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Standard Specification for Plain and Steel-Laminated Elastomeric Bearings for Bridges[1]

This standard is issued under the fixed designation D4014; 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 ~~bearings,~~bearings which consist of all elastomer or of alternate laminates of elastomer and steel, when the function of the bearings is to transfer loads or accommodate relative movement between a bridge superstructure and its supporting structure, or both.

1.2 The values stated in SI units are to be regarded as the standard.

NOTE 1—The words "elastomer" or "elastomeric" will be used interchangeably with the word "rubber" in this specification.

1.3 The following safety hazards caveat pertains only to the test methods portion, Section 8, of this specification: *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.*

1.4 *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
A1011/A1011M Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
D395 Test Methods for Rubber Property—Compression Set
D412 Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension
D518 Test Method for Rubber Deterioration—Surface Cracking (Withdrawn 2007)[3]
D573 Test Method for Rubber—Deterioration in an Air Oven
D832 Practice for Rubber Conditioning For Low Temperature Testing
D1149 Test Methods for Rubber Deterioration—Cracking in an Ozone Controlled Environment
D1415 Test Method for Rubber Property—International Hardness
D1418 Practice for Rubber and Rubber Latices—Nomenclature

[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] The last approved version of this historical standard is referenced on www.astm.org.

D2000 Classification System for Rubber Products in Automotive Applications
D2137 Test Methods for Rubber Property—Brittleness Point of Flexible Polymers and Coated Fabrics
D2240 Test Method for Rubber Property—Durometer Hardness
D3183 Practice for Rubber—Preparation of Pieces for Test Purposes from Products
E4 Practices for Force Calibration and Verification of Testing Machines

2.2 *AASHTO Standards:*[4]
M 251 Standard Specification for Plain and Laminated Elastomeric Bridge Bearings

3. Terminology

3.1 *Definitions:*

3.1.1 *design load*—the mean compressive stress applied to the area of the steel laminate.

3.1.2 *external load plate*—a steel plate bonded to the top or bottom elastomeric surface of a bearing, or both.

3.1.3 *lot*—unless otherwise specified in the contract or purchase order, a lot shall consist of a single type of bearing, of the same design and material, submitted for inspection at the same time.

3.1.4 *plain elastomeric bearing pad*—a bearing that consists only of elastomeric material.

3.1.5 *plain elastomeric sandwich bearing*—a bearing that consists of a single layer of elastomeric material bonded to one or two external load plates (3.1.2).

3.1.6 *steel-laminated elastomeric bearing*—a bearing molded of elastomeric material with one or more steel laminates embedded in and bonded to it, and to which one or two external load plates (3.1.2) may be bonded.

4. Classification

4.1 The bearings are furnished in four types as follows:

4.1.1 Plain elastomeric bearing pad.

4.1.2 Plain elastomeric sandwich bearing.

4.1.3 Steel-laminated elastomeric bearing.

4.1.4 Steel-laminated elastomeric bearing with external load plate(s).

NOTE 2—Examples of the types of elastomeric bearing construction are given in Fig. 1.

NOTE 3—The adjective elastomeric is omitted in this specification when referring to bearing types.

4.2 The elastomer for the manufacture of the bearing is furnished in two types as follows:

4.2.1 *Type CR*—Chloroprene rubber.

4.2.2 *Type NR*—Natural rubber.

4.2.3 If none is specified, then the manufacturer shall use one of those types.

NOTE 4—Appendix X1 relates to elastomeric materials which do not have fully documented in-service records or sufficiently widespread use, or both.

NOTE 5—The abbreviations for the elastomer types are taken from Practice D1418.

[4] 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.

