STATE OF OHIO
DEPARTMENT OF TRANSPORTATION

SUPPLEMENTAL SPECIFICATION 869

HIGH LOAD MULTI ROTATIONAL (HLMR) BEARINGS

October 17, 2014

869.01 Description. This item consists of designing, preparing shop drawings, fabricating, testing, furnishing and installing High Load Multi-Rotational (HLMR) Bearings. The Contractor may supply either pot or disc type bearings according to this specification.

869.02 Fabrication. Select fabricators that are listed by the Department before the Contract letting date as evaluated by the Office of Materials Management and pre-qualified according to C&MS 513 as a UF Level Fabricator.

Perform all work in accordance with C&MS 513, Level UF and these specifications.

869.03 HLMR Parts List. Supply pot or disc bearings consisting of the following common parts:

A. Sole Plate – Top side beveled to the slope of the girder and field welded to the girder flange. Bottom side, for expansion bearings: level and faced with stainless steel. Bottom side, for fixed pot bearings: level and attached to or integral with the piston. Bottom side, for fixed

disc bearings: level and recessed for shear restriction element.

B. Guide Bar/Bars (for Guided Expansion Bearings) – Attached to or integral with the sole plate for purpose of guiding expansion bearings and transmitting horizontal forces to the pot or upper bearing plate. Edges with sliding surfaces faced with stainless steel. All guide bearings shall be edge guided. The Department will not accept center guided bearings.

C. Sliding Surfaces (for Expansion Bearings) – Accommodate horizontal bridge movement by mated sliding surfaces consisting of stainless steel and Polytetrafluoroethylene (PTFE).

D. Upper Bearing Plate (for Expansion Bearings) – Top level and faced with PTFE. For disc bearings, bottom side level and recessed for shear restriction element. For pot bearings, bottom side level and attached to, or integral with, the piston. For guided bearings, edges with sliding surfaces faced with PTFE.

E. Masonry Plate – Distribute vertical and horizontal forces from the pot or disc to the concrete bridge seat. Masonry plate sits on a preformed bearing pad and is connected to the bearing seat with anchor bolts.

F. Preformed Bearing Pads – Placed between a concrete bearing seat and the masonry plate, used to accommodate minor surface roughness in the bearing seat.

G. Anchor bolts – Distribute horizontal or uplift forces from the bearing to the bearing seat.

869.04 Pot Bearing Parts List. Supply pot bearings with common parts defined in 869.03 and the parts listed below:

A. Circular piston – Transmits rotation, horizontal and vertical forces from the sole or upper plates to the pot. Attached to, or integral with, the upper bearing plate for expansion bearings. Attached to, or integral with, the sole plate for fixed bearings.

B. Pot – Confines the elastomeric disc and transmits vertical and horizontal forces from the piston to the masonry plates. Shop welded to masonry plates.

C. Elastomeric Disc – Supports the piston inside the confining pot for the purpose of providing rotation. The top and bottom surfaces of the elastomeric disc are lubricated with silicone grease. The disc is prevented from extruding between the piston edges and pot walls with sealing rings.

D. Sealing Rings – The seal between the pot and the piston which confines the elastomeric disc.

869.05 Disc Bearing Parts List. Supply Disc bearings with common parts defined in 869.03 and the parts listed below:

A. Elastomeric Disc – Distributes rotation, horizontal and vertical forces from the sole or upper plates to the masonry plate. The disc is an unconfined circular elastomer, with a centered round hole for the shear restricting element.

B. Shear Restricting Element – Transmits horizontal forces and restrains vertical uplift if specified from the sole or upper bearing plates to the masonry plate while providing for free rotation.

869.06 Bearing Height. Adjust beam seat elevations to account for differences between the bearing height detailed in the plans and the bearing height supplied by the fabricator.

As an alternative, the Contractor may increase the sole plate thickness, pot base thickness, masonry plate thickness, piston thickness or a combination thereof to match the total bearing height shown in the plans.

869.07 Applicable Design Standards. Design bearings according to all applicable sections of the current edition of the AASHTO LRFD Bridge Design Specification including all published interim revisions; the current edition of the AASHTO LRFD Bridge Construction Specifications including all published interim revisions; and this specification. Design bearings to accommodate the loads, forces and movements specified in the plans and this specification.

869.08 Submittal Process. Submit a design plan and design calculations along with the shop drawings according to the process defined in C&MS 501.04.A

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869.09 Design Requirements. Design HLMR bearings in accordance with Table 869.09-1: HLMR Design Requirements.

