Technical Specification

Transport and Main Roads Specifications
MRTS81 Bridge Bearings

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Queensland Government

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1 Introduction

This Technical Specification applies to the supply of bearings for support of bridge superstructures for normal installations. For aggressive installations, stainless steel bearings, in accordance with MRTS81A *Stainless Steel Bridge Bearings*, shall be used.

This Technical Specification shall be read in conjunction with MRTS01 *Introduction to Technical Specifications*, MRTS50 *Specific Quality System Requirements* and other Technical Specifications as appropriate.

This Technical Specification forms part of the Transport and Main Roads Specifications Manual.

2 Definition of terms

The terms used in this Technical Specification shall be as defined in Clause 2 of MRTS01. In addition, terms listed in Table 2 are applicable to this Technical Specification.

Table 2 – Definition of terms applicable to MRTS81

Term	Definition
Batch	A group of bearings with the same nominal size and properties (that is, the same Part No. as per AS 5100.4). A batch can include bearings for several bridges in one project, but will not carry across several projects.
Dummy bearing	A pot bearing consisting of identical properties (size and load characteristics), manufactured to assist with the shear test and co-efficient of friction test.
Contractor	The entity purchasing the bearings from the bearing supplier, usually the bridge construction contractor.
Laminated bearing	An elastomeric bearing with two or more metal plates bonded into the elastomer.
Pair	Any two adjacent bearings in the ordered list of compression values.
Plain bearing	A bearing made up of a single unbonded layer of elastomer.
Pot bearing	A bearing that carries vertical load by compression of an elastomeric disc confined in a steel cylinder and which accommodates rotation by angular deformation of the disc.
Strip bearing	A plain bearing pad in which the length is more than 10 times the width.

3 Referenced documents

Table 3 lists documents referenced in this Technical Specification.

Table 3 – Referenced documents

Reference	Title
AS 1214	*Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series)*
AS 5100.4:2004	*Bridge design – Bearings and deck joints*
AS/NZS 1252	*High strength steel bolts with associated nuts and washers for structural engineering*
AS/NZS 3678	*Structural steel - Hot-rolled plates, floorplates and slabs*
AS/NZS 3679.1	*Structural steel Part 1: Hot-rolled bars and sections*

Reference	Title
AS/NZS 4680	*Hot-dip galvanized (zinc) coatings on fabricated ferrous articles*
ASTM A240M	*Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels and for General Applications*
ASTM A480M	*Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip*
ASTM D3294	*Standard Specification for PTFE Resin Molded Sheet and Molded Basic Shapes*
ASTM D4745	*Standard Classification System and Basis for Specification for Filled Polytetrafluoroethylene (PTFE) Molding and Extrusion Materials using ASTM Methods*
BS 6564-3	*Polytetrafluoroethylene (PTFE) materials and products. Specification for E glass fibre filled polytetrafluoroethylene*
ISO 13000-1	*Plastics – Polytetrafluoroethylene (PTFE) semi-finished products – Part 1: Requirements and designation*
MRTS01	*Introduction to Technical Specifications*
MRTS50	*Specific Quality System Requirements*
MRTS81A	*Stainless Steel Bridge Bearings*

4 Standard test methods

The standard test methods stated in Table 4 shall be used in this Technical Specification.

Further details of test numbers and test descriptions are given in Clause 4 of MRTS01.

All tests are to be performed in Australia, witnessed by the Administrator. Testing shall be performed and reported by a NATA-accredited laboratory with suitable scope of accreditation.

All test results, including the results of bearings which are non-compliant, shall be reported.

Table 4 – Standard test method

Property to be tested	Method No.
Standard Test Methods for Cone Penetration of Lubricating Grease	ASTM D217
Standard Test Method for Evaporation Loss of Lubricating Greases and Oils	ASTM D972
Adhesives. Determination of peel resistance of adhesive bonds. Floating roller methods.	BS EN 1464
Appendix A	Single Unbonded Layer Bearing Test Method
AS 5100.4, Clause B4.1	AS 5100.4 Testing of Elastomer
Appendix B	Laminated Elastomeric Bearing Test Method
AS 5100.4, Appendix D	AS 5100.4 Testing of Laminated Elastomeric Bearings

Property to be tested	Method No.
Appendix D	Pot Bearing Test Method
AS 5100.4, Clause 13.2	AS 5100.4 Pot Bearings – Load Testing

5 Quality system requirements

5.1 Hold Points, Witness Points and Milestones

General requirements for Hold Points, Witness Points and Milestones are specified in Clause 5.2 of MRTS01.