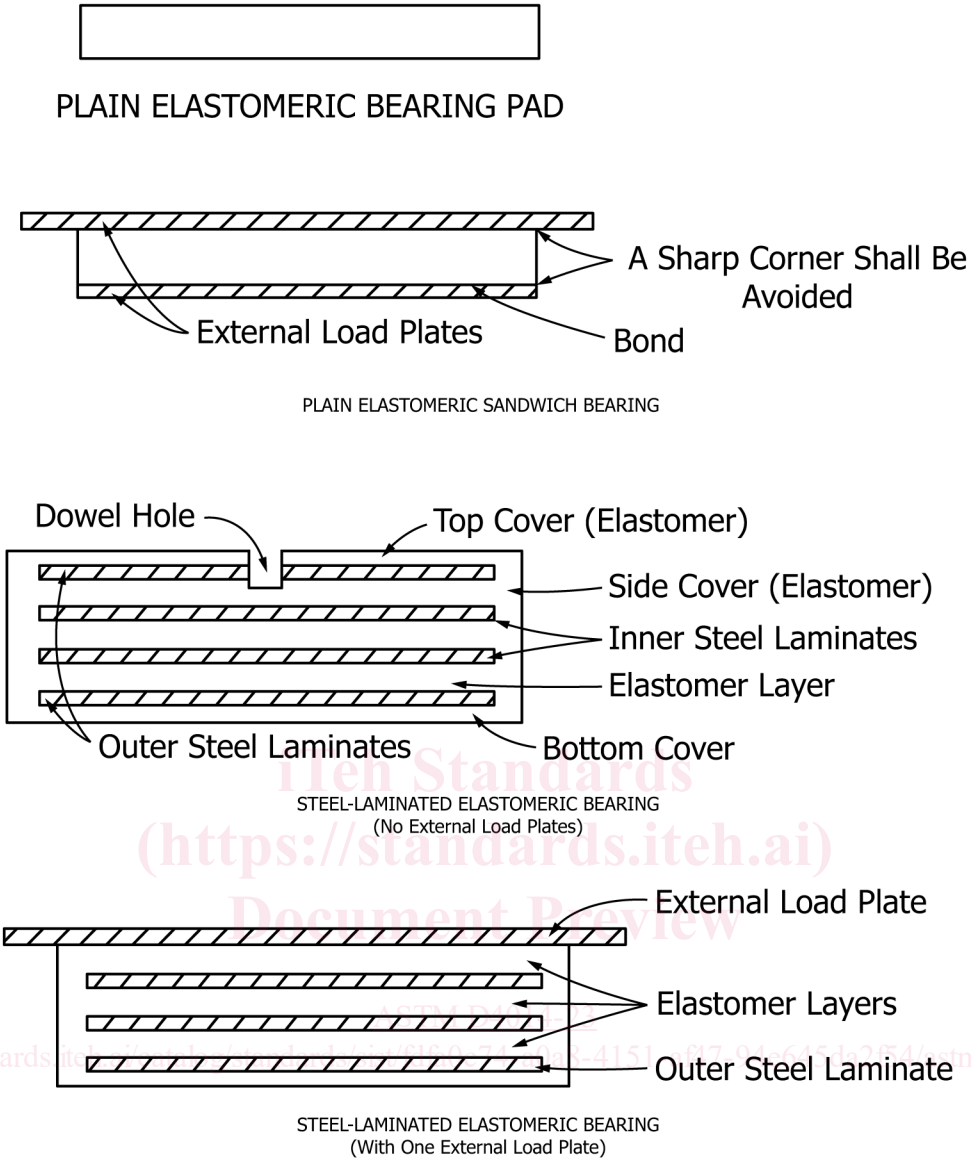

FIG. 1 Examples of the Construction of Elastomeric Bearings

4.3 The elastomer for the manufacture of the bearing is furnished in four grades of low-temperature properties. The grades and typical operating temperature conditions for each grade are as follows:

4.3.1 *Grade 0*—Suitable for continuous use down to +5 °C. (As per AASHTO M 251, NO low-temperature tests for Grade 0 to 2; recommend the same here.)

4.3.2 *Grade 2*—Sub-zero temperatures occur at night and occasionally persist for no more than one or two days.

4.3.3 *Grade 3*—Same as Grade 2 but occasional periods of up to two weeks continuously below zero.

4.3.4 *Grade 5*—Sub-zero temperatures down to −40 °C persisting for several months each year with up to two months continuously below −15 °C.

4.3.5 If a grade is not specified, Grade 0 shall be furnished. An elastomer of a higher grade number may be substituted for any lower grade.

NOTE 6—A discussion of low-temperature properties of elastomeric materials is given in Practice D832.

