Designation: D8507 – 23

Standard Specification for High Load Multi-Rotational Disc Bearings for Bridges and Structures[1]

This standard is issued under the fixed designation D8507; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers bridge bearings that consist of an unconfined polyether urethane rotational element subjected to compression loads, along with a resisting mechanism to transmit shear and/or tension loads through the bearing. For expansion and/or contraction applications, an additional stainless steel flat surface slides against a carbon steel plate faced with sheet polytetrafluoroethylene (PTFE). The function of the bearing is to transfer loads and to accommodate any relative movement, including rotation between a bridge superstructure and its supporting structure, or both.

1.2 The requirements stated in this specification are the minimums necessary for the manufacture of quality bearing devices. It may be necessary to increase these minimum values due to other design or construction conditions.

1.3 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A36/A36M Specification for Carbon Structural Steel

A240/A240M Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

A572/A572M Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel

A588/A588M Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi [345 MPa] Minimum Yield Point, with Atmospheric Corrosion Resistance

A709/A709M Specification for Structural Steel for Bridges

D395 Test Methods for Rubber Property—Compression Set

D412 Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension

D638 Test Method for Tensile Properties of Plastics

D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement

D2240 Test Method for Rubber Property—Durometer Hardness

D4894 Specification for Polytetrafluoroethylene (PTFE) Granular Molding and Ram Extrusion Materials

D4895 Specification for Polytetrafluoroethylene (PTFE) Resin Produced From Dispersion

2.2 *AASHTO Standards:*[3]

AASHTO Standard Specifications for Highway Bridges

AASHTO LRFD Bridge Design Specifications

AASHTO LRFD Bridge Construction Specifications

2.3 *AWS Standards:*[4]

C2.23 Specification for the Application of Thermal Spray Coatings (Metallizing) of Aluminum, Zinc, and Their Alloys and Composites for the Corrosion Protection of Steel

D1.5 AASHTO/AWS Bridge Welding Code

D1.6 AWS Structural Welding Code—Stainless Steel

2.4 *AREMA Standards:*[5]

AREMA Manual for Railway Engineering

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[1] This specification is under the jurisdiction of ASTM Committee D04 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.32 on Bridges and Structures.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American Association of State Highway and Transportation Officials (AASHTO), 444 N. Capitol St., NW, Suite 249, Washington, DC 20001, http://www.transportation.org.

[4] Available from American Welding Society (AWS), 8669 NW 36 St., #130, Miami, FL 33166-6672, http://www.aws.org.

[5] Available from American Railway Engineering and Maintenance-of-Way Association (AREMA), 4501 Forbes Blvd., Suite 130, Lanham, MD 20706, https://www.arema.org.

3. Classification

3.1 The bearings are furnished in six types, as follows:

3.1.1 *Fixed Disc Bearing*—Rotation only.

3.1.2 *Unidirectional Expansion Disc Bearing*—Rotation plus movement in one direction.

3.1.3 *Multi-Directional Expansion Disc Bearing*—Rotation plus movement in all directions.

3.1.4 *Fixed Uplift Disc Bearing*—Rotation plus uplift restraint.

3.1.5 *Unidirectional Expansion Uplift Disc Bearing*—Rotation plus uplift restraint and movement in one direction.

3.1.6 *Multi-Directional Expansion Uplift Disc Bearing*—Rotation plus uplift restraint and movement in all directions.

4. Material Specifications

4.1 *Steel*—The steel used for all major plates and guide bars, if used, shall be structural steel conforming to Specification A36/A36M, A588/A588M, A572/A572M, or A709/A709M, as required. All exposed surfaces shall be zinc metalized and sealed according to AWS C2.23 or treated with other project-approved coating systems such as zinc paint or hot-dip galvanizing. Hot-dip galvanizing should be used with caution since it can cause warping of the steel plates. The dry film thickness (DFT) of the approved coating system must be specified by the owner, as well as the paint manufacturer's recommendations if using a paint system.

4.2 *Shear and/or Tension Resisting Mechanism*—The shear and/or tension resisting mechanism shall be alloy steel capable of resisting the shear and/or tension loads transmitted through the bearing. The mechanism may be placed either inside or outside of the polyether urethane disc and shall not restrict the required rotation of the bearing.