Table 869.09-1 HLMR Design Requirements		
Component	**AASHTO LRFD Bridge Design Specifications**	**Modification Comments**
Sole, Masonry and Upper Bearing Plates	14.8	A,B
Pot Bearing Piston	14.7.4.7	C
PTFE	14.7.2	D
Stainless Steel	14.7.2.3.2	E
Pot Bearing Elastomeric Disc	14.7.4	F,G
Pot Bearing Sealing Rings	14.7.4.5	
Guide Bars	14.7.9	H,I
Pot Bearing Pot	14.7.4.6	J
Disc Bearing Elastomeric Disc	14.7.8.3	
Disc Bearing Shear Resisting Mechanism	14.7.8.4	
Anchorage	14.8.3	K,L
Modification Comments		

A	Rectangular or square in plan with beveled, level or recessed surfaces in accordance with 869.03.
B	Minimum thickness shall be 0.75 inches [19 mm].
C	The piston shall be machined from a single piece of structural steel
D	The mating surface to PTFE, shall be large enough to cover the PTFE during all conditions of expansion or contraction that the bridge will undergo plus an additional two (2) inches [50 mm]
E	Stainless steel surface used as a mating surface to PTFE, shall be large enough to cover the PTFE during all conditions of expansion or contraction that the bridge will undergo plus an additional two (2) inches [50 mm].
F	The disc shall consist of one solid piece of elastomer
G	The upper edge of the elastomeric disc shall be recessed to receive the sealing rings so that they sit flush with the upper surface of the disc.
H	The slide surfaces of the guide bars shall be faced with stainless steel
I	On guided bearings, the guide bars shall provide sufficient clearances between rotating and non-rotating parts to prevent binding of the bearing.
J	The pot shall consist of a solid plate into which a circular recess has been machined.
K	Design connections to the substructure using hooked or forged head anchor bolts
L	Design connections to the superstructure using fillet welds, 5/16” leg size is preferred

869.10 Materials. Supply materials in accordance with Table 869.10-1: HLMR Material Requirements.

Table 869.10-1 HLMR Material Requirements		
Component	**AASHTO LRFD Bridge Construction Specifications, ASTM or C&MS**	**Modification Comments**
Sole, Masonry and Upper Bearing Plates	C&MS 711.01	
Pot Bearing Piston	C&MS 711.01	

PTFE	AASHTO 18.8	
Stainless Steel	AASHTO 18.1.2.5	
Pot Bearing Elastomeric Disc	AASHTO 18.3.2.4	A
Pot Bearing Sealing Rings	AASHTO 18.3.2.6	G
Guide Bars	C&MS 711.01	B
Pot Bearing Pot	C&MS 711.01	C
Disc Bearing Elastomeric Disc	AASHTO 18.3.2.8	
Disc Bearing Shear Resisting Mechanism	ASTM A240/A276 UNS S21800 or ASTM A 193 Grade B7	
Anchor Bolts	ASTM F1554	D
Preformed Bearing Pad	C&MS 711.21	
Metallizing Wire	ASTM B833	E
Sealer	C&MS 708.02 D	F

Modification Comments	
A	The elastomer shall be Grade 3. Lubricate the top and bottom surfaces with Silicone grease meeting the requirements of MIL-S-8660C/SAE-AS8660.
B	Guide bars may be integral by machining from a solid sole plate or may be attached to the sole plate by welding. The slide surfaces of the guide bars shall be faced with stainless steel.
C	Machine the pot from a solid plate. Do not apply metallizing to the inside surfaces of pot walls and base.
D	Zinc hot-dipped or mechanically deposited coating required.
E	ASTM B833 having the 99.99% Zinc – UNS (Z13005) composition. Supply certified test data to the Engineer. Accompany all certified test data with copies of mill shipping notices or invoices showing the diameter and quantity of wire being accepted.
F	Supply a Sealer conforming to the C&MS 708.02 D, Urethane Finish Coat. The sealer color shall closely approach: Federal Standard number FS-595B-16314

	medium gray (the color of metallizing); FS-595B-20045 or 20059 (the color of weathering steel) for use with weathering steel bridges; or to match the specified 514 paint color.
G	Sealing Rings shall be rectangular in cross section.

869.11 Attachment of PTFE. Attach Sheet or Fabric PTFE to substrate according to the AASHTO LRFD Bridge Construction Specifications, Article 18.8.3.2. The Department will not permit migration of epoxy through the PTFE fabric. Furnish PTFE Fabric from a single piece. Over-sew or recess edges so that no cut fabric edges are exposed.

