MICHIGAN

DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION

FOR

**DISC BEARING**

BRG:JJA 1 of 7 APPR:MJF:REL:05-15-23

**a. Description.** This work consists of designing, manufacturing, testing, furnishing, shipping, and installing disc bearings including sole plates, masonry plates, elastomeric pad, and shim plates if needed in accordance with the plans, 2020 *AASHTO LRFD Bridge Design Specifications, 9th Edition with November 2021 Errata (hereafter referred to as AASHTO Design), 2017* *AASHTO LRFD Bridge Construction Specifications, 4th Edition, with November 2021 Errata and 2020 and 2022 Interim Revisions (hereafter referred to as AASHTO Construction)*, the standard specifications, and this special provision. No substitution for disc bearings are allowed. All other bearings specified on the plans are not covered by this special provision. The definition for disc style bearing is as follows:

**Disc Bearing.** Shear inhibited disc bearings must consist of a load bearing and rotational disc which is composed of a polyether urethane material and must be contained between upper and lower steel bearing plates. The bearing must be built with an internal shear restriction mechanism. Provide translation capability for both guided and non-guided expansion bearings by means of a polished stainless steel sliding plate that bears on a PTFE sheet bonded and recessed to the top surface of the disc. The PTFE surface of the steel bearing plate must be in contact with the steel plate fitted with a continuously welded, polished stainless steel face. Guided (unidirectional) expansion disc bearings consist of guide bars to restrict lateral movement of the structure. The guide bars and their opposing guided surfaces must be faced with opposing strips of PTFE/stainless steel similarly as the upper bearing plate. Inverted bearing or center-guided bearing configurations will not be permitted.

A. A guided disc bearing allows rotation in any direction but confines horizontal movement to one direction only, whereas a multi-directional disc bearing allows rotation in any direction and horizontal movement in all directions. The bearings must be designed to allow rotation due to superstructure beam movement and must resist horizontal forces in the constrained directions.

B. Fixed bearings allow rotation in any direction but are fixed against translation.

C. Disc bearings with uplift are not covered by this special provision.

The fabricator must demonstrate a minimum of 5 years of experience in the manufacture and fabrication of disc bearings and be certified under the *AISC* *Bridge Component Quality Management System Certification* (CPT). Ensure coating of the bearings is performed by a fabricator with an *AISC* Sophisticated Paint Endorsement or *SSPC QP 3*, *Certification Standard Procedure for Shop Application of Complex Protective Systems*.

**b. Materials.** Ensure all materials are as specified in this special provision or as recommended by the manufacturer of the bearing device, in which case, the Engineer's approval is required. Furnish materials that are new and unused with no reclaimed material incorporated in the finished bearings and in accordance with the following standards:

1. Steel Plate. Upper and lower steel bearing plates and sole and masonry plates in accordance with *AASHTO M270M/M 270* Grades 36, 50 or 50W. Galvanized where permitted in this special provision in accordance with *ASTM A123/A123M*.

2. Stainless Steel. In accordance with *subsection 18.1.2.5 of AASHTO Construction.*

3. Polytetrafluoroethylene (PTFE). In accordance with *subsection 18.8.1 of AASHTO Construction*, except manufacture PTFE from pure virgin unfilled PTFE resin.

4. Adhesive. In accordance with *subsection 18.8.2.4 of AASHTO Construction*.

5. Polyether Urethane Rotational Element. The rotational element used in the construction of the disc bearings must meet *subsection 18.3.2.8 of AASHTO Construction*.

6. Elastomeric Leveling Pad. Ensure elastomeric leveling pad used between the masonry plate and substructure concrete is in accordance with subsection 914.12.B of the Standard Specifications for Construction.

7. Connecting Bolts, Nuts, and Washers. Used between girder flange and sole plate. Ensure all bolts are high strength bolts that conform to subsection 906.07 of the Standard Specifications for Construction. Ensure lock washers are steel, regular, helical spring washers meeting *ANSI 818.21.1*. Ensure bolts and hardware are galvanized in accordance with *AASHTO M232M/M232*.

8. Anchor Bolts, Nuts, and Washers. Ensure anchor bolts, nuts, and washers are in accordance with subsection 908.14 of the Standard Specifications for Construction.