4.3 *Polyether Urethane Disc*—The polyether urethane disc material shall conform to the physical property requirements listed in Table 1. The polyether urethane element shall be molded as a single piece; separate layers are not allowed. Alternate disc material durometers can be considered by the owner with supporting testing provided on the polyether urethane materials as well as full-size disc bearing elements.

4.4 *Stainless Steel Flat Sliding Surface*—The sheet stainless steel used as the mating sliding surface to the sheet PTFE in the expansion disc bearings shall conform to Specification A240/A240M, type 304, 16 µin. (0.5 µm) rms finish.

TABLE 1 Physical Property Requirements for Polyether Urethane

Physical Properties	Test Method	Requirement
Hardness, Shore D Durometer	D2240	60–65
Tensile stress, min at 100 % elongation, psi (MPa)	D412	2100 (14.5)
Tensile stress, min at 200 % elongation, psi (MPa)	D412	3700 (25.5)
Ultimate tensile strength, min, psi (MPa)	D412	5500 (37.9)
Ultimate elongation, min, %	D412	253
Compression set, 22 h at 158 °F, Method B, max, %	D395	40

4.5 *Sheet Polytetrafluoroethylene (PTFE)*—The sheet PTFE shall be virgin material (not reprocessed) meeting the requirements of Specification D4894 or D4895. The PTFE shall be resistant to acids, alkalis, petroleum products, and non-absorption of water. It shall be stable for temperatures up to 500 °F (260 °C) and shall be nonflammable. Filler material, if used, shall be composed of milled glass or carbon fibers with a maximum of 25 % filler content.

4.5.1 The thickness of the sheet PTFE shall be a minimum of ¼ in. (6.35 mm) and shall be recessed at least one half of its thickness into a steel substrate.

4.5.2 The sheet PTFE for the principal sliding surface and for guide bars, if used, shall conform to the physical property requirements listed in Table 2.

TABLE 2 Physical Property Requirements for Sheet PTFE

Physical Properties	Test Method	Requirement
Ultimate tensile strength, min, psi (MPa)	D638	2800 (19.3)
Ultimate elongation, min, %	D638	200
Specific gravity	D792	2.13–2.19

4.5.3 Low-friction sliding materials other than PTFE can be considered for guide bars. If used, the low-friction sliding material shall be an engineered polymer that has good wear and abrasion resistance and minimal deflection under compression load. Along with a wide temperature operating range, it shall also have excellent weathering properties with good chemical resistance and a low water absorption rate.

5. Design Requirements

NOTE 1—To Designer: The bearing details shall be designed in accordance with the requirements of the current edition with interims of the AASHTO LRFD Bridge Design Specifications, AREMA Manual for Railway Engineering, or other governing design procedures.

5.1 *Rotational Element:*

5.1.1 The polyether urethane disc geometry shall be determined such that the bearing is capable of withstanding the design vertical load without liftoff between bearing components at the corresponding design rotation. Calculations showing determination of the disc geometry shall be submitted to the owner for approval.

5.1.2 The thickness of the polyether urethane disc shall not be less than:

$$(R_{ot} * D_d) / (2 * \varepsilon_{max}) \quad (1)$$

where:

D_d = outside dimension of the rotational element, in. (mm),

R_{ot} = design rotation of the bearing at service limit state (in radians), and

ε_{max} = compressive strain of the rotational element at design service vertical load with zero rotation, not including long-term creep, in/in. Not to exceed 10 % of the thickness of the unstressed rotational element.

5.1.3 The area of the polyether urethane disc shall be designed for a maximum average service limit stress of 5000 psi (34.5 MPa) unless otherwise substantiated by test data.

5.1.4 The rotational element shall be held in place by the shear/tension resisting mechanism, or other means of a positive locating device. See Fig. 1.

5.1.5 Vertical and horizontal clearance between the rotating (attached to the superstructure) and non-rotating (attached to the substructure) bearing components, including fasteners, shall be no less than ⅛ in. (3.17 mm) at maximum design rotation.

5.2 *Steel Bearing Plates:*

5.2.1 The minimum thickness of the upper and lower steel bearing plates shall be 0.045 * D_d when bearing directly on a steel masonry or sole plate, or 0.06 * D_d when bearing directly on concrete or grout.