869.12 Attachment of Stainless Steel. Attach stainless steel to its steel substrate according to the AASHTO LRFD Bridge Construction Specifications, Article 18.8.3.3. The Department will not accept any surface roughness from weld protruding above the surface of the stainless steel.

Weld guide bars to the sole plate before welding the stainless steel to the sole plate or guide bars.

869.13 Corrosion Protection. Shop metallize and seal all steel surfaces, except PTFE-stainless steel sliding surfaces and the inside of the pot. Refer to the SSPC-CS 23.00/AWS C2.23M/NACE No. 12, "Specification for the Application of Thermal Spray Coatings (Metallizing) of Aluminum, Zinc, and Their Alloys and Composites for the Corrosion Protection of Steel", C&MS 514 and Table 8XX.13-1.

Table 869.13-1 Shop Metallizing Requirements

Requirement	**Specification**
Surface Preparation	SSPC- SP10
Blast Medium	C&MS 514.13.C
Sharp Angular Blast Anchor Profile	ASTM D4417, Method C, 3 mills ± 1 mil (75 μm ± 25μm)
Minimum Metallizing Thickness	12 mils (305 μm)
Minimum Metallizing Adhesion	ASTM D-4541, 500 psi [3.4MPa]

869.14 Welding. Perform welding according to C&MS 513. If the contractor provides acceptable welding procedures to restrict the maximum temperature in the PTFE bonded area or to surfaces touching the elastomeric disc to less than 300E F [150E C], the Department will permit welding to a steel plate which has a bonded PTFE surface or touches an elastomeric disc. Repair corrosion protective coatings damaged by field welds according to 869.19.

869.15 Tolerances. Check all bearings for tolerances according to AASHTO LRFD Bridge Construction Specifications, Table 18.1.4.2-1.

To measure flatness, place a straightedge, longer than the nominal dimension to be measured, in contact with the surface to be measured or as parallel to it as possible. Select a feeler gauge having a tolerance of ± 0.001 inch [25 μm] and attempt to insert it under the straightedge (using the smallest number of blades). Flatness is acceptable if the feeler does not pass under the straightedge. The straightedge may be located at any position on the surface and not necessarily at 90 degrees to the edges. Class A = 0.001 x nominal dimension. Class B = 0.002 x nominal dimension. Class C = 0.005 x nominal dimension.

869.16 Testing Requirements. Test the bearings at a testing facility, possessing the proper testing equipment and trained personnel, capable of performing all tests specified in Table 869.16-1. Submit the test facility's qualification with the shop drawings according to the process defined in C&MS 501.04 A. The test facility's qualifications shall include: capacity and capabilities of each testing apparatus and qualifications of all personnel that will be performing tests for this contract.

Submit a report containing the results of tests specified in Table 869.16-1 with the Test Reports according to the process defined in C&MS 501.06 A. Present the results of all testing in a report including raw test data, reduced test data, sample calculations, measured tolerances and final results along with photographs and conclusions.

Perform tests on completely fabricated and randomly sampled bearings according to Table 869.16-1: HLMR Test Requirements

Table 869.16-1 HLMR Test Requirements		
Component	**Specification**	**Modification Comments**
Material Certification	C&MS 501.06	
Pot Bearing Elastomeric Disc	C&MS 711.23	
Material Friction Test	AASHTO 18.1.5.2.3	
Dimension Check	AASHTO 18.1.5.2.4	A
Clearance Test	AASHTO 18.1.5.2.5	A
Bearing Friction Test	AASHTO 18.1.5.2.6	
Proof Load Test	AASHTO 18.3.4.4.4	
Long Term Deterioration Test	AASHTO 18.1.5.2.7	B
Horizontal Force Capacity	AASHTO 18.1.5.2.8	C

Modification Comments	
A	Test all bearings
B	The Department will accept certified test data for testing performed within three years of the contract date on bearings with a design rotation of at least -0.02 rad. to +0.02 rad. and a service load of at least 200 kips (Proof load = 300 kips). The manufacturer shall certify in writing that the design and fabrication of the previously tested bearings are consistent with the bearings supplied to the project.
C	Guided or Fixed bearings only

Visually examine the bearing during all tests. Disassemble the bearing after completing the specified tests. Reject the entire lot of bearings if a sampled bearing exhibits visual defects, such as: extruded or deformed elastomer, polyether urethane or PTFE; damaged seals; cracked steel; and interference between rotating and stationary parts.

