alignment by means of shims and pull parts tightly against supporting members by use of clamps, temporary bolts, or other approved means before drilling and reaming holes for connecting bolts. Install all machinery within the specified tolerances and such that satisfactory operation is achieved. Utilize millwrights with demonstrated skill in this type work for all erection and adjustment of machinery.

Drill bolt holes in structural steel supports only after alignment of machinery. Fully grout and tighten anchors for pedestals prior to aligning machinery.

Do not install machinery unless mounting surfaces are clean of dirt, paint and other foreign materials. Securely tighten connecting screws, bolts and nuts to specified torque values.

Arrange for and have the machinery supplier or manufacturer inspect and approve the complete machinery installation prior to checkout operations for the bridge (i.e., compliance criteria and acceptance tests per the Contract Documents). Also have the machinery supplier observe the testing and trial runs of the equipment.

D. **Bolting.** Drill bolt holes in machinery parts for connection to supporting steelwork in the shop a minimum of 1/16 inch diameter smaller than the finished bolt diameter or drill from solid at assembly.
Drill and ream at final assembly.

Drill bolt holes in steelwork for turned bolts from solid at assembly or erection after proper alignment. Do not pre-drill holes full size prior to final assembly.

Clean all contact surfaces of structural steel to be bolted together before bolting.

Spot face bolt holes through unfinished, rough cast surfaces for the head and nut.

Tension ASTM A325M and ASTM A449 bolts, used for connecting steel machinery parts together or to structural steel and whose nominal threaded diameter is less than or equal to 1-1/2 inches, in accordance with the Structural Bolting requirements of Item 447 of the Texas Department of Transportation Standard Specifications for Maintenance of Highways, streets, and Bridges, 2004, as amended.

Tension turned bolts larger than 1-1/2 inches (nominal thread diameter) by turning the nut 1/4 turn past snug tight and adding a backing nut (double nuts) turned snug tight. If the Plans require a turned bolt larger than 1-1/2 inches to be tensioned, hydraulically tension the bolt as detailed below. If the Plans require a turned bolt larger than 1-1/2 inches to be tensioned but do not specify a preload value, tension the bolt to 70 percent of the minimum tensile yield strength of the bolt, using the nominal area of the threaded section.

Tension bolts, cap screws, stainless steel and other threaded fasteners as follows:

For permanent connections: \( F_t = 0.75 \times A_t \times S \)

Where:
- \( F_t \) = fastener preload
- \( A_t \) = tensile area of the fastener
- \( S \) = fastener proof strength

Preload may be applied by direct hydraulic tensioning or torque. Where torque is used it may be calculated as follows:

\[ T = K \times F_t \times d \]

Where:
- \( T \) = required wrench torque applied to fastener
- \( K \) = constant dependent upon bolt size, material and lubrication
- \( d \) = nominal fastener diameter

For mild-steel fasteners (SAE Grade 5 and lower) between 1/4 and 1 inch diameter a value of \( K = 0.2 \) may be used for dry assembly. For other materials and sizes use manufacturer recommended values.

Hydraulic Tensioning: Hydraulically tension pre-tensioned Anchors, including Undercut Anchors, anchored into concrete and high strength bolts whose length exceeds 12 bolt diameters. Bolts conforming to the requirements of ASTM A325M and ASTM A449 may be tensioned by the hydraulic tensioning method. Provide additional length of threaded shank as required to perform hydraulic tensioning operations. Hydraulically tensioned bolts shall be subject to the following requirements:

Bolts having a grip exceeding 12 inches or 12 bolt diameters, whichever is greater, must be hydraulically tensioned.

Tension pre-tensioned anchors embedded into concrete by use of the following procedures:

(a) Set and tension all bolts anchoring any one component at one time.

(b) Tension all bolts sufficiently to set them. The minimum setting load shall be as specified by the bolt Manufacturer.

(c) Perform final tensioning after all bolts are set. Tension all bolts by the use of a center hole calibrated hydraulic ram. Mount the ram on a chair which permits access to the anchor bolt nut. Tension bolts to 70 percent of the specified minimum tensile strength of the bolt or the anchor bolt Manufacturer's recommendation, whichever is greater. Snug the nut down prior to releasing the hydraulic pressure to the ram.

(d) Just after installation and again 60 days later, the preload shall be checked. Hydraulic tension shall be applied. The bolts shall have a tension equal to 60 percent of the minimum specified tensile load applied.
No movement of the nut shall be detected under this load.