5.3 *Shear/Tension Resisting Mechanism:*

5.3.1 A shear/tension resisting mechanism shall be provided to transmit horizontal and uplift loads through the bearing without restricting the required rotation. The shear/tension resisting mechanism shall be connected to the upper or lower steel bearing plate by threading or machining out of a solid.

5.3.2 The shear/tension resisting mechanism shall be capable of resisting a minimum horizontal and/or uplift load of at least 10 % of the design service vertical load.

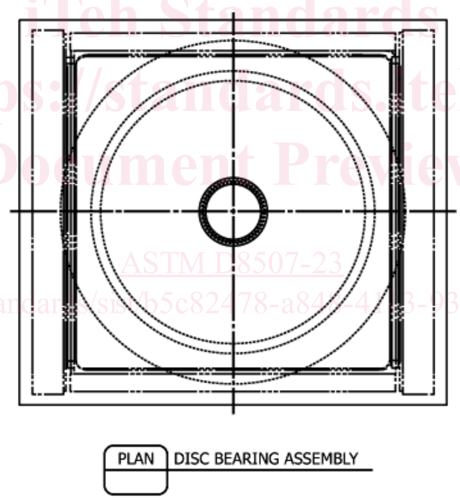
5.4 *Stainless Steel Sliding Surface:*

5.4.1 The minimum thickness of the stainless steel sheet shall be 12 gage, 0.105 in. (2.67 mm).

5.4.2 The stainless steel sheet shall be attached to its backing plate by continuous welding along its edges. It is essential that the stainless steel sheet remain in contact with the base metal throughout its service life and that interface corrosion cannot occur. The attachment of the stainless steel to its backup plate shall be capable of resisting the frictional force created in the bearing. Stainless steel sheet welding shall be in accordance with AWS D1.6 or AWS D1.5, unless specified otherwise by the owner.

5.4.3 The steel backing plate shall extend beyond the edge of the stainless steel sheet to accommodate the weld; also, the weld must not protrude above the stainless steel sheet. TIG welding of the stainless steel sheet is recommended to achieve this connection.

5.4.4 The flat horizontal stainless steel sliding surface shall cover the PTFE surface completely in all operations, plus one additional inch (25.4 mm) in all directions of movement. For a guided bearing with which there is little or no transverse movement, this requirement does not apply in the transverse direction.



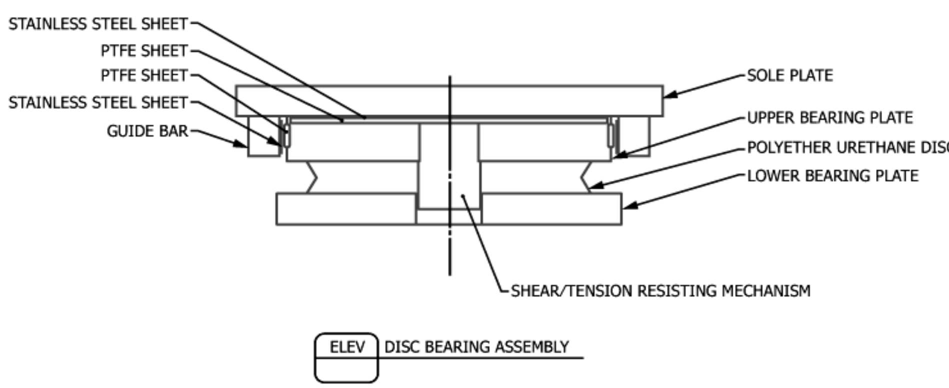


FIG. 1 Views of a Disc Bearing

5.5 *Sheet PTFE on Sliding Surfaces:*

5.5.1 The sheet PTFE shall be pure virgin, unfilled, meeting the requirements of Specification D4894 or D4895. The sheet PTFE shall be recessed to one half of its thickness and epoxy bonded to the steel substrate. The PTFE surface shall be smooth and free from blisters or bubbles after completion of the bonding operation.

5.5.2 The area of the sheet PTFE shall be designed for a maximum average service limit stress of 4500 psi (31.0 MPa).

5.5.3 The maximum service limit edge stress on the sheet PTFE shall not exceed 5500 psi (37.9 MPa). The effect of moments induced by the polyether urethane disc shall be included in the stress analysis.

5.5.4 The surface of the PTFE sheet to be epoxy bonded shall be etched using the sodium naphthalene or sodium ammonia etching process.