The Hold Points, Witness Points and Milestones applicable to this Technical Specification are summarised in Table 5.1.

Table 5.1 – Hold Points, Witness Points and Milestones

Clause	Hold Points	Witness Points	Milestones
5.2	1. Completion of Annexure MRTS81.1		
6.2.1.1	2. Working loads for testing of single unbonded layer elastomeric bearings		Notification of testing – single unbonded layer elastomeric bearings (7 working days)
6.2.1.2		1. Testing machine calibration certificate	
6.2.2	3. NATA-certified report		
6.3.1.1	4. Design requirements for testing laminated elastomeric bearings		Notification of testing – laminated elastomeric bearings (7 working days)
6.3.1.2		2. Testing machine calibration certificate	
6.3.2	5. NATA-certified report		
7.1	6. Design of guided sliding for pot bearings 7. Suitability of proposed pot bearings		
7.2.5	8. Alternative internal seal design		
7.5.1	9. Design requirements for testing pot bearings		Notification of testing – pot bearings (7 working days)
7.5.2		3. Testing machine calibration certificate	
7.5.6	10.NATA-certified report		

5.2 Annexure MRTS81.1

The designer shall complete the Annexure for this Technical Specification. **Hold Point 1** This document shall be included with the engineering documents of the Contractor.

It is the designer's responsibility to complete Annexure MRTS81.1 for every bearing type / size used in the project. This includes full details of all half bearings.

6 Elastomeric bearings

6.1 General

Elastomeric bearings shall conform to the requirements stated in AS 5100.4.

The specific requirements of elastomeric bearings for structures to be constructed under the Contract shall be detailed in Clause 1 of Annexure MRTS81.1.

6.2 Single unbonded layer bearings

Single unbonded layer bearings (plain pads or strips) shall be manufactured from an elastomer of natural or synthetic rubber as per AS 5100.4, Clause 12.2. The compound, when manufactured, shall be uniform and homogeneous throughout.

Properties of the elastomer shall comply with Category 1 tests stated in AS 5100.4.

6.2.1 Testing of single unbonded layer bearings

6.2.1.1 General

Bearings shall be tested in accordance with Clause 4 and Appendix A. The Contractor shall give the Administrator seven working days' notice for the date and the location of the testing of the bearings. **Milestone** The cost of testing shall be borne by the Contractor.

Prior to testing, the Contractor shall provide the bearing manufacturer, the testing facility and the Administrator a copy of the Annexure. **Hold Point 2** Failure to supply the Annexure MRTS81.1 shall result in the bearings being unable to be tested.

A minimum of one representative bearing selected from every 10 identical bearings from the same batch, or part thereof, shall be load tested.

Tolerances for dimensions of single unbonded layer bearings are set out in Table 6.2.1.1.

Table 6.2.1.1 – Tolerances for single unbonded layer bearings

Dimension	Tolerance (mm)
Plan dimensions	± 3
Bearing thickness	± 2
Out of parallel between top and bottom surfaces	1

6.2.1.2 Test machines

The accuracy of the load testing machine is to be Class A for the range of the test. The test machine shall be calibrated at least every 24 months. **Witness Point 1**

6.2.1.3 Acceptance criteria for single unbonded layer bearings

The representative sample bearings shall satisfy the following:

a) bearings (loaded or unloaded) shall not show surface splits, indentations or evidence of incomplete vulcanising of the rubber compound

b) the bearing shall conform to the properties specified in Clause B4.1 of AS 5100.4, and

c) dimensional tolerances of Table 6.2.1.1

If any one of the representative bearings fail to meet the acceptance criteria requirements, then all the bearings in the batch shall be tested in accordance with Appendix A of this Technical Specification. Any non-conforming bearings shall be rejected and replaced with new bearings which conform to the acceptance criteria stated above. **Nonconformance**