**c. Submittals.** Submit shop drawings and design calculations in accordance with subsection 104.02 of the Standard Specifications for Construction and as follows:

The Department will require up to 14 calendar days for each review cycle, and revisions may be required following each review. No extension of time or additional compensation will be granted due to delays in preparing the final working drawings, calculations and bearing material properties or securing approval from the Department. An exception may be granted for an extension of time only in the case that the Department’s review of a submittal exceeded 14 calendar days, and if it can be shown that such a delay impacts the final project completion date. Prior to fabrication of the bearing assemblies, the manufacturer must submit the following items to the Engineer for review and approval:

1. Shop drawings for all components (including shim plates if needed) and assemblies, including general arrangements and large-scale details. The shop drawings must include tables showing load capacity and movement rating, if applicable, of each bearing, including initial offset required at various ambient temperatures. The shop drawings must include the manufacturer’s instructions for proper installation of the bearing assemblies. Shop drawings which lack manufacturer’s installation instructions will be returned without approval.

2. Calculations showing conformance of the bearings to the design loadings, movements, and other specified requirements.

3. Ensure welder endorsements are in accordance with subsection 707.03.D.10.c of the Standard Specifications for Construction.

**d. Shop Inspection.** In accordance with subsection 707.03.B of the Standard Specifications for Construction.

**e. Design Requirements.** Design bearings for the loads and movements given on the plans and in accordance with the *AASHTO Design, Section 14*. Bearing designs must include a minimum rotation of 0.020 radians or the design rotation, whichever is greater. These rotations must include all applicable service loads and movements shown on the plans, maximum rotations caused by fabrication and installation tolerances, and allowance for uncertainty of not less than 0.005 radians. Designs must assume that vertical and horizontal loads occur simultaneously. The design must include all bearing components, upper and lower bearing plates, sole plates, masonry plates, elastomeric pads, connecting bolts, and concrete anchor bolts.

Ensure the design calculations are stamped by a Professional Engineer licensed in the State of Michigan.

The design of the bearings must meet the following additional requirements:

1. Sole and Masonry Plates. Design the sole and masonry plates to distribute the bearing loads into the surrounding superstructure and substructure. Design the sole and masonry plates in accordance with *AASHTO Design, Sections 3, 4, and 6*, but the thickness must not be less than 3/4 inch. Service or installation considerations specified by the Engineer, such as weldability and bearing height, may require shim plates or thicker masonry and sole plates than are required due to strength considerations alone. The masonry plate must have a machined recess sized to allow the snug placement of the lower bearing plates. Limit the horizontal dimensions to the available bearing seat area.

2. Upper and Lower Bearing Plates. Apply, as appropriate, the provisions of *AASHTO Design Sections 3, 4, and 6* to the design of the upper and lower steel plates used in disc bearings. Limit the thickness of each of the upper and lower steel plates to a minimum of 0.045 x disc diameter.

3. Guide Bars. Design guide bars and the shear restriction mechanism at the strength and extreme event limit stated for the horizontal force, but not less than 15 percent of the total vertical force from applicable service load combinations. Guiding from the fixed base or any extension of same is prohibited.

Ensure guides are parallel, long enough to accommodate the full design displacement of the bearing in the sliding direction and must permit a minimum of 1/32 inch and a maximum of 1/16 inch free slip in the restrained direction. Design guides to avoid binding under all design loads and displacements, including rotation.

4. Stainless Steel Sheet. Ensure stainless steel sheets are a minimum thickness of 16 gauge (1/16 inch) and are attached to the sole plates by continuous fillet welding along their edges. Bonding and/or mechanical fastening of sheets is prohibited. Ensure the attachment of stainless steel sheets to the sole plates is capable of resisting the frictional force set up in the bearing. Ensure welding is in accordance with *AWS D 1.6:2017 AMDI Structural Welding Code-Stainless Steel*. The sole plates must extend beyond the edge of the stainless steel sheets to accommodate the welds and the welds must not protrude above the stainless steel sheets. It is essential that the stainless steel sheets remain in contact with base metal throughout their service life such that interface corrosion cannot occur.