(e) If the preload test fails, the bolts shall again be tensioned to original tensioning values and the nut retightened. Retesting at 60 day intervals will be required until the bolts are accepted. Contract time will not be charged for re-testing if the preload test passes.

**E. Shafting and Pins.** Provide all shafts and pins with accurate finishes. Provide shafting that is round, true, smooth and straight, and has round fillets at shoulders. Blend all fillets smoothly to adjacent surfaces without tool marks, steps or scratches.

All shafts shall conform to tolerances in ASTM A29. Turned, ground and polished shafting straightness tolerances shall be 0.002 inches / foot for shafts up to and including 1-1/2 inch in diameter and 0.003 inches / foot for shafts over 1-1/2 inches in diameter.

Finished shafts shall be free of camber and run without vibration, noise or chatter at all speeds up to and including 120 percent of design speed.

Where shown on the Plans, stepped shafts shall have fillets blended in smoothly to adjacent surfaces without tool marks or scratches. The journal and coupling hub mating surfaces shall have maximum roughness of 250 microinches. Roughness of the painting, non-contact portions of the shaft shall have all burrs or other irregularities in shape removed and shall have a finish appropriate for the paint application.

Each end of all shafts, when finished to the required lengths, shall have a 60 degree lathe center, with clearance hole, at the exact center of the shaft. Shafts that are bored with an inspection hole shall have the ends prepared for the attachment of a centering device equivalent to the lathe center. Furnish all such devices as part of the work.

All hubs mounted on the ends of cold-finished shafts shall have the fit specified in this technical special provision or on the Plans. To obtain the required fit between hub and shaft, furnish the cold-finished shaft a minimum of 1/16 inch larger than the nominal diameter specified and turn the ends to the required dimension for the hub.

Machine and polish all journal bearing areas on shafts and pins, with no trace of tool marks or scratches on the journal surface or adjoining shoulder fillets. Burnishing of the shaft journal areas and adjoining shoulder fillets will be acceptable in lieu of polishing provided that the burnishing is done with a stellite roller or equal, finished to a mirror surface.

**F. Castings.** Weld repair of castings at the foundry shall conform to the required ASTM procedure. Weld repair after start of machining and/or assembly must be approved by the Engineer.

Clean all castings free of loose scale and sand, fins, seams, gates, risers, and other irregularities. Neatly cast all unfinished edges of castings with rounded corners, and provide all inside angles with ample fillets.

Perform, in the Manufacturer's shop, for each casting:

1. **Visual surface examination of all surfaces (100%) per ASTM A802, with Level II as the Acceptance Criteria. Linear discontinuities, cracks and tears are not permitted. Castings with test records meeting Level III may be considered for weld repair. All other discontinuities are unacceptable. Using ASTM Practice A802, identify and remove unacceptable surface discontinuities.**

2. **Magnetic Particle Testing (100 %) per ASTM E 709, with acceptance criteria per ASTM E 125. The Acceptance Criteria, as to the Type of Discontinuity and the Degree for acceptance, will be as follows:**

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type I</td>
<td>Cracks/Hot tears</td>
<td>3/16” Maximum</td>
</tr>
<tr>
<td>Type II</td>
<td>Shrinkage</td>
<td>Degree 3</td>
</tr>
<tr>
<td>Type III</td>
<td>Inclusions</td>
<td>Degree 3</td>
</tr>
<tr>
<td>Type IV</td>
<td>Chaplets</td>
<td>Degree 2</td>
</tr>
<tr>
<td>Type V</td>
<td>Porosity</td>
<td>Degree 1</td>
</tr>
</tbody>
</table>

Surface discontinuities may be considered for weld repair.
3. Ultrasonic 100 percent volumetric examination per ASTM A 609. All castings with solid sections of 4 inches thick or greater shall meet ASTM A609, Method A, Quality Level 3. Castings with test records meeting Quality Level 4, may be considered for weld repair.

If weld repair is approved by the Engineer following a review of the test results, submit detailed weld procedures, including a means to qualify the weld repair. Obtain approval from the Engineer before making any weld repairs. Perform weld repairs per ASTM A 488 or equivalent, and radiographic examination of welds per ASTM E 94.

