

ITEM 716.09----25 BASE ISOLATION BEARING SYSTEMS

1. DESCRIPTION:

- 1.01 **Scope.** This specification covers the material requirements for base isolation bearing systems. Bearings furnished under this specification shall adequately provide for thermal expansion and contraction, rotation, camber changes, creep, shrinkage and seismic stresses of structural members, where applicable.
- 1.02 **General.** All bearings fabricated under the terms of this subsection shall perform the functions for which they have been designed.
- 1.03 Stresses will be computed in accordance with the requirements of the AASHTO GUIDE SPECIFICATION FOR SEISMIC ISOLATION DESIGN dated 1998.

2. MATERIAL REQUIREMENTS:

- 2.01 Bearings fabricated under the requirements of this specification, except as modified by the terms of this subsection, shall meet the applicable requirements of subsections:

716-06; DISC-DESIGN STRUCTURAL BRIDGE BEARINGS,
716-07.01; POT-DESIGN STRUCTURAL BRIDGE BEARINGS,
716-11; STEEL LAMINATED ELASTOMERIC BRIDGE BEARINGS
716-12; ELASTOMERIC BRIDGE BEARINGS WITH EXTERNAL LOAD PLATES

All materials shall be new. No used, or reclaimed material will be permitted.

- 2.02 **Elastomeric Material.** The elastomeric compound shall be virgin polyisoprene (natural rubber) and shall meet, or exceed ASTM D4014, Type NR, Gr.3 (except as modified below):
- A. Low Temperature Properties
 - B. ASTM D2137 Method A (Brittleness Test at -13°F): no failure
 - C. ASTM D1229 (Compression Set at -14°F for 7 days at 25% compression)
 - D. Maximum permissible set: 65%
 - E. ASTM D2240 (Low Temperature Stiffness Conditioned for 22 hours at -13°F)
 - F. Maximum permissible change in durometer hardness: +10 Shore 'A' points
- 2.03 **Bond of Elastomer to Steel Laminate:** The average of the peak values of force during separation to determine the minimum peel strength shall be at least 44lb/in. Peel strength tests will be performed in accordance with the requirements of the applicable Subsections of 716-11 and 716-12.
- 2.04 **Tensile Strength and Ultimate Elongation of Elastomer:** Minimum tensile strength and ultimate elongation tests will be performed according to ASTM D412. The minimum tensile strength will be 2.25 ksi and the minimum ultimate elongation will be 550%.
- 2.05 **Hardness of Elastomer:** The durometer hardness will be determined by ASTM D2240 and will be 55 \pm 5 Shore 'A' points.
- 2.06 **Shear Modulus at 50% Shear Strain of Elastomer:** The shear modulus of the elastomer at 50% shear strain will be determined by ASTM D4014. The tangent modulus will be 100 psi \pm 10%.
- 2.07 **External Load Plates:** External load, bearing steel plate(s) in direct contact with the elastomer shall be factory vulcanized to the bearing for bearings where subsection 716-12 is applicable.

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2. MATERIAL REQUIREMENTS: (cont'd)

- 2.08 **Lead:** This shall meet the requirements of ASTM B29, Common Lead and shall have a minimum lead purity of 99%.
- 2.09 **Steel:** All external plates, regardless of purpose, shall meet the requirements of ASTM A36M, A572M- Gr. 50, or A588M as noted on the plans. All fabrication shall be done in accordance with the applicable requirements of the SCM.
- 2.10 **Fasteners:** These shall meet the requirements of the SCM unless otherwise noted on the plans.
- 2.11 **Protective Coating:** External load bearing plates shall be cleaned to meet SSPC-SP6, Surface Preparation Specification No. 6 Commercial Blast Cleaning and painted with three coats of paint. The paint, (primer, intermediate and finish coat) shall be selected from the Department's Approved List, Paints for Structural Steel. All coats of paint used shall be produced by the same manufacturer and applied at a rate sufficient to produce a minimum dry film thickness of 3 mils per coat. Each single paint coat shall be a color different from the others. For bearings used in conjunction with painted steel the color of the finish coat shall be the same color as the finish coat of the structural steel. For bearings used in conjunction with unpainted steel the color of the finish coat shall be a "rusty brown" color which is a reasonable visual match to Federal Color Standard No. 595, Color 20059.
- 2.12 Metal to metal surfaces to be field welded shall be given a coat of clear lacquer or other protective coating approved by the Engineer, or Inspector, if exposure is to exceed three months prior to welding. The coating shall be removed prior to welding. Painting shall be done after the completion of welding.

