



Standard Specification  
for

Plain and Laminated Elastomeric Bridge Bearings

AASHTO DESIGNATION: M 251-96

1. SCOPE

1.1 This specification covers the material requirements for plain and laminated elastomeric bridge bearings. Elastomeric bearings furnished under this specification shall adequately provide for thermal expansion and contraction, rotation, camber changes, and creep and shrinkage, where applicable, of structural members. Elastomeric bearings as herein defined shall include unreinforced pads (consisting of elastomer only) and reinforced bearings with steel or fabric laminates.

2. REFERENCED DOCUMENTS

2.1 AASHTO Standards:

- M 183 Specification for Structural Steel
- R 11 Recommended Practice for Indicating Which Places of Figures are to be Considered Significant in Specified Limiting Values
- T 67 Practices for Load Verification of Testing Machines

2.2 ANSI Standards:

- ANSI B46.1 Surfaces and Surfacing

2.3 ASTM Standards:

- A 570 Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality
- D 395 Rubber Property—Compression Set
- D 412 Rubber Properties in Tension
- D 429 Rubber Property—Adhesion to Rigid Substrates

- D 573 Rubber—Deterioration in Air Oven
- D 1043 Stiffness Properties of Plastics as a Function of Temperature-Torsion Test
- D 1149 Rubber Deterioration—Surface Ozone Cracking in a Chamber (Flat Specimens)
- D 2137 Rubber Property—Brittleness Point of Flexible Polymers and Coated Fabrics. Test for
- D 2240 Rubber Property—Durometer Hardness
- D 4014 Specification for Plain and Steel-Laminated Elastomeric Bearings for Bridges

2.4 Rubber Manufacturer's Association, Inc.:

- RMA F 3
- RMA T.063
- RMA F 2

2.5 Steel Structures Painting Council Specifications:

- SSPC, Vis 1-89, Visual Standard for Abrasive Blast Cleaned Steel

3. GENERAL REQUIREMENTS

3.1 All bearings shall be designed in accordance with specifications contained in the latest edition of the AASHTO *Standard Specifications for Highway Bridges*.

3.2 The dimensions of the furnished bearings shall be the dimensions required by the design documents within the tolerances shown in Section 6 of this specification. The bearings shall be composed of the specified materials; shall be tested

at the appropriate level; and shall satisfy any special requirements of the purchaser.

3.3 The contractor shall provide the purchaser with written notification 30 days prior to the start of bearing production. This notification shall include the contract number, quantity, and size bearings being produced, manufacturer's name, location, and the representative who will coordinate production, inspection, sampling, and testing with the purchaser.

3.4 Testing for the physical properties of the elastomer may require the destruction of one or more bearings from a lot. In these instances, provisions should be made to provide additional bearings for testing purposes.

3.5 In addition to material requirements for the bearings individual components, this specification provides for two levels of acceptance criteria for finished bearings. Level I acceptance criteria is applied to all bearings without exception. Level II acceptance criteria involves additional testing and, unless otherwise specified by the purchaser, shall be applied to the following:

3.5.1 All bearings designed to accommodate compressive loads in excess of 6900 kPa and be subjected to shear deformation.

3.5.2 All other bearings designed to accommodate compressive loads in excess of 7600 kPa.

3.5.3 In addition, the purchaser may require Level II testing for bearings considered to be more critical or bearings for which Level I testing was inconclusive.

3.6 For bearings that will be expected to perform at lower temperatures, an optional low temperature shear test requirement is included in the Level I testing.



be molded and vulcanized in large sheets and cut to size. Cutting shall be performed so as to avoid heating the materials and produce a smooth finish with no separation of the fabric from the elastomer. Fabric shall be free of folds and ripples and shall be parallel to the top and bottom surfaces. If external steel plates are required, a cold bonding process which will yield the strengths required in Section 8.8.3 of this specification may be used in lieu of hot bonding.

5.3 Plain pads may be molded or extruded, and vulcanized in large sheets and cut to size. Cutting shall not heat the materials, and shall produce a smooth finish to ANSI B46.1 6.3µm. Plain pads shall be molded or extruded to the finished thickness. Fabricators will not be allowed to make pads of finished thickness by plying pads of lesser thickness together. External load plates, when used, shall be protected from rusting by the manufacturer, and shall be hot bonded by vulcanization during the primary molding process.

5.4 Flash tolerance, finish, and appearance of bearings shall meet the requirements of the latest edition of the *Rubber Handbook* as published by the Rubber Manufacturers Association, Inc., RMA F3 and T.063 for molded bearings and RMA F2 for extruded bearings.

6. TOLERANCES

6.1 Plain pads and laminated bearings shall be manufactured to the design dimensions tolerances listed in Table 2, unless other tolerances are shown on the design drawings.