5.6 *Sheet PTFE on Guiding Surfaces:*

5.6.1 Attachment of the sheet PTFE to the steel substrate of the guiding surface shall be performed by epoxy bonding and mechanical fastening. The mechanical fastening shall consist of a minimum of two screws located on the centerline of the strip of PTFE and located within 1 in. (25.4 mm) of each end of the PTFE strip. The top of the screws shall be recessed a minimum of 50 % of the amount of protrusion of the PTFE above the steel substrate.

5.7 *Guide Bars:*

5.7.1 Unidirectional bearings shall be provided with at least one guide bar to restrict the direction of structure movement. Each guide bar shall be manufactured from a monolithic piece of steel. Guide bars may be made integral by machining from the solid shape or fabricated from solid bars that are welded, bolted, or recessed into the guiding plate, or some combination thereof. Carbon steel welding shall be in accordance with AWS D1.5, unless specified otherwise by the owner.

5.7.2 Guided surfaces shall be faced with opposing strips of stainless steel and sheet PTFE. No metal-to-metal contact shall be permitted. The minimum total gap required between the guiding surfaces shall be 1⁄16 in. (1.59 mm).

5.7.3 The guide bars and their connections to the sliding/sole plate shall be designed for the horizontal loads on the bearing but not less than 10 % of the maximum vertical service load on the bearing.

5.7.4 Guiding arrangements shall be designed so that the PTFE-faced guide surface is kept parallel and always within the limits of the stainless steel-faced guides at all points of translation and rotation of the bearing. Guiding against the fixed base or any extension of it is not recommended.

6. Sampling

6.1 *Lot Size:*

6.1.1 Sampling, testing, and acceptance consideration will be made on a lot basis prior to shipment by the manufacturer. A lot shall be defined as the smallest number of bearings determined by the following:

6.1.1.1 A lot shall not exceed 25 bearings.

6.1.1.2 A lot shall consist of those bearings of the same type and may consist of differing vertical load capacities. Unidirectional and multi-directional expansion bearings may be considered the same type for lot designations.

6.2 *Sampling:*

6.2.1 The number of bearing tests to be performed shall be in accordance with Table 3.

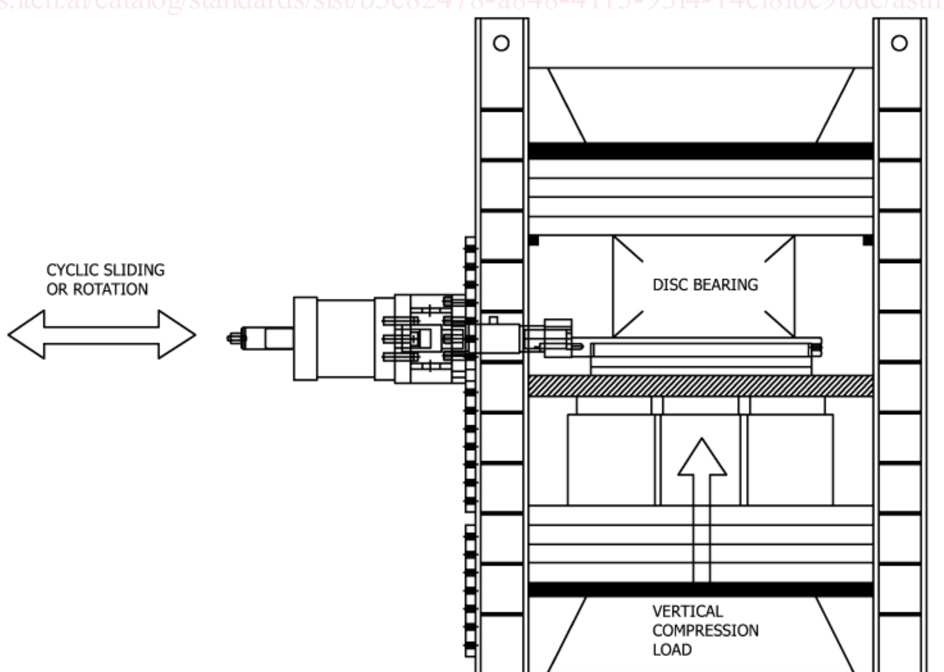


FIG. 2 Diagram of a Disc Bearing Testing