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DCE MEMORANDUM 20-09
(FHWA Approved: 11/18/09)

This Memo Has Expired

TO: DISTRICT CONSTRUCTION ENGINEERS

FROM: David A. Sadler, Director, Office of Construction 

COPIES: Robert Robertson, Tom Malerk, Tim Lattner, Chris Richter, Ann Allshouse, Brian Blanchard, Bob Burleson, Paul Steinman

SUBJECT: TESTING OF ELASTOMERIC BEARING PADS FOR BRIDGE STRUCTURES

The current 2010 Standard Specification Article 932-2, Structure Bearing Pads, requires elastomeric bearing pads to be furnished in accordance with AASHTO LRFD Bridge Construction Specifications, Section 18.2. LRFD Section 18.2 then refers the reader to AASHTO Standard Specification M 251, for detailed testing requirements. The M 251 source document dated 2004 has been revised in an interim specification, designated M 251-06 which is the document that Contractors must refer to in order to be in full compliance with the current 932-2 specification.

The requirements of M 251-06 are more rigorous than the provisions they replaced. After a review, and partly based on information in NCHRP report 596, the Department has modified M 251-06 for FDOT use so that the testing requirements for this product are more comparable with past practice and the revised version is attached. In addition, there is a revision to Specification 932-2.2.3 that follows this memorandum, changing the applied testing load from 1,600 pounds to 2,400 psi (laminated pads) or 1,750 psi (plain pads).

Effective immediately, all projects currently underway and all projects let in the future, until an officially revised specification is implemented by the Specifications Office, shall use the

attached AASHTO M 251-06 revised for FDOT and the following version of 932-2.2.3 shall be used in lieu of the 2010 Standard Specification version.

Specification 932-2.2.3 Testing: Comply with the testing requirements established in the “AASHTO LRFD Bridge Construction Specifications” Section 18.2. Unless otherwise shown in the Contract Documents, the rated service load in pounds for load testing shall be 2,400 pounds per square inch (laminated pads) or 1,750 pounds per square inch (plain pads) times the pad area in square inches.

This memorandum serves as a blanket approval to process a no cost specification revision and shall be attached to the work order or supplemental agreement required for its processing.

Further, there are ongoing projects for which pads have been placed and the Contractor has submitted the required certification stating that the pads are in full compliance with the Contract Documents. This office has been informed that some of these certifications may be invalid because the bearing pad suppliers were not aware of the new provisions and did not actually perform all of the required tests. Therefore, on all active projects, District Construction personnel shall review any certifications received to ensure compliance with the detailed provisions of the revised version of AASHTO M 251-06 provided herein. If the pads are not in compliance with all the revised specification testing requirements, then one of the following actions must be taken:

- 1) The Contractor can test a coupon from the same lot of pads that have been previously installed.
- 2) The Contractor shall provide the Department with a warrantee bond having a duration of five (5) years.
- 3) The Contractor shall remove and replace all noncompliant pads with compliant pads.

For questions or discussion of this matter, contact Steven Plotkin at (904) 360-5501.

DS/pw

Standard Specification for Plain and Laminated Elastomeric Bridge Bearings

FDOT Modifications to AASHTO M 251-06

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 plain pads (consisting of elastomer only) and laminated bearings with steel or fabric laminates. Bearings manufactured and tested under this specification shall have a plan area less than 1000 in² and be less than 8 inches in height.

2 REFERENCED DOCUMENTS

2.1 AASHTO Standards:

R 11, Indicating Which Places of Figures Are to Be Considered Significant in Specified Limiting Values
T 67, Standard Practices for Force Verification of Testing Machines
AASHTO LRFD Bridge Design Specifications

2.2 ASTM Standards:

A 36/A 36M, Specification for Carbon Structural Steel
D 412, Test Method for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers, Tension
D 746, Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
D 751, Test Method for Coated Fabric
A 1011M, Specification for Steel, Sheet and Strip
D 3183, Practice for Rubber-Preparation of Pieces for Test Purposes from Products
D 4014, Specification for Plain and Steel-Laminated Elastomeric Bearings for Bridges

2.3 ANSI Standard:

ANSI B46.1, Surfaces and Surfacing

2.4 Rubber Manufacturers Association, Inc. Standards:

RMA F 3
RMA T.063

RMA F 2

- 2.5 The Society for Protective Coatings Specification: 1
SSPC-VIS 1-01, Visual Standard for Abrasive Blast Cleaned Steel

3 GENERAL REQUIREMENTS

- 3.1 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 contract documents.
- 3.2 The cost of providing additional bearings and/or coupons for testing purposes shall be borne by the supplier.
- 3.3 In addition to material requirements for the bearing's individual components, this specification provides acceptance criteria for finished bearings.

