# CONTRACT SPECIFICATIONS - SEISMIC ISOLATION BEARINGS

## 1.0 DESIGN

### 1.1 Scope of Work

**1.1.1** This work shall consist of furnishing Isolation Bearings and installing Isolation Bearing Assemblies at the locations shown on the plans in accordance with these specifications and the *AASHTO LRFD Bridge Design and Construction Specifications*. Isolation bearing assemblies shall include seismic isolation bearings (isolators), distribution plates, distribution pads, and connection hardware.

**1.1.2** All bearings shall be sliding isolators. Elastomeric isolators will not be allowed.

### 1.2 Qualification Requirements

Isolators shall be subject to the qualification requirements for acceptance listed below.

**1.2.1** Isolation bearings shall be designed and constructed in accordance with *AASHTO LRFD Bridge Design Specifications 5$^{th}$ Edition, Section 14, and Construction Specifications 3$^{rd}$ Edition, Section 18* for non-seismic loading conditions. Seismic design, performance, and testing shall be assessed in accordance with the *AASHTO Guide Specifications for Seismic Isolation Design; 3$^{rd}$ Edition*.

**1.2.2** Isolation bearings shall display the characteristics shown in Table 1.3.1A. Seismic forces and displacements for all structures generated using these bearing properties shall be substantiated using analyses per AASHTO LRFD specifications. Analytical results for each structure shall be submitted to the Engineer for approval at the time of the preconstruction conference. Conformance of alternate isolation systems shall be substantiated analytically, at no cost to the owner, using the same methodology as the system shown in the contract plans. The analysis model shall be an accurate representation of each bridge structure, the soil and foundations, and the sliding isolation system.

**1.2.3** The supplier shall show previous history in the design and fabrication of sliding isolation bearings. Documentation showing a minimum of five bridge installations of sliding isolation bearings shall be provided to the engineer.

**1.2.4** Sliding bearings shall be stiff in shear, i.e. negligible shear displacement shall occur within the load bearing element.

**1.2.5** Isolation system shall be fully test verified utilizing shake table testing. Documentation of the testing shall be provided as well as verification from a member of the test team.

**1.2.6** Energy dissipation shall not be achieved via the material degradation of a structural element in the bearing system. A structural element in the bearing system is defined as the element resisting AASHTO service loads (WS, WL, CE, BR, etc.)

**1.2.7** The structural element shall be designed to provide adequate resistance to service loads independent of the rate of load application. The structural element should be able to resist static design lateral loads for a period of 12 hours without creep or excessive displacement.

**1.2.8** Prototype testing results and calculations shall be provided to the engineer showing conformance with the *AASHTO Guide Specifications for Seismic Isolation Design*. Specific and detailed information relating expected changes in system properties over time shall be submitted to the engineer.

**1.2.9** Isolation bearings shall be maintenance free for seismic, post-seismic and non-seismic conditions.

**1.2.10** Isolation bearing manufacturers shall have successfully completed the HITEC test program and submit a technical evaluation report prepared by HITEC.

**1.2.11** The vertical load support element shall be designed for rotational fatigue at the design vertical load. Rotational loading shall be static dead load rotation plus cyclic live load rotation. Bearings that rely upon the lateral confinement of elastomer to sustain the vertical load shall include ½ the design horizontal load. Rotational fatigue test results shall be provided to the Engineer.

**1.2.12** Each bidder is required to identify their intended isolation system supplier at the time of bid. Within sixty working days following the contract award, the isolation system supplier shall submit prototype test data for review by the Engineer.

**1.2.13** Systems utilizing non-linearity of an elastomer shall utilize the "run in", (10 cycles minimum) shear modulus for service load resistance.

**1.2.14** Systems utilizing lead or other creep susceptible elements shall utilize their static lateral load (12 hour) yield strength for service load resistance.

## 1.3 Performance Standards

### 1.3.1 Design Standards

The use of base isolators can substantially reduce forces transferred to the substructures. The substructures on this project have been designed based on the seismic forces generated using isolators with the characteristics in Table 1.3.1A. Maximum seismic forces and displacements resulting from analyses per Section 1.2.2 shall be submitted to the Engineer. Calculations demonstrating service load displacements and forces are less than those listed in Table 1.3.1B shall be submitted to the Engineer.