Castings that do not pass each of the above tests against the respective acceptance criteria may be rejected. Submit all test results, whether positive or negative, to the Engineer, as Certified Test Reports. Test Reports showing Quality Levels and Degrees of Discontinuities higher than those that may be considered for weld repair shall be cause for rejection, and such castings will not be considered for weld repair.

G. **Forgings.** Perform, in the Manufacturer's shop, for each forging:

1. Magnetic Particle examination per ASTM A275 and ASTM E709, or Liquid Penetrant examination per ASTM E165. Acceptance criteria of ASTM A788, Supplementary Requirements S18 and S19, shall apply.

2. Ultrasonic examination per ASTM A388 or ASTM E2375. Acceptance criteria of ASTM A788, Supplementary Requirements S20, Level BR and Level S, shall apply.

Provide test results, for review and approved prior to shipping.

H. **Keys and Keyways.** All keys shall be effectively held in place, preferably by setting them into closed-end keyways milled into the shaft. Round the ends of all such keys to a half circle of diameter equal to the width of the key. Keyways shall have a radius in the inside corners. Keyways shall not extend into any bearing. If two keys are used in a hub, locate them 120 degrees apart and in line with wheel arms where practicable.

I. **Bushings.**

1. For split bushings, the outside diameter fit between bushing and housing shall be as specified in the Plans. Double flanged bushings shall have the same fit between flanges and the end faces of the base and cap. Finish bores to achieve the fit with the shaft journal as specified in the Plans. Turn bushings with a predetermined gap between halves to suit the liner or shim thickness. The total thickness of liners in each bushing set shall include at least 1/8 inch laminated construction, permitting adjustment in increments of 0.003 inches. Liners shall be cut to fit shoulder fillets, shall be square with bushing flanges, and shall have bolt holes drilled through them. Provide bushings that have spiral grease grooves such that the grooves intersect at the center of each bushing half. All grease lubricated bronze bushings 8 inches in diameter or less shall have grease grooves cut in a spiral pattern for the full length of half the bearing. All grease grooves shall be machine cut and smooth. The corners of all grooves shall be 3/16 inches wide at the bearing surface and be rounded to a 1/8 inch radius.

2. For solid bushings provide fits between the bushing OD and housing and between the bore and the shaft as specified in the Plans. Provide bushings that have spiral grease grooves. All grease lubricated bronze bushings 8 inches in diameter or less shall have grease grooves cut in a spiral pattern for the full length of half the bearing. All grease grooves shall be machine cut and smooth. The corners of all grooves shall be 3/16 inches wide at the bearing surface and be rounded to a 1/8 inch radius.

J. **Welding and Weldments.**

1. Perform all welding and weld inspection of machinery in accordance with ANSI/AASHTO/AWS D1.5. Treat all welded machinery and weldments that support machinery as main members, all welds as subject to tension or stress reversal, and all welds as joining primary components. Do not perform field welding on these elements.
2. Perform coupon testing and provide a certified copy of test reports prior to any welding procedure involving attachment to existing steelwork. Provide report showing the chemical composition of the specific steel piece(s) to be welded. Design weld procedure specific to this chemical composition.

3. Connect elements of weldments by complete joint penetration welds. Do not use fillet welds where they would require machining to provide clearance for machinery, fasteners, or other attachments. Clip stiffeners to avoid overlapping stiffener welds with welds at the intersection of main plates.

4. Stress relieve weldments after welding and prior to final machining. Finish machined surfaces of weldments to flatness as required in this technical special provision and parallel to each other and to the bottom of the base plate. The height of the weldment shall be per Plan height ±1/8 inch. All exposed edges of weldments shall be ground to a chamfer or radius to eliminate sharp edges and burrs. Weldment base plates which will be placed against concrete or grout shall have ¾ inch minimum radii on the corners.

5. Finished mounting surfaces shall have those surfaces thoroughly coated with an approved corrosion inhibitor and shall be skidded or crated for protection during handling, shipment and storage. Prime weldment base surfaces which will have concrete or grout cast against them, but do not finish coat them.

K. Lubrication of Machinery

1. Connect grease fittings with tubing or fittings so that grease is introduced directly into the grease grooves for distribution. Tubing is to be extended from the bearings to convenient lubrication stations. Install vibration absorbent braided stainless steel hose, 8 inch minimum length, between the pipe and the component lubricated. Provide tubing supports at increments not to exceed 3 feet between supports.