7. MARKING

7.1 Each reinforced bearing shall be marked in indelible ink or flexible paint. The marking shall consist of the order number, lot number, bearing identification number, and elastomer type and grade. Unless otherwise specified in the contract documents, the marking shall be on a face which is visible after erection of the bridge.

8. BEARING TESTING AND ACCEPTANCE CRITERIA

8.1 All test apparatus used to determine conformance with these specifications, shall be calibrated annually in accordance with AASHTO T 67.

8.2 Sampling, testing, and acceptance consideration will be made on a lot basis. A lot of bearings shall be considered to be a group of 100 or less

bearings which are manufactured in a reasonably continuous manner from the same batch of elastomer, cured under the same conditions, and are all the same size and type (plain, fabric reinforced, or steel reinforced). A lot may include 100 or less fabric reinforced bearings of different plan size if cut from a large sheet or sheets meeting these requirements.

8.3 The manufacturer shall designate the bearings in each lot and certify that each of the bearings in the lot were manufactured in a reasonably continuous manner from the same batch of elastomer, and cured under the same conditions. In addition, the manufacturer shall certify that each bearing in the lot satisfies the requirements of the design specification and meets the dimensional tolerances of Section 6 of this specification.

8.4 The dimensions of each bearing shall be checked. If any dimensions are outside the limits listed in Section 6 of this specification, the lot shall be rejected.

8.5 The purchaser shall select sample bearings from the lot for testing in accordance with this specification. Sampling rate shall be as follows:

*Plain bearings* - Three full size bearings per lot.

*Laminated Bearings* - One full size bearing per every five per lot, a minimum of three bearings.

8.6 Elastomer taken from the sampled bearings shall be tested for conformance with the requirements of Section 4.1-4.4 of this specification. If the sampled elastomer fails to meet any of these requirements, the lot shall be rejected.

8.7 Additional testing shall be conducted on the sampled bearings. The acceptance criteria shall be at two levels. Level I acceptance shall be applied to all bearings. Level II acceptance criteria, unless otherwise specified by the purchaser, shall be applied to the following:

8.7.1 All bearings designed to accommodate compressive loads in excess of 6900 kPa and be subjected to shear deformation.

8.7.2 All other bearings designed to accommodate compressive loads in excess of 7600 kPa.

8.7.3 In addition, the purchaser may require Level II testing for bearings considered to be more critical or bearings for which Level I testing was inconclusive.

TABLE 2 Tolerances

	mm
1. Overall vertical dimensions:	
Design thickness 32 mm or less	-0, +3
Design thickness over 32 mm	-0, +6
2. Overall horizontal dimensions:	
For measurements 914 mm and less	-0, +6
For measurements Over 914 mm	-0, +12
3. Thickness of individual layers of elastomer (laminated bearings only) at any point within the bearing	± 20 percent of design value but no more than ± 3 mm (± 1/8)
4. Variation from a plane parallel to the theoretical surface: (as determined by measurements at the edge of the bearings):	
Top	Slope relative to the bottom of no more than 0.005 radians
Sides	6
5. Position of exposed connection members	3
6. Edge cover of embedded laminates of connection members	-0, +3
7. Size of holes, slots, or inserts	± 3
8. Position of holes, slots, or inserts	± 3

Level I and Level II tests may be performed by the manufacturer, by the purchasing agency or by an outside independent laboratory subject to the approval of the purchaser. If testing is performed by the manufacturer or an independent laboratory, certified test results shall be provided. Regardless of the agency designated to test the pads, the purchaser reserves the right to obtain test samples from the bearings for confirming test results.

8.8 Level I criteria shall include the following requirements:

8.8.1 Each sampled bearing shall be tested to determine compressive strain at the maximum design compressive load in accordance with Section 9.1 of this specification. If the resultant compressive strain exceeds 0.10, the lot shall be rejected.

8.8.2 Each sampled bearing shall be subjected to a compressive load equal to 1.5 times the maximum design load. The load shall be held for 5 minutes, removed, and reapplied for a second period of 5 minutes. The bearing shall be visually examined while under the second loading. If the bearing exhibits three separate surface cracks which are greater than 2 mm wide and 2 mm deep or a single crack deeper or wider than 6 mm, the lot shall be rejected. For laminated bearings, if bulging patterns imply laminate placement which does not satisfy design criteria and manufacturing tolerances or if bulging suggests poor laminate bond, the lot shall be rejected.

8.8.3 For reinforced bearings, a minimum of one sampled bearing per lot shall be tested for bond strength in accordance with Section 9.2 of this specification. Fabric reinforced pads shall have a minimum bond strength of 5.2 kN/m and steel reinforced pads a strength of 6.9 kN/m. If the testing bearing fails to meet the required minimum bond strength, the lot shall be rejected.