2.13 **Fabrication Tolerances:**

<u>Dimension</u>	<u>Tolerance</u>
Overall thickness of Rubber Cover	+1/8 in. - 0 in.
External Plan Dimension	± 1/4 in.
Flatness of Exterior Top Surface of Completed Bearing	- 0.01 in
Flatness of Exterior Bottom Surface of Completed Bearing	± 1.6 mm
Variation from Plan Parallel to the Theoretical Surface:	
Top Slope relative to the bottom no more than	0.006 radians
Sides	± 1/4 in.
Overall Bearing Height	± 1/4 in.

- 2.14 Bearings not meeting the above dimensional requirements shall be subject to rejection.
- 2.15 **Testing:** The overall objective of this testing is to evaluate the actual performance of the bearing system in accordance with the contract documents. The contractor shall allow a minimum of 90 days for testing and inspection of the bearings. If the Environmental Aged Test is waived, the contractor shall allow a minimum of 50 days for testing and inspection.

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2. MATERIAL REQUIREMENTS: (cont'd)

- 2.16 The Manufacturer shall arrange to test each system type with such test witnessed and attested to by a NYSTA representative designated by the Director, Structures Design for compliance with specified performance requirements as listed herein. Testing shall be performed at a test facility approved by the Materials Bureau. The NYSTA representative shall be notified of the scheduled tests 14 days prior to the testing. NYSTA shall have free access to the testing area.
- 2.17 Except where otherwise specified, two bearing assemblies shall be tested for each lot. A lot shall be defined as the lot designation stated in the applicable item, 716-11, 716-12, 716-06, or 716-07. These bearings shall be selected at random, by the NYSTA representative, from the lot of production bearings. The chosen bearings are to be tested to the applicable design forces and displacements for that bearing. The test values for each bearing are to be taken from the tables in the contract plans.
- 2.18 At the completion of the tests, each bearing shall be inspected by the N.Y.S.D.O.T. representative, and all damaged components shall be replaced with new components made from the same batch of material as that used in the production lot. If the bearings meet the test criteria, the tested bearings may be refurbished to their pre-tested condition and used in the completed structure.
- 2.19 Each bearing selected for testing will be performance characteristic tested in accordance with the applicable requirements of the above subsections as well as the following:

A. Environmental Aging

1. Purpose: To verify performance of the selected bearing assembly in a salt spray environment such as may be encountered over a long period of time under an expansion deck joint which is subject to salting.
2. Procedure: The selected bearing assembly shall be exposed in a salt spray chamber for 1000 hours in accordance with the requirements of ASTM B117. The bearing subjected to this test will then undergo other testing to verify continued satisfactory function.

B. Temperature Testing

1. Purpose: Establish dependence on temperature.
2. Sequence: Three fully reversed cycles to peak design displacements (d_{max}) under seismic loading. Tests shall be conducted for temperatures at the start of cyclic loading corresponding to 0°F and 90°F. Tests shall be conducted with a vertical load equal to the total dead load of the superstructure.
3. Procedure: Place the salt spray bearing in an environmental chamber; maintain the temperature to within $\pm 5^\circ\text{F}$ of that specified for a period of 24 hours for 90°F, and 24 hours for 0°F. After conditioning the bearing for the required time, place the bearing in the test machine and secure it to the supports and loading plate. Apply a vertical load equal to the total dead load of the superstructure to the bearing and allow the load to stabilize. Apply the cyclic lateral load equal to peak design displacements (d_{max}) to the bearing for 3 fully reversed cycles. The test shall be run continuously without pause between cycles. Actual testing shall commence within 15 minutes of removing the sample from the environmental chamber, and shall proceed without interruption.

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2. MATERIAL REQUIREMENTS: (cont'd)

2.19 (cont'd)

4. Criteria: The system, unit or component response is considered to be independent of temperature if:
 - a. The average Effective stiffness measured at temperature 0°F is within 20% of the average effective stiffness measured at a temperature of 90°F.
 - b. the average Energy Dissipation per cycle measured at temperature 0°F is within 20% of the average Energy Dissipation per cycle measured at a temperature of 90°F.