4 MATERIALS

- 4.1 Properties of the Elastomer—the elastomer compound used in the construction of bridge bearings shall contain only virgin crystallization resistant polychloroprene (neoprene) as the raw polymer. Elastomer compounds used in the construction of bearings for ancillary structures shall contain only virgin crystallization resistant polychloroprene (neoprene) or virgin natural polyisoprene (natural rubber) as the raw polymer. All materials shall be new with no reclaimed material incorporated in the finished bearing. The elastomer compounds shall be classified as being of low-temperature Grade 2, 3, 4, or 5 as specified by the minimum grade requirements of Table 14.7.5.2-2, “Low Temperature Zones and Minimum Grade of Elastomer,” of the AASHTO LRFD Bridge Design Specifications. Low temperature zones used in this table are as defined in Figure 14.7.5.2-1, “Temperature Zones,” of the same publication.
- 4.2 The cured elastomer shall meet the minimum requirements of Table 1. The properties of the cured elastomeric compound material listed in Table 1 may be determined using samples taken from actual bearings or from special coupons molded or fabricated for the purpose. Coupons shall be produced from the same elastomer used in the fabrication of the bearing lot.
- 4.3 All material tests shall be carried out at $74^{\circ} \pm 4^{\circ}\text{F}$ unless otherwise noted.
- 4.4 For the purpose of determining conformance with this specification, an observed or calculated value shall be rounded off to the nearest 15 psi for tensile strength, to the nearest 10 percent for elongation, and to the nearest 1.5 psi for shear modulus.

Table 1 - Materials Test Procedures for Elastomeric Bridge Bearing Elastomers

| Material Property | ASTM Standard | Test Requirement | Polychloroprene (Neoprene) | Units |
|-----------------------------|-------------------------|--------------------------------|-----------------------------------|--------------|
| Physical Properties | ASTM D 4014 | Shear Modulus | See Section 8.8.3 | psi |
| | Annex A1 | | | |
| | D 412 | Min Tensile Strength | 2,250 | psi |
| | D 412 | Min Ultimate Elongation | 400 | % |
| Low Temperature Brittleness | D 746 Procedure B | Grades 0 & 2—No Test Req'd | ----- | |
| | | Grade 3—Test at -40°F | Passes | |
| | | Grade 4—Test at -55°F | Passes | |
| | | Grade 5—Test at -70°F | Passes | |
| Heat Resistance | D 573 at specified temp | Specific temp. of the test | 212 | °F |
| | | Aging time | 70 | hours |
| | | Max change in tensile strength | -15 | % |
| | | Max change in ult. elongation | -40 | % |

- 4.5 Steel Laminates—Steel laminates used for reinforcement shall be made from rolled mild steel conforming to ASTM A 36/A 36M, ASTM A 1011M, or equivalent, unless otherwise specified by the purchaser. The laminates shall be of the thickness specified by the purchaser or, if left unspecified, have a minimum nominal thickness of 0.1345 in. Holes in plates for manufacturing purposes shall not be permitted unless considered in the design of the bearing. The edges of all steel laminates shall be ground smooth and rounded prior to being molded in the bearing.
- 4.6 If specified, external load bearing plates shall conform to the requirements of ASTM A 36/A 36M, ASTM A 1011M, or equivalent, unless otherwise specified in the contract documents. Except as noted, all bearings surfaces of external load plates shall be finished or machined flat within 0.01 in. The bottom surfaces of external load plates (masonry plates) designed to rest on bearing pads shall not exceed an out-of-flatness value of 0.0625 in. The external load bearing plates shall be protected from rust until all exposed surfaces can be field painted. Any rust inhibitor utilized must be removed from all surfaces to be welded prior to welding.
- 4.7 Fabric Laminates—Fabric laminates shall be woven from 100 percent glass fibers of “E” type yarn with continuous fibers. The minimum thread count in either direction shall be 10 threads per cm. The fabric shall have either a crowfoot or an 8-harness satin weave. Each ply of fabric shall have a minimum tensile strength of 800 lbf/in. of width in each thread direction, which shall be determined by ASTM D 751.

5 FABRICATION

- 5.1 Bearings with steel laminates shall be cast as a unit in a mold and bonded and vulcanized under heat and pressure. The molds shall have standard shop practice mold finish. The internal steel laminates shall be blast cleaned to a condition matching that of SSPC-Vis 1-01, Pictorial Standard BSP6 or CSP6, and additionally cleaned of any oil or grease before bonding. Plates shall be free of sharp edges and burrs, and shall have a minimum edge cover of 0.25 in. External load plates (sole plates) shall be protected from rusting by the manufacturer, and shall be hot bonded to the bearing during vulcanization. Bearings with steel laminates which are designed to act as a single unit with a given shape factor must be manufactured as a single unit.
- 5.2 Fabric-laminated bearings may 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 that will yield the strengths required in Section 8.8 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, 6.3 um (248 uin.). 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 F 3 and T.063 for molded bearings and RMA F 2 for extruded bearings.
- 5.5 Wax anti-ozonants or other foreign material shall not accumulate or be applied to the surface of the bearing.