2. Immediately after erection and before operation, lubricate all rotating and sliding parts and fill all gear housings with the approved lubricants specified on lubrication charts.

L. Protection for Shipment.

1. Coat all finished metal surfaces as soon as practical, after machining, with corrosion inhibiting compound. Coat non-stainless shims with corrosion inhibiting compound prior to shipment and wipe clean before installation. Completely protect machinery parts from weather, dirt and foreign materials during manufacture and store indoors while awaiting bascule leaf fabrication and erection. Exposed shaft journals shall be greased, wrapped in oil-soaked burlap and securely timber lagged for shipment. Assembled units, including bearings, lockbar operators and other devices having finished mounting surfaces will have those surfaces thoroughly coated with corrosion inhibiting compound and shall be skidded or crated for protection during handling, shipment and storage.

2. Bag and crate mounting hardware and other small parts for shipment. Provide and secure tags, recording the part number, to each part with wire or plastic ties prior to shipment.

M. Startup Requirements. Implement startup procedures that protect the equipment from damage and ensure safe working conditions during bridge operations throughout construction. This section identifies specific requirements related to movable bridge startup operations.

1. Assure that drive train and pivot bearing have been fully lubricated.

2. Perform initial movement of a complete or partially complete span using a step-by-step procedure with incremental clearance checks to verify that there are no interferences between the span, machinery, fixed structure, or other equipment. When moving the Bascule Leaf for the first time after elements have been initially installed or added, perform the following:
   a. Rotate the bridge in increments of 5 degrees or less.
   b. At each increment, bring the span to a complete stop and check clearances at applicable machinery and movable span/fixed pier interfaces, including end wedge assemblies, center wedge assemblies, pivot bearing, gears, deck joints, handrail joints, traffic barrier joints and control house.
3. Movable leaves shall not be operated at greater than position 2 on the drum switch until all of the following conditions have been met:
   a. Span control limit switches have been set and initially adjusted.
   b. The permanent bridge electrical service and power distribution equipment (Disconnect Switch, etc.) has been installed, tested and energized and is in stable operating condition.
   c. The Control Panel (CP-1) and Control Desk (CP-2) connections to the motor are installed, wiring complete with wires labeled (no splices or temporary connections). Interlocks are active and functioning.
   d. E-Stop operation has been verified.

N. Protection of Equipment. During construction, all equipment shall be protected from damage as a result of construction operations and contamination from dust and debris. Prior to installation, equipment shall be stored in an enclosed room. Should any equipment become contaminated, immediately clean the equipment, relubricate, and protect from further contamination. The bridge shall not be operated and no enclosed equipment opened during any period in which construction operations can contaminate the equipment.

O. Drawings.
1. Description. Provide Shop Drawings in accordance with the Contract Documents, including detail and assembly drawings for all operating machinery and parts, together with an outline drawing containing all information necessary for computing the strength of the machinery parts. Prepare Shop Drawings with sufficient detail to permit the fabrication of parts without reference to patterns, other drawings, or individual shop practice. Provide primary units on Shop Drawings consistent with the manufacturing tools and instrumentation to be used in fabrication. Show the estimated weights of individual parts and the total weights of all parts furnished under this item. Furnish permanent reproducibles of the detailed Shop Drawings for the span and machinery, including end and center wedge assemblies, to the Department upon request.

2. Accuracy and Tolerance. Give limits of accuracy and tolerance required for machining, surface finishes and allowances for fits so that prescribed limits are obtained. Apply the fits and finishes in TABLE 2. Provide dimensions between machined surfaces that have a tolerance of 0.010 inches.

3. Dimensioning. The dimensions given on the Plans for manufactured components are nominal and intended for guidance. Clearly delineate in Shop Drawings any variations from the nominal dimensions shown on the Plans. Verify all field dimensions given on the Plans prior to shop drawing preparation.