6.2.2 Reporting of findings

At least 10 working days prior to delivery of the bearings to site, the Contractor shall provide a NATA-certified report to the Administrator detailing all test results and parameters including the following: **Hold Point 3**

a) the testing load

b) dimensions of the tested bearings

c) durometer readings of tested bearings

d) a photograph of one in five tested bearings

e) a photograph of all visible failure types as stated in Clause 6.2.1.3 (a), and

f) any observations noted during the testing process.

This requirement means all test results, including the results of all non-compliant bearings, shall be reported.

6.3 Laminated elastomeric bearings

Laminated elastomeric bearings shall be manufactured to the requirements specified in AS 5100.4, including tolerances.

6.3.1 Testing of laminated elastomeric bearings

6.3.1.1 General

Bearings shall be tested in accordance with Clause 4 and the method set out in Appendix B. The Contractor shall give the Administrator seven working days' notice for the date and the location of the testing of the bearings. **Milestone** The cost of testing shall be borne by the Contractor.

Each bearing shall be stamped with a unique number and the manufacture's name.

Prior to testing, the Contractor shall provide the bearing manufacturer, the testing facility, a copy of the Annexure. **Hold Point 4** Failure to supply the Annexure MRTS81.1 shall result in the bearings being unable to be tested.

6.3.1.2 Test machines

The accuracy of the load testing machine is to be Class A for the range of the test. The test machine shall be calibrated at least every 24 months. **Witness Point 2** The accuracy of the lateral load shall be within 1% of error.

6.3.1.3 Tolerances on compressive stiffness

The permissible tolerance on compressive stiffness of completed laminated elastomeric bearings shall be ± 25% of the design value.

6.3.1.4 Acceptance criteria for laminated elastomeric bearings

The tested bearings shall satisfy the following:

a) the bearings (loaded or unloaded) shall not show misaligned plates, bond failure and surface defects

b) the bearing shall conform to the properties specified in AS 5100.4, Appendix A

c) durometer hardness meets the requirements of AS 5100.4

d) compressive stiffness tolerance meets the requirements of Clause 6.3.1.3

e) the bearing quality meets the requirements of AS 5100.4, Appendix D, and

f) shear stiffness tolerance meets the requirements of AS 5100.4

If any one of the representative bearings fail to meet the acceptance criteria requirements, then all the bearings in the batch shall be tested in accordance with Appendix B of this Technical Specification. Any non-conforming bearings shall be rejected and replaced with new bearings which conform to the requirements of AS 5100.4 and this Technical Specification. **Nonconformance**

6.3.2 Reporting of findings

At least 10 working days prior to delivery of the bearings to site, the Contractor shall provide a NATA-certified report to the Administrator detailing all test results and parameters including the following: **Hold Point 5**

a) the testing loads

b) durometer readings of tested bearings

c) compressive stiffness values

d) shear stiffness values

e) a photograph of one in 10 bearing tested in compression

f) a photograph of one in five bearing tested in shear

g) a photograph of all visible failure types as stated in Clause 6.3.1.4 (a), and

h) any observations noted during the testing process

> This requirement means all test results, including the results of all non-compliant bearings, shall be reported.

6.4 Care of bearings

Bearings shall, at all times, be handled carefully and protected from direct sunlight and from extremes of heat and cold. Bearings shall be stored under cover and, after installation, they shall be adequately protected from the elements until the superstructure has been placed. Bearing shall not be located in the substructure where water may pool.

6.5 Anchorage details

Any details such as dowel pins or sockets, shown in the drawings, as necessary, to provide anchorage in any direction, shall be incorporated in the bearing manufacture, with true alignment to the bearing surface.

7 Pot bearings

7.1 General

The type and dimensions of the pot bearings for structures to be constructed under the Contract shall be as detailed on the drawings and in Clause 2 of Annexure MRTS81.1.