***Table 1.3.1A*** *- Bearing Characteristics - Seismic*

| Model | Location | Direction | D | $d_{max}$ | $K_{eff}$ | Kd | EDC |
|---|---|---|---|---|---|---|---|
| 100 | Abutments | Longit & Trans | 50 | 2.25 | 4.9 | 3.0 | 39.2 |
| 200 | Piers 1 & 4 | Longit & Trans | 103 | 2.25 | 6.9 | 3.0 | 78.8 |

| | |
|---|---|
| L | Longitudinal |
| T | Transverse |
| D | Maximum dead load, unfactored, plus seismic live load, if applicable (kips) |
| dmax | Maximum seismic displacement across isolator (in) |
| Keff | Effective stiffness *at dmax* (kips/in) |
| Kd | Post-elastic stiffness (kips/in) |
| EDC | Energy dissipation capacity per cycle *at dmax* (kips*in) |

***Table 1.3.1B*** *- Service Forces per Bearing*

| **Model** | **Location** | **$\delta_{RST}$** | **RST** | **δs** | **S** |
|---|---|---|---|---|---|
| 100 | Abutments | 0.7 | 4.9 | 0.5 | 3.5 |
| 200 | Piers 1 & 4 | 0.5 | 7.2 | 0.5 | 9.5 |

| | |
|---|---|
| $\delta_{RST}$ | Maximum displacement due to thermal, based on installation between 20°F and 70°F (in) |
| RST | Force resulting from maximum thermal displacement (kips) |
| δs | Displacement resulting from maximum service force (in) |
| S | Maximum service force per bearing (kips) |

**1.3.2** There shall be no increase or decrease in the overall height of any isolator due to thermal displacements which results in a change of more than 0.125 inches in the pavement profile.

**1.3.3** Isolation bearing service load resistance shall not be accomplished by friction alone. Friction in conjunction with enclosed energy control devices is acceptable.

**1.3.4** Stability of isolation bearings shall be evaluated in accordance with Section 12.3 of the *AASHTO Guide Specifications for Seismic Isolation Design*. In computations pertaining to stability of reinforced elastomeric bearings, the bonded dimensions shall be used instead of the gross dimensions, and the lower bound shear modulus shall be used in lieu of the average shear modulus.

**1.4 Shop Drawings**

The Contractor shall submit shop drawings to the Engineer for approval, and shall have received said approval prior to the construction of the beam seats and fabrication of isolators. These drawings shall include, but not be limited to, the following information:

(1) Plan and elevation of each isolator size
(2) Complete details and sections showing all materials, with ASTM or other designations, incorporated in the isolators.
(3) Vertical and horizontal load and movement capacities.
(4) All bearing connection details.

The shop drawings and design calculations shall be sealed by a professional engineer employed by the bearing supplier with at least 5 years of documented history of isolation bearing design experience.

**2.0 CONSTRUCTION**

**2.1** All materials shall be new and unused, with no reclaimed material incorporated in the finished bearing. All materials shall meet the requirements of Section 16.2 of the *AASHTO Guide Specifications for Seismic Isolation Design*.

**2.2** All steel plates, except stainless steel, of the bearing shall conform to the requirements of the type of steel designated on the Contract Plans.

**2.3** Stainless steel shall conform to the requirements of ASTM A240 - Type 304. Higher grades of stainless are permissible. Stainless steel in contact with PTFE shall be polished to a No. 8 bright mirror finish. The minimum thickness of the stainless steel shall be 12 gage.

**2.4** Polytetrafluoroethylene (PTFE) sheet shall be manufactured from pure virgin (not reprocessed) PTFE resin. PTFE sheet shall meet the applicable material requirements of *AASHTO LRFD Bridge Construction Specifications, Section 18.8.2*. Alternative friction materials may be considered for use on both the guide bars and horizontal sliding surface.

**2.5 Fabrication Details**

**2.5.1** The Contractor shall provide the Engineer with written notification prior to the start of bearing fabrication. This notification shall include all of the information shown on the shop drawings which are required by Sections 1.2, 1.3 and 1.4. The bearing fabricator shall be certified by the American Institute of Steel Construction (AISC) for Simple Steel Bridges Category.