NOTE 7—The grade numbers for the low-temperature properties correspond to those in Table 6 of Classification D2000.

5. Ordering Information

5.1 Orders for each type of bearing under this specification shall include the following:

5.1.1 Quantity,

5.1.2 Bearing design,

NOTE 8—An example of the design information required is given in Appendix X2. Working drawings may be substituted.

5.1.3 Design load,

5.1.4 Shear modulus of the elastomer,

5.1.5 Rubber type,

5.1.6 Rubber grade, and

5.1.7 Ozone test partial pressure, if higher than 50 mPa (formerly referred to as a concentration of 50 parts per hundred million (pphm)).

6. Materials and Manufacture

6.1 The elastomeric compound used in the construction of a bearing shall contain only either natural rubber or chloroprene rubber as the raw polymer. No reclaimed rubber shall be used.

6.2 Internal steel laminates shall be of rolled mild ~~steel.~~steel (Specification A1011/A1011M).

6.3 External load plates shall conform to the requirements of Specification A36/A36M unless otherwise specified in the contract or purchase order.

6.4 Plain bearing pads shall be molded individually, or cut from previously molded strips or slabs, or extruded and cut to length. Cutting shall produce a smooth surface and no heating of the elastomer.

6.5 A steel-laminated bearing or a plain sandwich bearing shall be molded as a single unit under pressure and heat.

6.6 All bonding of elastomer to steel laminates and to external load plates shall be carried out during molding. The elastomer at the outer edges of bonds to external load plates shall be shaped to avoid serious stress concentrations (see Fig. 1).

6.7 Internal steel laminates shall be free of sharp edges.

6.8 External load plates shall be protected from rusting when supplied by the manufacturer.

6.9 All molds shall have a standard shop-practice mold finish.

6.10 The use of internal alignment pins to hold the steel reinforcement plates shall be allowed.

7. Dimensions and Permissible Variations

7.1 All elastomeric layers, for example, plain-bearing pads, laminates, and covers, shall be of uniform thickness unless otherwise specified in the contract or purchase order.

7.2 All internal steel laminates shall be of uniform thickness. When specified in the contract or purchase order, the thickness of the outer steel laminates may differ if not adjacent to an external load plate (see Fig. 1).

7.3 The minimum thickness of internal steel laminates shall be ~~1.5~~2.0 mm or ~~0.060 in. (16~~0.078 in. (14 gage) when the greater of the length or width of a rectangular bearing or the diameter of a circular bearing is less than 450 mm or 18 in. In all other cases, the minimum thickness shall be 2 mm or 0.075 in. (14 gage).

7.4 External load plates shall be of uniform thickness unless otherwise specified in the contract or purchase order.

7.5 Bearing dimensions and elastomer layer thicknesses shall satisfy the tolerances in Table 1, in which *D* is the length, width, or diameter as appropriate, and *T* is the total elastomer thickness.

7.6 Variation from a plane parallel to a design surface shall not exceed an average slope of 0.005 for the upper surface and 0.006 for a side surface.

8. Test Methods and Acceptance Requirements

8.1 *Bearing Compression Tests*—All bearings sampled from a lot shall be subjected to the compression tests. The cost of replacement bearings and of testing them shall be borne by the supplier.

8.1.1 The bearings shall be brought to a temperature of 23 ± 6 °C and shall be tested at this temperature.

8.1.2 *Compression Stiffness*—Load the bearing to the design load (3.1.1) by increments of ~~one-fifth~~ one fifth of the design load. For each load increment, the loading time shall be within the range of 1.4 to 2.6 min. When the increment has been applied, the load or deflection (depending on the type of testing machine) shall be maintained constant for 30 s then the load and deflection measured. From a plot of load against deflection, the compression stiffness shall be determined as the slope of the best straight line through the points, ignoring the first point at zero load. Record the compressive stiffness for each bearing.

8.1.3 *Visual Inspection*—Increase the load to 1.5 times the design load, then maintain either load or deflection constant while the bearing is inspected for visual faults, as follows:

8.1.3.1 If lack of elastomer to steel bond is indicated, the bearing shall be rejected.

8.1.3.2 If laminate placement faults are observed which result in elastomer layer thickness that exceeds the tolerances in 7.5, the bearing shall be rejected.