   a. Submit Shop Drawings for all mechanical and hydraulic assemblies, systems and components, regardless of the detail provided in the Plans. Provide Shop Drawings that include complete layout drawings and location diagrams for each system. Where left handed and right handed components are required, detail both components regardless of which component is detailed in the Plans.
   b. Group Shop Drawings for components or elements of a system or assembly together for submittal. Assign each submittal a unique submittal number and sequentially number all drawings or pages within each submittal. Except for stand-alone components show all components and adjacent structures or supports in an assembly drawing that identifies the number, relationship, and location of all items. Submit each group of shop drawings for a component or element as a complete package. Partial submittals will not be reviewed and will be returned as “Incomplete” or “Not Approved”.
   c. Provide complete assembly drawings for all shop assembled components. Provide assembly tolerances, required lubrication, bolt and screw tension (or torque) values and complete references to component drawings or part numbers.
d. Include Manufacturer's test data, certified by the Manufacturer, and identify the application for which products are proposed. Mark standard drawings or catalog cut sheets to indicate the model or size proposed and all appropriate options or modifications.

e. If requested by the Engineer, submit for inspection, samples of the proposed substitute items at no cost to the Department. Submit all support data in quintuplicate for checking. The Department will not be liable for any materials purchased or work done or any delay incurred prior to their review. Failure of the Engineer to note unsatisfactory materials as received will not relieve the Contractor from responsibility. Provide Manufacturers' guarantees or warranties on materials to the Engineer upon receipt of the materials.

f. Submit Shop Drawings for Lubrication Charts which include a detailed layout of all equipment requiring lubrication, a schedule of required lubricant and a complete bill of materials for lubrication fittings, piping and piping supports.

2139.B MAIN DRIVE SYSTEM

1. Description

A General: The work included under this article includes: cleaning all of the operating machinery from grease and debris, including but not limited to, open gearing, shafts, reducer, bearing housings and balance wheel assemblies; removal of the bearing housing caps for cleaning; flushing the balance wheel assemblies with solvent; repairing the primary speed reducer internal oil pump and adding a breather vent; and applying proper lubricant to all operating machinery mentioned previous.

B. Reducer.
   a. Drain the lubricant from the reducer and fill with approved lubricant at the completion of repairs.
   b. Clean the inside of the speed reducer with materials and procedures of generally accepted industry practice.
   c. Install a breather vent in the existing breather location.

C. Submittals. Provide dimensioned drawings, materials and catalog cuts for approval.

2. Materials

A. Breather. Provide breather vent with porous bronze element with minimum 40 micron filtration rating.

B. Lubrication. Provide lubrication approved by the Department maintenance office.

3. Construction

A. Flushing and Cleaning: Contain and remove all debris collected from cleaning and flushing drive machinery and balance wheel assemblies. Dispose of debris in accordance with local and state regulations.

B. Breather. Route breather vent lines such that vent in protected from moisture intrusion (i.e. vent opening is facing down).

C. Operation. Prior to operating the span, ensure that the speed reducer oil pump is in operational condition. DO NOT OPERATE THE SPAN WITHOUT CONSTANT LUBRICATION TO THE INTERNAL GEAR SET OF THE SPEED REDUCER. All open gear sets and bearing bushings shall be lubricated prior to operation of the span.

END OF SECTION 2139
2139.C CENTER PIVOT BEARING

1. Description.
   A. General. Jack the span using an approved jacking procedure prior to the start of jacking. Disassemble the center pivot bearing housing. Replace the upper convex bronze disc. Inspect the lower concave steel disc and replace if necessary. Reassemble the center pivot bearing housing and install new reservoir.

   B. Submittals. Provide jacking procedure, dimensioned drawings, materials and catalog cuts for approval.

2. Materials
   A. Upper Disc. Fabricate the upper concave bronze disc from ASTM B22, Alloy C91300. Match the dimensions of the existing disc, accounting for wear and include oil lubrication grooves matching the original configuration.

   B. Lower Disc. Remove and inspect the lower disc for wear or abrasions. Clean and polish rotational contact surface. If scoring or pitting is evident that cannot be removed with polishing or light sanding replace lower convex disc. Material shall be AISI 4340 with a BHN of 210 – 250. Match the dimensions of the existing disc, including any oil passages for lubrication.

   C. Oil Reservoir. Provide oil reservoir with aluminum top and bottom plate with clear plastic bowl and self-closing fill cap. Reservoir shall have a minimum oil capacity of 5 oz. and a minimum height of 4 inches. Piping to oil reservoir shall be 1/4 inch NPT schedule 40 Brass piping and fittings.

      Oil for center pivot bearing shall be viscosity motor oil (30W or 40W), as approved by the Department.