**2.5.2** All steel surfaces exposed to the atmosphere, except stainless steel surfaces and metal surfaces to be welded, shall be shop coated in accordance with the Contract Plans. Prior to coating, the exposed steel surfaces shall be cleaned in accordance with the recommendations of the coating's manufacturer.

**2.5.3** Stainless steel sheet shall be attached to its steel substrate with a continuous seal weld.

**2.5.4** All welding shall conform to, and all welders shall be qualified in accordance with the requirements of the American Welding Society (AWS).

**2.5.5** Except as noted, all bearing fabrication tolerances shall be in accordance with *AASHTO LRFD Bridge Construction Specifications, Table 18.1.4.2-1*.

**2.5.6** Every bearing shall have an individual bearing serial number indelibly marked with ink.

**2.5.7** After assembly, including sole plates and masonry plates as applicable, bearing components shall be held together with steel strapping, or other means to prevent disassembly until the time of installation.

## 2.6 Production Bearing Testing

**2.6.1** Quality Control testing shall be performed in accordance with *AASHTO Guide Specifications for Seismic Isolation Design, Section 17.2*. Combined compression and shear tests shall be performed at the vertical load, D, as defined in Table 1.3.1A, and at a cyclic frequency no less than 0.3 Hz. If testing equipment with adequate combined force and velocity capability is not available to meet project needs, then testing production bearing components may be acceptable. Component test data shall be mathematically combined to determine bearing and group compliance with *AASHTO Guide Specifications for Seismic Isolation Design, Table 15.2.2-1.*

**2.6.2** Each bearing shall be visually examined both during and after testing. Any resultant defects, such as bond failure, physical destruction or cold flow of PTFE to the point of debonding, shall be cause for rejection. Defects such as permanently extruded or severely deformed elastomer or cracked steel shall also be cause for rejection. Minor deformations in the elastomer are allowed.

**2.6.3** One production bearing shall be subjected to the "Low Temperature Test" in the *AASHTO Guide Specifications for Seismic Isolation Design, Section 13.1.1* for Zone C. The supplier shall show that the lateral forces transmitted into the substructure at the low temperature during an earthquake are no more than 10% greater than the seismic forces generated using the bearing properties listed in Table 1.3.1A.

# 3.0 INSTALLATION

**3.1** Bearings delivered to the bridge site shall be stored under cover on a platform above the ground surface. Bearings shall be protected at all times from injury. When placed, bearings shall be dry, clean, and free from dirt, oil, grease, or other foreign substances.

**3.2** Bearing devices shall not be disassembled unless otherwise permitted by the Engineer or Manufacturer.

**3.3** Bearings shall be installed in accordance with the alignment plan and installation scheme as shown in the Contract Plans. Upon final installation of the bearings, the Engineer shall inspect the bearing components to assure that they are level and parallel to with ± 0.005 radians. Any deviations in excess of the allowed tolerances shall be corrected.

**3.4** Bearings assemblies shall be handled by their bottom surfaces only, unless specially designed lifting brackets are used. Do not lift bearings by their tops, sides and/or shipping bands. Lifting brackets shall be approved by the bearing supplier prior to use.

**3.5** Caution shall be taken to ensure that the steel temperature directly adjacent to the polyether urethane elements does not exceed 225°F. The polyether urethane elements must not be exposed to direct flame or sparks.

## 4.0 CERTIFICATE OF COMPLIANCE

**4.1** In addition to records of test results, the Contractor's isolator supplier shall submit Certificates of Compliance for the isolators indicating the materials, fabrication, testing, and installation are as specified herein.

## 5.0 PAYMENT

**5.1** If a portion or all of the isolation bearings are either fabricated or tested at a site more than 300 airline miles from all NY State airports, additional shop inspection expenses will be sustained by the Owner. Payment to the Contractor for furnishing the isolation bearings will be reduced $5,000 for any fabrication or testing site located more than 300 airline miles from all NY State airports, or in the case where the fabrication or testing site is located more than 3000 airline miles from all NY State airports, payment will be reduced $15,000.