C. **Proof Test:** The sampled bearing shall be axially loaded with a compressive load equal to 110% of the capacity of the bearing (live plus dead load) for 15 consecutive hours. The bearing shall show no signs of lack of rubber adhesion, laminate displacement, or cracks greater than 1/16 in. in depth, or width. The proof test will not be required if rotational testing is performed as required under items 716-06 and 716-07.

D. **Combined Compression plus Shear:** The requirements of the AASHTO GUIDE SPECIFICATIONS FOR SEISMIC ISOLATION DESIGN, dated 1998, shall apply. Two tests are required; one test shall be performed using the environmental aged sample (Test 1), and one test shall be performed using another bearing sample. The manufacturer should determine if their equipment requires more than one bearing to perform this testing. If two bearings are required, the manufacturer is responsible for conditioning additional bearings to satisfy the requirements of the Environmental Aging section (Test 1).

Each tested bearing will be evaluated for the following performance requirements:

1. The effective stiffness (k_{eff}) shall be within the range of $\pm 10\%$ of the required value (Figure 1, page 9).
2. The slope of the loading curve (K_r) shall be equal to, or greater than, 90% of the required value (Figure 1).
3. The average value of energy dissipated per cycle (EDC) shall be equal to or greater than the required value (Figure 1).

Values for the above noted force-deflection characteristics are given in the contract plans. The combined compression plus shear test can be performed simultaneously with the Lateral Load testing (Test 5).

E. **Lateral Load Testing:** The bearing assembly that has passed the above tests shall be subjected to the seismic testing requirements of the AASHTO 1998 Guide Specifications for Seismic Isolation Design, Section 13. The test results should be within tolerances set forth in Section 13. The vertical load applied to the bearing during this testing shall be dead load plus the live load.

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2. MATERIAL REQUIREMENTS: (cont'd)

2.19 (cont'd)

E. Lateral Load Testing: (cont'd)

Failure of an elastomeric device is defined as when;

1. The elastomeric material visually tears or
2. Delaminates, or a damping feature cracks or breaks and the lateral shear stiffness degrades significantly, or
3. Additional lateral deflection reduces the lateral shear load.

Failure of a friction energy dissipater occurs when;

1. There is a sudden unexpected increase/decrease in stiffness or
2. A significant change in performance occurs.

For bearing systems utilizing the nonlinearity of the elastomer, submit tests on the bearings that give the 1st and 10th cycle test results for the shear modulus versus shear strain. Submit calculations based on 10th cycle data that give displacements under the maximum of the AASHTO lateral service load groups, from the AASHTO Standard Specifications for Highway Bridges, as shown on the contract plans. All test data (prototype and quality control) shall be gathered after the bearing has been "scrapped" (pre-loaded) for 3 complete cycles to at least 150% shear strain.

F. Dynamic Performance Characteristics at Temperature Extremes: Purpose: To assess the effects of extreme temperature on the performance characteristics, specifically, stiffness, damping, and EDC.

1. Procedure: With the full dead load and live load applied (for load bearing isolators), three fully reversed cycles of the design displacement are applied at a frequency corresponding to a 2.0 second period at the upper and lower temperature extremes specified by the manufacturer. The temperature range of interest for this evaluation program is from -29°F to 120°F. Further test procedures for handling hot or cold test articles are as follows:

- a. The test article and mounting hardware is placed in the heating/cooling unit for 48 hours.
- b. The test article and mounting hardware is installed in the test rig within 75 minutes after being removed from the thermal chamber; and;
- c. Testing is performed within five minutes after installation is complete.

Criteria: The bearing is considered acceptable if :

2. The variation in stiffness from ambient temperature (68°F) to extremes (-15°F and 120°F) shall not exceed 30%.
3. The variation in EDC from ambient temperature (68°F) to extremes (-15°F and 120°F) shall not exceed 15%.