3. Construction
   A. Span Jacking. The span shall be jacked for center pivot bearing replacement while in the closed position with the end jacks driven or other acceptable means of supporting the span, as approved by the Engineer. The span will be jacked using four hydraulic jacks, two on each side of the pivot girder. The total span load is approximately 902,000 lbs. The capacity of the jacks used for lifting the span shall be a minimum of 125% of that required for lifting and all jacks shall be of equal capacity. The capacity of the jacks used for lifting the span shall be a minimum of 125% of that required for lifting and all jacks shall be of equal capacity. A manifold will be used to ensure that each jack will carry 1/4 of the span load with the load shared by balanced hydraulic pressure. Calibrated pressure gauges shall be used to verify the pressure in each jack, along with a manual shut-off and check valves in line with the hydraulic cylinders. The jacks will be placed on a plate, a minimum of 1 inch thickness and a minimum of 200 square inches per pair of jacks, to avoid concentrated compressive loads in the concrete. The pairs of jacks will be centered about the centerline of the pivot girder of the swing span and located beneath s stiffened portion of this girder. Jacks shall provide transverse stability, while the end wedge assemblies, or other suitable methods, shall provide longitudinal stability. Bearing plates will be used between the jack and the girder to distribute the load. The jacks shall be placed on the pivot pier inside of any cantilever portions of the pier cap.

      Do not perform jacking of the span until calculations have been prepared, and reviewed and approved by the Engineer, verifying that the span unbalance, wind and construction loads are within the capacity of the mechanism used to jack the span.

      Perform initial movement of the span using a step-by-step procedure with incremental clearance checks to verify that there are no interferences between the span, machinery, fixed items on pivot pier or other equipment. Raise the leaf in 1/8 inch increments or less, stopping to perform clearance checks prior to proceeding.

      While raising the span, and while the span is raised, the end wedges shall be driven and locked in place. Jacks or other acceptable means of supporting the tips of the span may be used, as approved by the Engineer. Upon raising of the swing span, the jacks will be locked off using integrated locking collars.
All calculations for jacking the span and the supporting frame work for jacking shall be performed by a Professional Engineer licensed in the State of Texas. Calculations shall account for all work that is to be performed on the span while the span is in the jacked position.

B. **Span Height.** Prior to jacking and disassembly of the center pivot bearing measure and record the gap at each balance wheel. After installation of the center pivot bearing and removing the jacking system the balance wheels shall have a clearance of 1/16 inch to 3/32 inch between the bottom of the wheel and the top of the track with the end and center wedges pulled. Note that prior to balancing, the span may rest primarily on two to three balance wheels requiring that the gap beneath each wheel be calculated mathematically.

C. **Pivot Bearing Housing.** Modify existing center pivot bearing housing to facilitate new external oil reservoir with visual indication of oil level and drain. Perform work on housing prior to reassembly. Bottom of reservoir sight glass, or permanent indication of low oil level, shall be located 1/2 inch above beginning of convex surface of bronze disc in order to maintain lubrication of pivot bearing at all times. Top of oil reservoir shall not be located above the top of the housing. Drain shall be located at lowest accessible location on housing. Install 1/4 inch NPT stainless steel ball valve at drain location with schedule 40 Brass piping and fittings.

Clean all existing gasket material from bearing housing and solvent clean. Prior to final installation clean with rubbing alcohol and air dry. New gasket material shall be cut from a 1/16 inch thick Buna-N sheet gasket. Apply a thin film of Permatex ultra-blue RTV silicone gasket maker to each side of gasket prior to assembly. Where bottom and side gaskets intersect apply a proportionate amount to fill maximum 1/8 inch gap between gaskets.

Fill oil reservoir with oil specified to a level of 2 inches minimum above beginning of convex surface of bronze disc. No oil leakage must be evident from pivot bearing housing after filling with the proper amount of oil.

END OF SECTION

2139.D **END AND CENTER WEDGE ASSEMBLIES**

1. **Description.**
   
   A. **General.** Remove and dispose of existing end and center wedge operating machinery. The wedge assemblies and existing framing to remain. Install and align new operating machinery as detailed in the Plans and specified herein.