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. Use the following equation to define alignment tolerance limits for steel laminate when tolerance #3(± 0.125 in.) is exceeded: $7.5\theta + v/hr \leq 0.35$ provided $\theta \leq 0.02$ where θ (radians) and v (in) are absolute values of steel laminate rotation and vertical displacement. If the specified layer elastomeric layer thickness is hr , the bearing length is L , and $H1$ and $H2$ are the measured maximum and minimum thicknesses at the edges of the layer, then $v = |hr - 0.5 (H1 + H2)|$ and $\theta = |(H1 - H2) / 2L|$ for interior layers and $\theta = |(H1 - H2) / L|$ for top and bottom layers provided that the minimum elastomer layer thickness $H2 \geq 0.2$ in.). Bearings with tolerances that satisfy this equation must also satisfy the compression test in Sect. 8.8.

Table 2 - Tolerances

| Measurement | inches |
|---|---|
| 1. Overall vertical dimensions: Design thickness 1.25 in. or less Design thickness over 1.25 in.) | -0, +0.125 -0, +0.25 |
| 2. Overall horizontal dimensions: For measurements 36 in. and less For measurements over 36 in.) | -0, +0.25 -0, +0.5 |
| 3. Thickness of individual layers of elastomer (laminated bearings only) at any point within the bearing | ±0.125 |
| 4. Variation from a plane parallel to the theoretical surface (as determined by measurements at the edge of the bearings): Top Sides | Slope relative to the bottom of no more than 0.005 radians 0.25 |
| 5. Position of exposed connection members | ±0.125 |
| 6. Edge cover of embedded laminates of connection members | -0, +0.125 |
| 7. Size of holes, slots, or inserts | ±0.125 |
| 8. Position of holes, slots, or inserts | ±0.125 |

7 MARKING

- 7.1 Each elastomeric 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 that 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 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 fewer bearings which are manufactured in a reasonably continuous manner from the same elastomer, cured under the same conditions, and are all the same size and type (plain, fabric-laminated, or steel-laminated). A lot may include 100 or less fabric-laminated 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 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 bearing shall be rejected. However, tolerance measurements for test number 4 and 6 shall be made on a one per lot basis. If dimensions are outside the limits listed in Section 6 of this specification, the bearing shall be rejected and an additional ten random bearings of the lot shall be tested. If any of the ten samples are outside the limits listed in Section 6 of this specification, the lot shall be rejected.

- 8.5 The independent testing agency shall select two sample bearings from the lot for testing: one for compression (8.8.1) and one for shear bond (8.8.2).
- 8.6 Special elastomer coupons molded or fabricated for the purpose, on a lot basis, shall be tested for conformance with the requirements of Sections 4.1 through 4.4 of this specification. If the elastomer fails to meet any of these requirements, the lot shall be rejected.
- 8.7 Tests shall be performed or witnessed by an outside independent laboratory that is approved by the Department. Certified test results shall be provided to the Department. The Department reserves the right to obtain test samples from the bearings for confirming test results.
- 8.8 Bearing criteria shall include the following:
 - 8.8.1 One sampled bearing per lot shall be subjected to a compressive load equal to 2400 psi for laminated pads and 1,750 psi for plain pads. The load shall be held for five minutes, removed, and reapplied for a second period of five minutes. The bearing shall be visually examined while under the second loading. If the bearing exhibits three separate surface cracks which are greater than 0.083 in. wide and 0.083 in. deep or a single crack 0.125 in. deep or wider than 0.25 in., the bearing shall be rejected and an additional ten more random samples of the lot shall be tested. 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.
 - 8.8.2 One sampled bearing per lot shall be tested for bond strength in accordance with Appendix X2. If the tested bearing fails to meet the minimum bond strength, the lot shall be rejected.
 - 8.8.3 One elastomer shear test specimen per lot shall be fabricated and tested for shear modulus in accordance with ASTM D 4014 Annex A1 modified as follows: the initial cycles shall be taken to a strain of 0.7 and on the last cycle the shear modulus shall be determined at 0.5 strain. If the shear modulus is not within ± 15 percent of the value specified, the lot shall be rejected. If shear modulus does not meet the specified minimum value from Table 1, the lot shall be rejected.