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2. MATERIAL REQUIREMENTS: (cont'd)

- 2.20 **Documentation:** The bearing manufacturer shall submit certified test results to the D.C.E.S. that indicate all bearings and/or bearing components meet the following requirements of this specification:

<u>Specification Requirement</u>	<u>Material</u>
Low Temperature Properties	Elastomer
Ozone Resistance	Elastomer
Shear Modulus	Elastomer
Purity of Lead	Lead
Proof Test	Bearing
Combined Compression plus Shear Test	Bearing
Environmental Aging Test	Bearing
Temperature Test	Bearing
Lateral Load Test	Bearing

Bearing Testing Frequency

Test	Number of Bearings to be Tested⁴
Environmental Aging	1 per lot
Temperature Testing	1 per lot ¹
Proof Test	1 per lot ²
Combined Compression plus shear	2 per lot ³
Lateral Load Testing	2 per lot ³
Dynamic Performance Characteristics at Temperature Extremes	1 per lot ⁵

¹-This test is performed on the Environmental Aged Bearing

²-This test is not required if a rotation test is required

³-This test is performed on an Environmentally Aged Bearing and on a similar unaged bearing.

⁴-Tests performed on Environmentally Aged Bearings and the Environmental Aging test may be waived if the requirements of the special note are met.

⁵-Tests performed for Dynamic Performance Characteristics at Temperature Extremes test may be waived if the requirements of the special note are met.

In addition, certification shall be provided to the Director, Structures Design for the following:

1. Mill conformance certificate for all steels used.
2. Certificate of compliance for all non-ferrous metals.
3. Certificate of compliance for all bolts and cap screws supplied.
4. A certificate of compliance for the bearings executed by an officer of the manufacturer's company.

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Q_d = Characteristic strength
 F_y = Yield force
 F_{max} = Maximum force
 K_d = Post-elastic stiffness
 K_u = Elastic (unloading) stiffness
 K_{eff} = Effective stiffness
 Δ_{max} = Maximum bearing displacement
 EDC = Energy dissipated per cycle = Area of hysteresis loop (Area enclosed by ABCD)

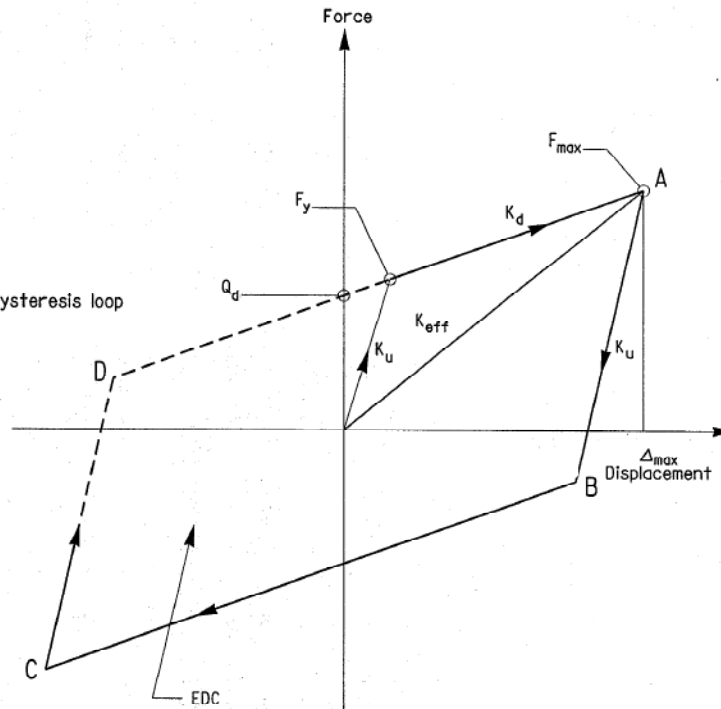


FIGURE 1

An Idealized force - displacement (hysteretic) loop of an isolation bearing

3. BASIS OF ACCEPTANCE.

3.01 Bearings will be approved for shipment to the project site at the manufacturing facility, in project lot quantities, or portions thereof, in accordance with the procedural directives of the Materials Bureau.

A. RE: Testing for Dynamic Performance Characteristics at Temperature Extremes

1. The Dynamic Performance Characteristics at Temperature Extremes Test is one of several quality assurance tests done on base isolation bearing systems under 25716-09.
2. The Department will waive the Dynamic Performance Characteristics at Temperature Extremes Test for base isolation bearing systems if bearing manufacturers provides written certification that the bearing design to be used has been previously tested for Dynamic Performance Characteristics at Temperature Extremes and the results of this testing shall satisfy the following performance criteria: 1) the variation in stiffness (K_{eff}) from ambient temperature (68°F) to extremes (-15°F and 120°F) shall not exceed 30%. 2) The variation in energy dissipation per cycle (EDC) from ambient temperature (68°F) to extremes (-15°F and 120°F) shall not exceed 15%. Bearings tested and determined satisfactory under Highway Innovative Technology Evaluation Center's (HITEC¹) evaluation of seismic isolation and energy dissipation devices (Test #7) will satisfy this requirement.