   B. **Submittals.** Provide dimensioned drawings, materials and catalog cuts for approval.

2. **Materials**

   A. **Linear Actuator.** Provide linear actuators meeting the requirements in the plans, particularly thrust, speed and stroke. Linear actuator shall have a self-locking acme screw driven by a 3 phase, 60 Hz electric motor with a parallel gear box via a timing belt with an electro-magnetic brake. Linear actuators shall have the following accessories provided: trunnion mounting brackets, spherical rod end and manual operation with motor disconnect when engaged, normally disengaged. Provide linear actuators of a complete package to include all electrical motors, belts, pulleys, reducers, acme screws, rod ends, manual cranks with safety disconnect, trunnions, trunnion mounting brackets and accessories. Paint actuators and all mounted equipment with a factory finish intended for industrial applications. Provide storage compartment or clamp for the hand crank at each actuator location.
B. **Spherical Rod End.** Provide spherical rod ends for link arms, one left hand thread and one right hand thread per assembly, meeting the requirements within the Plans with 2-12UN-3A threads, 6.0 degrees allowable angular misalignment, minimum 4.5” thread length, a static load capacity of 75,000 lbs. and a grease lubricated with a zerk type fitting or equal.

3. **Construction**

   A. **Machinery Removal.** Remove and properly dispose of all end and center wedge drive assemblies. All items of existing assemblies are to be removed with the exception of the end and center wedge receivers, end and center wedges and end and center wedge bases, which are to remain and be incorporated into the new end and center wedge assemblies per the Plan details.

   B. **Alignment Criteria.** Install components of end and center wedge assemblies to have a maximum misalignment of 3 degrees between mating components, i.e. link arm to wedge, link arm to crank arm and crank arm to linear actuator. Assemblies shall operate smoothly throughout travel without binding, popping or requiring significant force when actuated without load or off of the wedge base based on current draw of the drive motors.

   C. **Lubrication.** Prior to operation of the end or center wedge assemblies lubricate all rotating and sliding surfaces, including but not limited to trunnion bearings, roller bearings, rod ends and upper and lower sliding surfaces of wedge. Refer to the manufactures recommendation for type and quantity of lubrication for each item.

   D. **End Wedge Assembly Adjustment.** Adjustment of the end wedge assemblies shall be performed after all work affecting roadway elevation, leaf elevation, balance and span tip weight are complete. Adjust the limit switches such that when driven the link arm and crank arm are parallel within 5 degrees, but does not travel over center. Adjust the limit switches such that the linear actuator pulls the crank arm to the angle shown in the plans. Additional adjustment may be required for pulling the end wedges to clear the end wedge base or other obstructions on the end pier cap not detailed in the plans. Adjust the link arm such that when in the full driven position as determined by the limit switches that the vertical height difference between the tip of the span and the approach spans shall not exceed ± 1/8 inch at the break, measured in three places even spaced across the span.

   E. **Center Wedge Assembly Adjustment.** Adjustment of the center wedge assemblies shall be performed after all work affecting leaf elevation and balance are complete. The center wedge assemblies shall be adjusted after adjustment of the end wedge assemblies has been performed. The center wedge assemblies shall be adjusted with the end wedges driven and the span leveled. Equal clearance between the balance wheels and track shall be verified prior to adjusting the link arms. Adjust the limit switches such that when driven the link arm and crank arm are parallel within 5 degrees, but does not travel over center. Adjust the limit switches such that the linear actuator pulls the crank arm to the angle shown in the plans. Additional adjustment may be required for pulling the center wedges to clear the center wedge base or other obstructions on the pivot pier cap not detailed in the plans. Adjust the link arm such that when in the full driven position as determined by the limit switches that the wedges are firmly in contact with the wedge receiver and the wedge base. The center wedges are not intended to create uplift on the span. When driving or pulling, the wedges shall not cause vertical movement of the pivot girder. There may be a slight rotation of the pivot girder when driving after operation of the span.
2139.E CENTERING DEVICE

1. Description.
   A. General. Provide new centering device as detailed in the Plans.
   B. Submittals. Provide dimensioned drawings, materials and catalog cuts for approval.

2. Materials
   A. Neoprene Pad. Provide neoprene pad for centering device with the following properties: temperature range: -40° to +220° F; tensile strength: 2500 psi; durometer: 70A; for outdoor use.

3. Construction
   A. Installation. With end wedge assemblies driven and the wedges centered within the wedge bases within +/- 1/8 inch set the centering device with 1/2 inch nominal gap between neoprene pad and shoe weldment. Do not use centering device to locate span until grout has cured and undercut anchors properly tensioned.