APPENDIX X1 - TEST AND ACCEPTANCE CRITERIA FOR ANCILLARY ELASTOMERIC BEARINGS

This Appendix is for ancillary elastomeric bearings specified by durometer. The materials specifications remain as listed in M 251-06 as noted.

Table 1 in Section 4 is replaced by the following tests:

Table X1 - Materials Test Procedures for Ancillary Elastomeric Bearing Elastomers

| Material Property | ASTM Standard | Test Requirement | Polyisoprene (Natural Rubber) | | | Polychloroprene (Neoprene) | | | Units |
|-----------------------------|---|--|-------------------------------|-------------------------------------|-------|----------------------------|-------------------------------------|-------|--------------------------------------|
| | | | 50 | 60 | 70 | 50 | 60 | 70 | |
| Physical Properties | D 2240 | Hardness | 50 ±5 | 60 ±5 | 70 ±5 | 50 ±5 | 60 ±5 | 70 ±5 | Shore A pts psi % |
| | D 412 | Min Tensile Strength | 450 | 450 | 300 | 2250 | 2250 | 2250 | |
| | D 412 | Min Ultimate Elongation | 450 | 450 | 300 | 400 | 350 | 300 | |
| Heat Resistance | D 573 at specified temp | Specific temp. of the test | | 160 | | | 212 | | °F hours Shore A pts % % |
| | | Aging time | | 168 | | | 70 | | |
| | | Max change in durometer hardness | | +10 | | | +15 | | |
| | | Max change in tensile strength | | -25 | | | -15 | | |
| | | Max change in ultimate elongation | | -25 | | | -40 | | |
| Compression Set | D 395 Method B at specified temp | Specific temp. of the test | | 160 | | | 212 | | °F % |
| | | Max permissible change (after 22 hours) | | 25 | | | 35 | | |
| Low Temperature Brittleness | D 746 Procedure B | Grades 0 & 2—No Test Required Grade 3—Test at -40°F Grade 4—Test at -55°F Grade 5—Test at -70°F | | ----- Passes Passes Passes | | | ----- Passes Passes Passes | | |

APPENDIX X2 - BEARING SHEAR BOND TESTING AND ACCEPTANCE CRITERIA

For laminated bearings, a minimum of one sampled bearing per lot shall be tested for bond strength. Fabric reinforced pads shall have a minimum bond strength of 30 lbf/in. and steel reinforced pads a strength of 40 lbf/in. If the testing bearing fails to meet the required minimum bond strength, the lot shall be rejected.

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

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 1 in. wide, 5 in. long, and at least 0.25 in. thick.

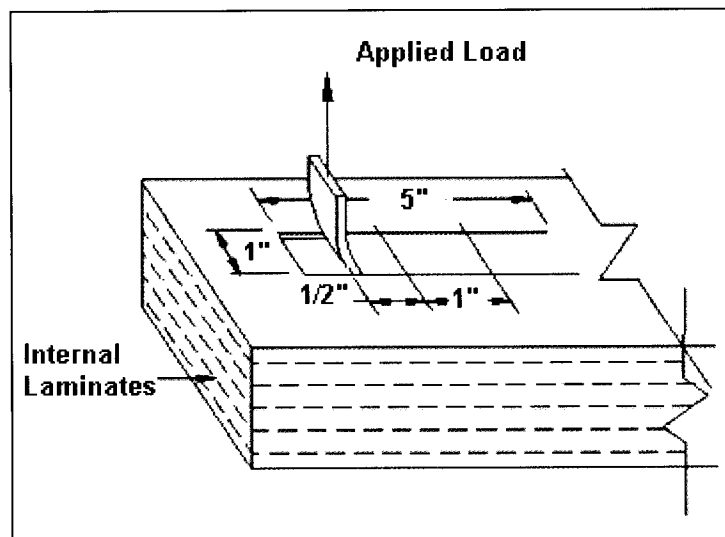


Figure 1 - Preparation of Bond Strength Specimens

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.

Draw lines across the strip 0.5 in. and 1.5 in. from where the peeled portion of the strip meets the internal laminate. 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.

Apply the tensile load at the required rate until the elastomer peels back beyond the 1.5 in. mark while recording the load as required. If the load reaches 60 lbf without the elastomer starting to peel from the laminate surface, end the test and record the bond strength as 60 lbf/in. If the elastomer peels back to the 1.5 in. mark without reaching 60 lbf of load, record the bond strength as the average load in lbf/in. of width required to peel the elastomer between the marks. If the elastomer tab rips off the bearing before reaching the 1.5 in. mark or reaching 60 lbf of load, retest in another area of the bearing.