8.8.4 When required by the purchaser, a minimum of two pads per lot shall be tested for low temperature shear in accordance with the purchaser's requirements and Section 9.3 of this specification. Maximum allowable shear stresses will depend on the temperature at which the bearings are conditioned and the hardness of the elastomer. For bearings conditioned at  $-29^{\circ}\text{C}$  and con-

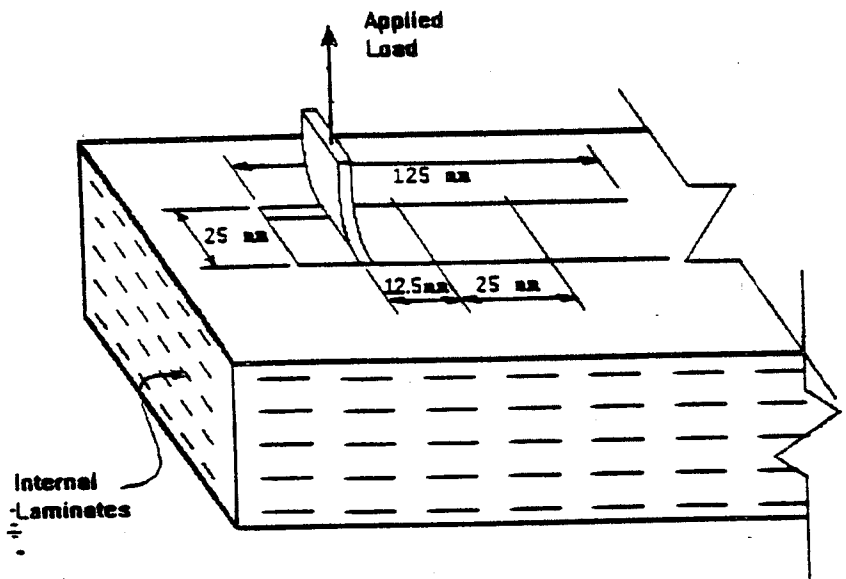


FIGURE 1 Preparation of Bond Strength Specimens

structed with 50 durometer elastomer, shear stress shall not exceed 345 kPa for bearings constructed with polychloroprene (neoprene) or 207 kPa for bearings constructed with polyisoprene (natural rubber). If the measured shear stress exceeds the specified value, the lot shall be rejected.

8.9 Level II criteria shall include the following requirements:

8.9.1 The pads must meet all Level I criteria.

8.9.2 The shear modulus of the elastomer shall be determined at  $23^{\circ}\text{C} \pm 1^{\circ}\text{C}$  in accordance with Annex A1/ ASTM D 4014. Shear modulus shall be determined by testing a specimen cut from the sampled bearings. Alternatively, at the purchaser's discretion, a comparable nondestructive stiffness test may be conducted on a pair of sampled bearings. If nondestructive stiffness test is performed, the shear modulus shall be computed from the measured shear stiffness of the bearings, taking into account the influence on shear stiffness of bearing geometry and compressive load. The shear modulus shall be within 15 percent of the value specified value, or within the limits listed in Table 3 for the specified nominal hardness. If shear modulus does not meet the specified minimum value, the lot shall be rejected.

8.9.3 For elastomer grades 2-5, addi-

tional shear modulus testing shall be performed on elastomer from the sampled bearings in accordance with Section 9.4 of this specification. If the measured stiffness at the specified temperature exceeds 4 times the stiffness measured at  $23^{\circ}\text{C}$ , the lot shall be rejected.

8.9.4 Elastomer from the sampled bearings shall be tested for instantaneous thermal stiffening in accordance with ASTM D 1043. The elastomer stiffness shall be measured at  $23^{\circ}\text{C}$  and at a lower temperature corresponding to the specified grade of elastomer. The lower test temperatures for the various grades of elastomer shall be as follows:

- Grade 0 & 2 Test @  $-32^{\circ}\text{C}$
- Grade 3 Test @  $-40^{\circ}\text{C}$
- Grade 4 Test @  $-46^{\circ}\text{C}$
- Grade 5 Test @  $-54^{\circ}\text{C}$

If the stiffness of the elastomer measured at the specified lower temperature is more than four times the stiffness of the elastomer measured at  $23^{\circ}\text{C}$ , the lot shall be rejected.

8.9.5 A sampled bearing from each lot of bearings shall be subjected to a long term compression test. This test shall be conducted in accordance with the requirements of Section 8.8.2 of this specification except that the second load shall be maintained for 15 hours. If the load drops below 90 percent of its target value during this time, the load shall be in-

TABLE 3 Shear Modulus Requirements

Nominal hardness	50	60	70
Shear modulus at 23° C	0.62 - 0.90 MPa	0.90 - 1.40 MPa	1.40 - 2.05 MPa

creased to the target value and the test duration shall be increased by the time for which the load was below the required value. The bearing shall be visually examined at the end of the test while it is still under load. If the bearing exhibits three separate surface cracks which are greater than 2 mm wide and 2 mm deep or a single crack deeper or wider than 6 mm, the lot shall be rejected. For laminated bearings, if bulging patterns imply laminate placement which does not satisfy design criteria and manufacturing tolerances or if bulging suggests poor laminate bond, the lot shall be rejected.