8.1.3.3 If there are at least three separate surface cracks which are each at least 2 mm wide and 2 mm deep, the bearing shall be rejected.

8.1.4 Record the median compressive stiffness (*K*) of the bearing of median stiffness. The compressive stiffness of each bearing tested shall not differ from (*K*) by more than 10 %.

8.1.5 For each bearing that fails to meet the requirements in 8.1, two additional bearings may be sampled and shall meet all the requirements in 8.1 or the lot shall be rejected.

TABLE 1 Tolerances for Bearing Dimensions and Elastomer Layer Thicknesses

Dimension	Tolerance	
	Minimum	Maximum
Length, width or diameter of bearing, mm (in.)	0	5 (0.2) + 0.005*D*
Height of bearing, mm (in.)	0	2 (0.1) + 0.04*T*
Thickness of elastomer cover at top, bottom or side, mm (in.)	0	3 (0.1)
Thickness of internal elastomer laminate, %	±20 % of design value	

8.1.6 If the lot is not rejected, the bearing of median stiffness (*K*) shall be subjected to the elastomeric material tests in 8.2.

8.2 *Elastomeric Material Tests:*

8.2.1 All test specimens used for the determination of the properties of the vulcanized elastomeric material shall be taken from bearings (see Practice D3183). Tensile and hardness specimens for the quality control tests in 8.2.3, specimens for the ozone resistance test in 8.2.5, and strips for the low-temperature brittleness test in 8.2.6.1, if applicable, shall include an outer surface of a bearing. All other specimens shall be taken from within the middle ~~one-third~~ one third of a bearing. Compression-set specimens shall be as specified in Test Methods D395, Method B, Type 1.

8.2.2 The temperature at which the tests shall be carried out shall be 23 ± 2 °C, except where otherwise specified in this specification.

8.2.3 *Quality Control Properties*—The quality control properties of the elastomer shall meet the requirements of Table 2 for the hardness and type of rubber used.

8.2.4 *Shear Modulus*—The shear modulus of the elastomer determined in accordance with Annex A1 shall not differ by more than ±15 % from the required shear modulus of the elastomer.

8.2.5 *Ozone Resistance*—An ozone resistance test shall be carried out on test strips mounted in accordance with procedure A of Test Method D518. The test shall be carried out in accordance with Test Methods D1149 at 20 % strain and at 40 ± 2 °C for 100 h. The ozone test partial pressure shall be 50 ± 5 mPa, formerly referred to as a concentration of 50 ± 5 pphm, unless a higher test partial pressure has been specified. The test strips shall be examined for cracks using a 7× magnification lens. The elastomer has adequate ozone resistance if no perpendicular cracks are observed on that surface of the strip corresponding to the outer surface of the bearing.

8.2.6 *Low-Temperature Grade Tests:*

8.2.6.1 When low-temperature Grade ~~2, 3,~~ 3 or 5 is specified, a low-temperature brittleness test shall be carried out in accordance with Test Methods D2137, Method A, using five test strips. The temperature at which the strips shall be conditioned and tested shall be −10 °C for Grade 2, −25 °C for Grade 3, and −40 °C for Grade 5. To meet the requirements of this specification, none shall fail.

9. Sampling

9.1 Unless otherwise specified in the contract or purchase order, sampling shall consist of the following:

TABLE 2 Quality Control Properties of Elastomer

Rubber	NR	CR
Hardness limits (Test Method D1415 or D2240)	45 to 75	45 to 75
Physical properties (Test Methods D412):		
Tensile strength, min, MPa (psi)	15.5 (2250)	15.5 (2250)
Ultimate elongation:		
45 to 55 hardness, min, %	400	400
56 to 65 hardness, min, %	400	350
66 to 75 hardness, min, %	300	300
High-temperature resistance (Test Method D573)		
Aging time, h	168	70
Aging temperature, °C	70	100
Change in hardness, max, %	+10	+15
Change in tensile strength, max, %	−25	−15
Change in ultimate elongation, max, %	−25	−40
Compression set (Test Methods D395, Method B)		
After 22 h at 70 °C, max, %	25	. . .
After 22 h at 100 °C, max, %	. . .	35