The bearing plates and the steel piston shall maintain continuous and uniform contact for the duration of the specified test. The Department will reject the entire lot if any observed lift-off occurs during testing. The Contractor may incorporate bearings not damaged during testing into the finished structure.

The manufacture may test all bearing in a rejected lot at his expense to establish acceptance of individual bearings in a rejected lot.

869.17 Sampling. Randomly sample bearings according to AASHTO LRFD Bridge Construction Specifications, Article 18.3.4.

869.18 Shipping And Packing. Securely band bearings together as units so that they may be shipped to the job site and stored without relative movement of the bearing parts or disassembly at any time. Wrap bearings in moisture proof and dust proof material to protect against shipping and job site conditions.

Store bearings at the job site in a dry, sheltered area free from dirt or dust until installation.

Mark the centerlines on appropriate bearing parts for checking alignment in the field. Show locations of alignment marks on shop drawings.

Permanently mark all components of each bearing with a number unique to that bearing. Identify the mark number and placement location on the shop drawings.

869.19 Installation. Have a representative from the bearing manufacturer on site to ensure proper installation of the bearings.

Leave wrapping, bearing straps or retaining clamps in place as long as possible to ensure parts of bearings are not inadvertently displaced relative to each other.

Evenly support each bearing over their upper and lower surfaces under all erection and service conditions. Do not dis-assembled bearings for erection purposes.

The Engineer may require the bearings be shipped back to the manufacturer, if the bearing has been unwrapped or dis-assembled prior to erection.

Prepare concrete seat per C&MS 516.07 except that seats shall be level within 0.03125 in/ft.

Install anchor bolts per C&MS 516.07.

Align the centerlines of the bearing assembly with those of the substructure and superstructure. On expansion bearings align the bearings, taking into consideration the ambient temperature (to allow for the design expansion or contraction of the structure). Offset upper and lower bearing parts to compensate for ambient temperature and additional dead load rotation.

Field weld bearing sole plate to beam/girder flange according to 869.14. Perform permanent field welding after all dead load rotations are complete. Temporary tack welds (5/16” x 2” long minimum); clamping or blocking may be required to assure structural stability during the application of the remaining dead load. Define temporary connections in the construction plan. Temporary connections do not eliminate the contract requirement to check and re-align bearings as necessary to achieve the temperature adjusted neutral position after the application of all dead load.

Repair damaged or field welded metallized coatings by metallizing and sealing in accordance to this specification. Field welds that connect painted and metallized surfaces can be repaired according to the specified painting system. Protect and mask non-damaged or non-field welded metallized surfaces, elastomeric parts, PTFE and stainless sliding surfaces during all repairs to prevent damage or contamination.

Protect bearings from construction silage, painting and sealers by wrapping with clear plastic sheeting 6 mils thick secured by straps or tape. Provide the protection until completion of all construction activities. Do not restrict the thermal or rotational movements of the bearing with the straps or tape.

869.20 Method of Measurement. The Department will measure HLMR bearings by the number of each bearing determined by the maximum vertical reaction listed in the contract. The Department will not make a distinction between fixed or expansion bearings.

869.21 Basis of Payment. The Department will not pay separately for the work listed under testing and acceptance of this specification. Include this work in the unit price bid.

The Department will pay for accepted quantities at the contract prices for:

Item	Unit	Description
869	Each	High Load Multi-Rotational (HLMR) Bearings

Designer Note:

This specification is to be used on all projects that utilize high load multi-rotational bearing types (e.g. pot bearings or disc bearings). Designers shall assume a bearing height based on AASHTO design specifications and project parameters. Refer to the ODOT Bridge Design Manual, Section 700 for plan notes regarding setting beam seat elevations. The plans shall also include the following design data for each bearing to allow the bearing manufacturer to properly design the bearings:

- Strength Limit State – Total Vertical Load
- Service Limit State – Total Vertical Load
- Service Limit State – Vertical Dead Load
- Strength Limit State – Total Horizontal Load
- Service Limit State – Total Horizontal Load
- Strength Limit State – Total Rotation
- Strength Limit State – Total Movement

For the Strength Limit State data, the Designer shall compare the Extreme Event Limit state to the Strength Limit State and include the governing limit state data in the plans under the label of Strength Limit State. This simplifies the information presented to the bearing designer to avoid confusion. The plans shall indicate the direction of Total Movement (e.g. longitudinal and transverse). In addition to the above data, the designer shall specify for each bearing the location (e.g. Rear Abutment, Forward Abutment, Pier 1, etc.), bearing type (e.g. guided expansion, unguided expansion or fixed), quantity, bearing orientation and assumed bearing height.