END OF SECTION

2139.F SPAN BALANCING

1. Description
   A. General. Remove and dispose of all existing balance blocks on span, primarily located within the pivot pier location. Note that some of the existing balance blocks may be located on the pivot pier and not on the span. The existing balance blocks weight approximately 300-400 lbs. Determine and add the weight required to balance the span as specified herein.
   B. Submittals. Provide construction balance procedure, dimensioned drawings, calculations, materials and catalog cuts for approval.

2. Materials
   A. Balance Weights. Provide steel or cast iron weights of a size and shape suitable for locating and permanently storing on the span. Weights shall not exceed 110 lbs. per unit. Weights shall be free of corrosion and properly coated as to prevent corrosion from forming with an approved paint system. A suitable means of attaching the weights to the span shall be detailed in shop drawings, such as pockets or baskets permanently attached to the span. Balance weights shall not interfere with operation of the span or access to machinery or electrical components. The span will require approximately 9600 lbs. of counter balance weight added to the tender house side of the span, and approximately 1800 lbs. at one tip due to construction tolerances.

3. Construction
   A. Maintaining Span Balance. During construction on the movable span any changes to the span that will affect span balance (i.e. removing/adding grating, railings, control house, ect.) shall be performed with the tips of the span supported by either the end wedges, or jacks placed under the end floor beam, and the center wedges driven, or jacks placed under the pivot girder. The balance wheels shall not be used to prevent rotation or support the span under imbalance conditions.
B. **Span Jacking.** Do not perform jacking of the span until calculations have been prepared, and reviewed and approved by the Engineer, verifying that the span unbalance, wind and construction loads are within the capacity of the mechanism used to jack the span.

The span shall be jacked in the closed position, with the end jacks driven or other means to support the tips of the span.

Perform initial movement of the span using a step-by-step procedure with incremental clearance checks to verify that there are no interferences between the span, machinery, fixed items on pivot pier or other equipment. Raise the leaf in 1/8 inch increments or less, stopping to perform clearance checks prior to proceeding.

C. **Final Balance.** Perform final span balance calculations and adjustments after all work on the span affecting span balance has been performed. Transverse adjustment of the span balance shall occur within the pivot pier, as close to the main girders as possible and evenly spaced on both sides of the pivot girder. Longitudinal adjustment of the span balance shall occur at the tips of the span. The remaining support members for the end wedge machinery previously removed may be used to support the balance pockets used to contain the balance weight.

The span imbalance shall not exceed 30 kip-ft in longitudinal and transverse direction. The imbalance should be determined by use of a calibrated jack and pressure gauge using the following procedure:

1. Jack the span in four quadrants 90 degrees from each other, two of which shall be located beneath the pivot girder. The quadrants opposite each other shall be equidistant from the pivot bearing. Each quadrant shall be jacked individually with no resistance on the span to prevent rotation, such and end or center wedges being driven. The jack should be about 20 tons, based on a jacking distance of 7 foot from the center of the pivot bearing.

2. Pressurize the jack using constant flow, pump until span moves (an air over oil pump is not allowed for this procedure). Note the maximum pressure on the gauge. This will be the force due to imbalance and static frictional force from the pivot bearing. Perform the test three times, ensuring that the balance wheels do not contact the track during testing. Alternating jacking between two sides may be required.

3. Multiply the distance from the center of the pivot bearing to the center of the jack, in feet, by the pressure of the gage, psi, and by the bore diameter of the jack, square inches, to determine the moment required to move the span. Subtract the numbers from quadrants opposite each other, which the resultant is the imbalance force. Add or subtract weight as required to achieve the desired imbalance. Multiple iterations may be required.

END OF SECTION
2139.G FUNCTIONAL TESTING

1. Description.
   A. General. Refer to the Sections under “Verification Testing” and “Test Result Reporting” in Special Specification 2139 for “Electrical Construction for Moveable Bridge Rehabilitation” for additional details and information on this item.

2. Materials
   A. Not applicable to this section.

3. Construction
   A. Clean, polish and make ready all fixtures, equipment, system components and materials thoroughly in preparation for verification testing. Remove all excess material, debris and unnecessary supplies from the project site. Place all electrical and mechanical systems in complete working order before requesting or performing final verification testing from the Engineer.
   B. Assure mechanical and electrical systems function completely and interface correctly with all other systems. Make good on any faults or imperfections that may arise due to defects or omissions in materials or workmanship with no additional compensation and to the complete satisfaction of the Engineer.

END OF SECTION