The stainless steel sheets must face downward and must completely cover the PTFE sheets in all operating positions, plus an additional 1 inch in the direction of movement. Finish the surface in contact with the PTFE to a smoothness of 20 micro-inch (rms) or less.

5. Polytetrafluoroethylene (PTFE) Sheets. Ensure PTFE sheets are a minimum of 1/16 inch thick, after compression. Ensure recessed sheet PTFE is at least 3/16 thick when the maximum dimension of the PTFE is less than or equal to 24.0 inch, and 1/4 inch when the maximum dimension of the PTFE is greater than 24.0 inch. Ensure PTFE surfaces are smooth and free from blisters and bubbles.

Ensure the design is in accordance with *AASHTO Design, Section 14.7.2*.

6. Geometric Limitations. Ensure the horizontal dimensions are limited to the available bearing seat area of the concrete and the bottom flanges as detailed on the plans. Ensure any modifications required to accommodate the bearings chosen is submitted to the Engineer for approval prior to ordering materials. Ensure required modifications are made at no additional cost.

7. Structural Steel Coordination. The bearing manufacturer must coordinate all connections and fit up with the fabricator of the girders. Ensure any modifications required to accommodate the bearings chosen is submitted to the Engineer for approval prior to ordering materials. Ensure required modifications are made at no additional cost to the project.

8. Translation Capacity. Ensure the translation capability for both guided and multi-directional bearings are provided by means of a polished stainless steel sliding plate that bears on a PTFE sheet.

9. Connecting Bolts. The bearing manufacturer must coordinate the bolted connections between the sole plate and bottom girder flange with the fabricator of the plate girders. Pretension high strength bolts used to connect the sole plate of the bearing to the bottom flange of the steel girder must use the "Turn-of-Nut" method in accordance with subsection 707.03.E.6 of the Standard Specifications for Construction.

10. Polyether Urethane Disc. Ensure the rotational disc which is composed of Polyether Urethane is contained between upper and lower steel bearing plates. Build the bearing with an internal shear pin. Ensure the design of the disc is in accordance with *AASHTO Design, Section 14.7.8*.

11. Elastomeric Leveling Pads. Ensure the elastomeric pads, or approved equivalent, are a minimum thickness of 1/8 inch and extends a minimum of 3/4 inch beyond the edge of the masonry plate.

**f. Fabrication Tolerances.** Ensure fabrication is in accordance with the *AASHTO Construction, Section 18*.

**g. Cleaning and Coating.** Clean and coat the bearing assemblies in accordance with section 716 of the Standard Specifications for Construction. Galvanizing is not permitted, except for sole and masonry plates. Ensure the surfaces to be painted are shown on the shop drawings. All surfaces covered by stainless steel or PTFE sheets must not be painted. Mask tapped holes off during painting.

**h. Sampling, Testing, Acceptance, and Performance Testing.** Ensure all sampling and testing is in accordance with the *AASHTO Construction, Section 18.1.5 and Section 18.3.4*. Perform all testing in the presence of a representative of MDOT or its designated inspection agency.

Perform long-term deterioration testing on one sample disc bearing of each lot.

If the size of the bearing prohibits adequate testing with available equipment, MDOT may permit a test on one scaled down bearing with comparable requirements.

At the discretion of MDOT, a long-term proof load test may be substituted for the short-term proof load test in accordance with *AASHTO Construction, Section 18.3.4.4.4*.

The bearing manufacturer must furnish, to the Engineer, certified copies of the test reports on the physical properties of the component materials for the bearings to be furnished and a certification by the bearing manufacturer stating the bearing assemblies furnished conform to all the requirements shown on the plans and specifications contained herein. When directed by the Engineer, the manufacturer must furnish random samples of component materials used in the bearings for testing by MDOT. MDOT reserves the right to have the manufacturer perform the specified load tests on one or more of the furnished bearings. A furnished bearing will be defined as a structural bearing assembly that has been delivered to the site. If the tested bearing shows failure, ensure it is replaced, and the remaining bearings load tested by the manufacturer for acceptance at the manufacturer’s expense. Ensure all material used in the manufacture is new and unused with no reclaimed material incorporated into the finished assemblies. Any visual defects will be cause for rejection.

**i. Identification, Storage and Handling.** Ensure each bearing is stamped with the manufacturer's name, bearing type or model number, bearing number, and the installed location. Ensure the stamp is on a surface visible after installation.