Bearings shall be supplied by a manufacturer experienced in the design and construction of such bearings. Proprietary bearings shall be fitted with a name plate indicating the manufacturer's name, bearing model or type, year of manufacture, unique number ID and maximum vertical and horizontal loads. A movement gauge shall be fitted indicating the full horizontal movement range of the bearing.

In the case of guided sliding pot bearing, it shall be designed with two parallel guide bars located outside the cylinder. Pot bearing with a single guide bar at the centre of the cylinder shall only be considered for pot bearings with a design vertical load of greater than 15,000 kN. **Hold Point 6**

> The formulas for calculating the design of a pot bearing in AS 5100.4 do not take into account loss of area in the PTFE due to an internal guide bar. This needs to be taken into consideration when designing a pot bearing with a single guide bar.

All bearings shall be fitted with readily removable keep plates or similar to firmly hold components together during transport and erection. Keep plates shall be removed after installation is completed. Before ordering pot bearings, the Contractor shall submit to the Administrator detailed working drawings of the bearings proposed to be used together with evidence as to the satisfactory performance in service of similar bearings. Manufacturing tolerances shall be included on the drawings. The Contractor shall allow 14 days for a direction from the Administrator as to suitability of the proposed bearings. **Hold Point 7**

7.2 Materials

7.2.1 Stainless steel plate sliding surface

Stainless steel plate sliding surfaces shall be made of austenitic stainless steel Grade 316L with mirror finish using automated machinery complying with the requirements of ASTM A240M, having a surface finish at any point not rougher than 0.4 µm Ra in two directions at right angles.

7.2.2 Polytetrafluoroethylene

The resin used in the manufacture of polytetrafluoroethylene (PTFE) sheets shall be 100% virgin PTFE, complying with ISO 13000-1 or AS 5100.4 as appropriate.

The following shall apply for PTFE to be permanently lubricated:

a) The PTFE shall be dimpled or grooved to form lubrication reservoirs in the PTFE surface.

b) The lubrication reservoirs shall cover between 10% and 30% of the total plan area of the PTFE.

c) The volume of the reservoirs shall form between 3% and 20% of the total volume of the PTFE or the unconfined portion if the PTFE is recessed.

d) The depth of the reservoirs shall not be greater than half the thickness of the PTFE or the height of the PTFE above the backing plate if the PTFE is recessed, and

e) With the exception of uplift bearings, the lubrication reservoirs shall be filled with long-life silicone grease under factory conditions. After filling the lubrication reservoirs, the contact surface of the PTFE and the stainless steel shall not be allowed to separate at any time.

The PTFE pad for sliding bearings shall have a minimum thickness of 6 mm for pads with any dimension larger than 650 mm and 4 mm for smaller dimensions. The pad shall be restrained by adhesive bonding and it shall recess into the backing material to a depth of half the thickness of the PTFE to prevent its extrusion.

The lubricant used shall meet the requirements of Clause 7.2.6 of this Technical Specification.

7.2.3 Pot and piston

The cylinder and base plate of the pot shall be fabricated from a single piece of structural steel. The welding of a separate base plate to the cylinder shall be approved if supporting design calculations and experimental evidence are submitted showing that the strength of the welded component is equivalent to that made from a single piece of steel.

The piston shall be machine-cut from a single piece of steel.

The piston rim shall have a nominal diameter not less than the internal diameter of the pot, minus 1.0 mm. The vertical contact rim of the piston, which bears against the cylinder wall, shall be flat in cross-section only where serviceability (SLS) rotation angle is less than or equal to 0.025 radians and where its thickness is less than or equal to 15 mm. Where the piston rim thickness is greater than 15 mm or if the SLS rotation is greater than 0.025 radians, the vertical contact rim shall be bevelled or curved.

The vertical flatness of the internal surfaces of the bearing shall be finished with not more than 0.005 times the nominal vertical dimension and to a maximum surface roughness of 6.3 µm Ra.

The gap between the pot and the piston shall be sealed against dust and moisture using either a small compression seal supplied and installed using a neutral cure silicon sealant with at least 50% movement accommodation factor. The seal shall remain effective and undamaged at the maximum SLS rotation.