8.9.6 The purchaser may require more severe testing of pads such as fatigue or test to failure under Level II criteria.

## 9. TESTS

### 9.1 Determination of Compression Strain at Maximum Design Load:

9.1.1 The bearing to be tested shall be placed in a test machine capable of applying a compressive load equal to the bearing's maximum design dead plus live service load.

9.1.2 A pair of deflectometers shall be placed on opposite sides of the bearing in the test machine. The deflectometers shall be located as near as possible to the center of the bearing.

9.1.3 The bearing shall be loaded at a rate of 520 kPa/min. to a compression stress equal to 5 percent of the bearing's maximum design dead plus live service load. The 5 percent load shall be maintained for two minutes. At the end of the two minutes, the deflectometer readings shall be recorded.

9.1.4 The compressive load shall be increased at a rate of 520 kPa/min. to a compressive stress equal to the bearing's maximum design dead plus live service load. The load shall be maintained for

a period of two minutes, at the end of which the deflectometer readings shall be recorded.

9.1.5 The total compressive deflection between the two loadings shall be calculated for each deflectometer. The bearing's compressive strain shall be calculated as the average of the compressive deflections indicated by the two deflectometers divided by the design effective rubber thickness of the tested bearing.

### 9.2 Determination of Bond Strength:

9.2.1 Bond strength shall be determined in accordance with ASTM D 429 Method B as modified herein.

9.2.2 The bond test shall be performed on sampled bearings by cutting the required strip from an elastomer layer bonded to an internal laminate. The strip size shall be 25 mm wide, 125 mm long, and at least 6.3 mm thick.

9.2.3 Peeling of the elastomer strip from the internal laminate shall be initiated by carefully cutting the elastomer back to create a tab long enough to install in the grips of the testing machine.

9.2.4 Draw lines across the strip 12.5 mm and 37.5 mm from where the peeled portion of the strip meets the internal laminate (see Figure 1). Install the specimen in the grips so that the angle between the elastomer tab and the surface of the bearing will be approximately 90° for the duration of the test.

9.2.5 Apply the tensile load at the required rate until the elastomer peels back beyond the 37.5 mm mark while recording the load as required. If the load reaches 270 N without the elastomer starting to peel from the laminate surface, end the test and record the bond strength as  $10.5 \pm kN/m$ . If the elastomer peels back to the 37.5 mm mark without reaching 270 N of load, record the bond strength as the average load in kilonewtons per meter of width required to peel the elastomer between the marks. If the elastomer tab rips off the bearing before

reaching the 37.5 mm mark or reaching 270 N of load, retest in another area of the bearing.

### 9.3 Low Temperature Shear Test:

9.3.1 Two bearings shall be conditioned at a specified temperature for  $96 \pm 1$  hours. Unless otherwise specified by the purchaser, the conditioning temperature shall be  $-29^\circ C \pm 0.5^\circ C$ . After conditioning, the bearings shall be placed in a compression machine such that one bearing is on top of the other bearing with the top bearing upside down.

9.3.2 The bearings shall be loaded in compression to a stress of 3400 kPa based on the design net internal reinforcement area of the bearing.

9.3.3 The bearings shall be sheared to a total strain equivalent to 25 percent of the design effective rubber thickness. Shear stress, based on the design net plan area of the elastomer shall be recorded 15 minutes after reaching 25 percent shear strain. The total time lapse between removal from the conditioning environment and completion of the test shall not exceed 30 minutes.

### 9.4 Additional Shear Modulus Testing for Elastomer Grades 2-5:

9.4.1 Shear modulus testing shall be performed as described in Annex A1 of ASTM D 4014 except as modified below.

9.4.2 The test specimens shall be taken from sampled bearings. After preparing the test specimen, it shall be conditioned for a period of time at a specified temperature. Conditioning times and temperatures for the various elastomer grades shall be as follows:

Grade 2 - 7 days @  $-18^\circ C$

Grade 3 - 14 days @  $-26^\circ C$

Grade 4 - 21 days @  $-37^\circ C$

Grade 5 - 28 days @  $-37^\circ C$

9.4.3 Shear modulus testing shall be performed with the test specimen in an enclosed freezer unit capable of maintaining the specified conditioning temperature. A  $\pm 25$  percent strain cycle shall be applied with a period of 100 seconds. The first  $3/4$  cycle of strain shall be discarded and the stiffness shall be determined by the slope of the force deflection curve for the next  $1/2$  cycle of loading.