Ensure each bearing is fully assembled at the manufacturing plant and delivered to the construction site as complete units. Ensure all bearings, whether in the fabrication shop, on site or at an independent warehouse are stored in a clean, dry, covered facility. When in storage, keep the bearings banded, wrapped, and secured in a condition suitable for shipment. Wrapping material must meet the approval of the Engineer. Ensure the bearings are held together with removable restraints so sliding surfaces are not damaged, during handling, transporting, and shipping. The bearing devices are not to be disassembled prior to installation without the knowledge of the Engineer and manufacturer. At the time when the Contractor takes receipt of the bearing assemblies from the manufacturer, the Contractor assumes the responsibility for the care, handling and storage of the bearing assemblies. Any damage to the bearings, while in the Contractor's possession, is the responsibility of the Contractor. Repair or replacement of damaged bearing assemblies in part or in whole will be at the discretion of the Engineer and manufacturer with no additional cost to the project. Submit copies of all delivery tickets to the Engineer.

Ensure centerlines are marked on masonry and sole plates for alignment in the field. Ensure the bearings are shipped and stored in moisture-proof and dust-proof covers.

**j.** **Construction.** Prior to beginning work at each bearing location, measure and record the vertical elevation of each abutment seat. Use survey methods with a minimum accuracy of 1/16 inch.

Ensure bearing seat surfaces are constructed or adjusted, smooth and level, and to the designated elevations within 1/16 inch. Adjust bearings seats by either grinding the surface or by shimming the bearings. Make sure that guides for the guided bearings are in the correct orientation before final placement of the bearing.

Bearings must have bearing regions designed to be free draining to avoid ponding around bearings.

Attach upper bearing plate to sole plate by shop welding in accordance with *AASHTO/AWS D1.5 Bridge Welding Code* (as modified by 20SP-707A – Structural Steel and Aluminum Construction). Ensure welding and testing are in accordance with bridge welding subsections 707.03.D.10 and 707.03.D.11 of the Standard Specifications for Construction.

Repair damaged galvanized surfaces in accordance with subsection 716.03.E of the Standard Specifications for Construction.

The location of expansion bearings must correspond with the temperature at the time of erection.

Install the bearings in strict conformance to the manufacturer’s instructions, as approved by the Engineer, including anchor bolt tightness requirements, or as modified by the manufacturer. Furnish technical assistance to the Contractor and the Engineer through the personal services of a technical representative who is a full time employee of the manufacturer during installation of the bearings. The manufacturer’s technical representative is required to be present for the placement of the first bearing. At the option of the Engineer, the technical representative may be required to be present for the placement of any number of additional bearings. Take measures to limit bearing rotation to 0.02 radians during construction.

**k.** **Future Maintenance.** Design and manufacture bearings so that they are easy to inspect, and that future maintenance of the bearings can be performed. The manufacturer must demonstrate in writing and with drawings how individual components of the bearings or entire assemblies could be replaced. Vertical upward movements of the superstructure, due to jacking, must not exceed 3/8 inch. The procedures for future replacements of individual components must meet the approval of the Engineer prior to the manufacture of any bearings for this project.

**l. Measurement and Payment.** The completed work, as described, will be measured and paid for at the contract unit price using the following pay items:

**Pay Item Pay Unit**

Disc Bearing, Fixed Each

Disc Bearing, Guided Each

Disc Bearing, Multi-Directional Each

**Disc Bearing, Fixed;** **Disc Bearing, Guided;** and **Disc Bearing, Multi-Directional** includes the design, all testing, furnishing of all materials, fabrication of the bearing assemblies, labor, equipment, shipping, installing, shop welding and welding inspection, and furnishing an on-site representative during installation of the disc bearing assemblies including sole plates and masonry plates.

Furnishing and installing anchor bolts, connecting bolts, nuts and washers, elastomeric pads or approved equivalent, anchor bolts, nuts, washers, shim plates, and miscellaneous hardware is considered included in the Disc Bearing pay items and no additional compensation will be provided.

The cost of temporary bearings or using permanent bearings as temporary bearings is considered included in the Disc Bearing pay items and no additional compensation will be provided.