Where structural steel attachment plates are used, manufacture of such plates shall be from structural steel conforming to AS/NZS 3678 and/or AS/NZS 3679.1.

7.2.4 Guide bars

Each guide bar shall be manufactured from a single piece of steel. Guide bars shall be recessed into the sliding plate and shall be able to withstand the lateral forces shown in the drawings. The two contact surfaces of the guide bars shall be parallel and flat to within 0.001 of the nominal dimension.

The maximum gap between a guide and its corresponding sliding surface shall not exceed 3 mm when the other guide bar is in full contact with its corresponding sliding surface.

7.2.5 Internal seal

The internal seal shall consist of one or more sealing rings to enable the elastomeric pad to perform as a viscous fluid under pressure permitting the bearing's piston to rotate.

Single sealing chain made up with hard plastic material for internal sealing may be used as an alternative to the sealing rings. However, the performance of such alternative sealing arrangements shall be proved equal or better compared to the sealing rings.

Alternate internal seal designs shall be submitted to the Deputy Chief Engineer (Structures) for approval prior to the manufacture of the bearings. **Hold Point 8**

7.2.6 Lubricant

Lubricant shall be silicone compounds used for filling the lubrication reservoirs in the dimpled face of the PTFE sliding pad and for lubrication of the top and bottom surfaces of the elastomeric disc. It shall retain its consistency at room temperature over a temperature range of - 40°C to + 200°C. The lubricant shall be compatible with all components in contact with it. It shall also comply with the requirements of Table 7.2.6.

Table 7.2.6 – Properties of lubricant

Properties	Requirements	Method of Test
Penetration worked 60 stroke	< 260	ASTM D217
Evaporation – 24 h at 200°C	< 2%	ASTM D972

7.2.7 Elastomeric disc

Each elastomeric disc shall be made from a single piece of elastomer, individually moulded or machine-cut from the moulded rubber slab. No discs shall be layered or stacked.

The disc shall be lubricated with a silicone compound complying with the requirements of Clause 7.2.6 of this Technical Specification.

In the unloaded condition the lateral clearance between the pot and the elastomeric disc shall not exceed 0.2% of the diameter of the pad or 0.5 mm, whichever is greater.

7.2.8 Holding-down bolts

Holding-down bolts and sockets for pot bearings shall be high strength, complying with the requirements of AS/NZS 1252 and shall be hot-dipped galvanised in accordance with AS 1214. Secondary coatings may be applied to achieve the design life.

7.3 Design requirements

7.3.1 Design life

All components of bearings shall be formulated to have a service life of not less than 100 years. For Exposure Classification B2 of AS 5100, bearings to this Technical Specification shall be used. For Exposure Classifications C and U of AS 5100, stainless steel pot bearings to MRTS81 *Bridge Bearings* shall be used.

7.3.2 Design loads

The Ultimate Design Load, Tested Axial Load and Combined Axial and Lateral Loads for each type of bearing shall be as stated in Clause 2 of Annexure MRTS81.1 or shown on the drawings.

7.3.3 Rotation

Bearings shall be capable of a rotation of at least 0.02 radians unless shown otherwise on the drawings. In the rotated position, no part of a bearing shall be in contact with the holding-down bolts, irrespective of the displacement of the sliding plate.

7.3.4 Movement

The required movement of sliding bearings is stated in Clause 2 of Annexure MRTS81.1 or shown on the drawings.

Directions of any presets shall be clearly identified by markings on the drawings.

7.3.5 Coefficient of friction

The coefficient of friction of sliding surfaces shall not exceed 0.04.

7.3.6 Centre of rotation

Shifts in the centre of pressure due to rotation, not considering uplift bearings, shall be limited so as not to exceed $\frac{D}{6}$ where *D* is the diameter of the elastomer. Calculations of rotational movement and the value of the centre of pressure shall be in accordance with the AS 5100.4.

7.3.7 Compressive stress on elastomer

The maximum mean compressive stress on the elastomer shall be 50 MPa. The initial compression of bearings under the design loads shall not exceed 1.5 mm at Serviceability Limit State and 3 mm at Ultimate Limit State.