SPECIAL NOTE: 25716-09 BASE ISOLATION BEARING SYSTEM

3. BASIS OF ACCEPTANCE. (cont'd)

3.01 (cont'd)

3. Previous evaluation and acceptance of the Dynamic Performance Characteristics at Temperature Extremes Test by the Director, Materials Bureau will also be a basis to waive this test, provided the general design of the base isolation bearing system remains unchanged. Proof of acceptance shall be submitted to NYSTA.
4. The Authority will **consider** waiving the Dynamic Performance Characteristics at Temperature Extremes Test if a base isolation bearing system was previously tested and evaluated by other laboratories. Factors used to evaluate other laboratories include which laboratory performed the test, the background and experience of individuals performing the test, the test method used, and who witnessed, documented, and coordinated the testing. Evidence of Dynamic Performance Characteristics at Temperature Extremes testing by other laboratories will be submitted to the NYSTA for evaluation.
5. Written documentation that base isolation bearings have been tested for Dynamic Performance Characteristics at Temperature Extremes shall be submitted to the NYSTA for evaluation for each bearing design on each Authority contract. A written decision concerning the need to complete Dynamic Performance Characteristics at Temperature Extremes testing for a specific contract will be issued by the NYSTA within 7 calendar days. The request to waive Dynamic Performance Characteristics at Temperature Extremes testing shall be made prior to the start of other quality assurance testing.
6. If a bearing manufacturer has not completed Dynamic Performance Characteristics at Temperature Extremes testing on a specific bearing design, or their submitted testing documentation is found to be unacceptable by the NYSTA, the bearing manufacturer shall complete the Dynamic Performance Characteristics at Temperature Extremes test in addition to all other required bearing testing.

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B. RE: Environmental Aging Test

1. The Environmental Aging Test is one of several quality assurance tests done on base isolation bearing systems under 25716-09. Environmental Aging is a time consuming test requiring the evaluation of bearings subjected to a salt and fog chamber environment for 42 days.

SPECIAL NOTE: 25716-09 BASE ISOLATION BEARING SYSTEM

3. BASIS OF ACCEPTANCE. (cont'd)

3.01 (cont'd)

2. The Authority will waive the Environmental Aging Test for Base Isolation Bearing Systems if bearing manufacturers provide written documentation that the bearing design to be used has been previously tested for Environmental Aging using ASTM B117 "Practice for Operating Salt Spray (Fog) Testing Apparatus" and this testing did not diminish the bearing's performance for effective stiffness (Keff) and energy dissipation per cycle (EDC). Bearings tested and determined satisfactory under Highway Innovative Technology Evaluation Center's (HITEC¹) evaluation of seismic isolation and energy dissipation devices (Test #6) will satisfy this requirement.
3. Previous evaluation and acceptance of the Environmental Aging Test in accordance with ASTM B117 by the Director, Materials Bureau will also be a basis to waive this test, provided the general design of the base isolation bearing system remains unchanged. Proof of acceptance shall be submitted to NYSTA.
4. The Authority will **consider** waiving the Environmental Aging Test if a base isolation bearing system was previously tested and evaluated by other laboratories. Factors used to evaluate other laboratories include which laboratory performed the test, the background and experience of individuals performing the test, the test method used, and who witnessed, documented, and coordinated the testing. Evidence of Environmental Aging testing by other laboratories will be submitted to the NYSTA for evaluation.
5. Written documentation that seismic bearings have been tested for Environmental Aging in a salt chamber in accordance with ASTM B117 shall be submitted to the NYSTA for evaluation for each bearing design on each Authority contract. A written decision concerning the need to complete Environmental Aging testing for a specific contract will be issued by the NYSTA within 7 calendar days. The request to waive environmental testing shall be made prior to the start of other quality assurance testing.
6. If a bearing manufacturer has not completed Environmental Aging testing on a specific bearing design, or their submitted testing documentation is found to be unacceptable by the NYSTA, the bearing manufacturer shall complete the 42 day Environmental Aging tests in addition to all other required bearing testing.

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