7.3.8 Shape of elastomer

The thickness and formulation of the elastomer shall depend on the required rotational capacity and the smoothness of the inner surface of the pot.

However, in no case shall the total pad thickness be less than the larger of one-fifteenth of the diameter of the elastomeric pad or 10 mm.

7.3.9 Internal seal

The rings shall have a maximum surface roughness Ra of 6.3 µm.

7.3.10 Extrusion of elastomer

The elastomer shall be prevented from extrusion from the pot in accordance with the requirements of AS 5100.4.

7.3.11 Sliding surface

The horizontal sliding surface of sliding bearings shall consist of a confined pad of pure PTFE in contact with a polished stainless steel plate.

The stainless steel plate shall be not less than 1.5 mm thick and shall be secured to a backing plate by continuous edge welding, stainless steel countersunk screws or similar method.

The stainless steel plate shall be sufficiently large so that under the ultimate limit state movement range, the PTFE does not extend over the edge of the stainless steel plate.

The minimum thickness of unfilled (pure) PTFE shall be 4 mm, restrained by recessing it into a metal backing plate to a depth of half of the thickness of the PTFE. The PTFE shall normally be bonded under factory-controlled conditions to the backing plate. However, provided that the backing plate does not deform under load, and the recess satisfactorily resists the shearing forces, recessing only may be permitted.

For guides, filled PTFE to ASTM D4745 or BS 6564, or other approved low friction material sliding on polished stainless steel, shall be used. Filled PTFE shall consist of pure PTFE filled with no more than 25% glass filler. Test method and requirements shall comply with ASTM D3294.

Filled PTFE may be located by bonding only, provided that the bond to the backing plate is made with a proven adhesive and achieves a minimum peel strength of 4 N/mm width when tested in accordance with BS EN 1464. Alternatively, the filled PTFE may be fixed using countersunk fasteners.

The compressive stress on pure PTFE at the ultimate limit state shall not exceed the values stated in Table 7.3.11. Values for filled PTFE may be 50% greater where this can be verified by test data.

Table 7.3.11 – Compressive Stress on Pure PTFE

Load combination	Ultimate Compressive Stress (MPa)	
	Confined	
	Mean	Peak
Total loads	50	60

The overall clear dimension between runner bar sliding surfaces shall not be more than 3 mm greater than the overall width of the plate that slides between them.

Sliding bearings shall have the larger of the sliding surfaces positioned above the smaller, so that the sliding surfaces are kept clean. Where shown on the drawings, sliding bearings shall be fitted with a clearly visible movement scale and pointer.

Alternative materials for sliding elements with performances equal or better than PTFE may be submitted to Transport and Main Roads Structures for assessment. Applications of such materials are subjected to Deputy Chief Engineer's (Structures) approvals.

7.4 Protective coatings

After all welding and preliminary machining have been carried out, bearings shall be hot-dipped galvanised or hot zinc metal sprayed in accordance with the requirements of AS/NZS 4680.

After galvanising, the inside surfaces of the pot and side faces of the piston shall be machined or hand finished to the manufacturer's normal tolerance. All internal surfaces shall have a minimum 10 µm thickness of galvanising after machining. A full 1 mm difference on diameter between piston and cylinder shall be allowed. Machined recesses for the PTFE disc shall be finished to specified flatness. All threads shall be tapped clean.

7.5 Testing of pot bearings

7.5.1 General

Bearings shall be tested in accordance with the method set out in Clause 4 and Appendix D. The Contractor shall give the Administrator seven working days' notice for the date and the location of the testing of the bearings. **Milestone** The cost of the testing shall be borne by the Contractor.

Prior to testing, the Contractor shall provide the bearing manufacturer, the testing facility and the Administrator, the load requirements as per Clause 2 of Annexure MRTS81.1. **Hold Point 9** Failure to supply the Annexure MRTS81.1 shall result in the bearings being unable to be tested.

A minimum of one representative bearing selected from every five identical bearings, or part thereof, shall be load tested. Representative bearings shall be tested in accordance with the Clause 7.5.3, Clause 7.5.4 and Clause 7.5.5. The direction of loads or rotations applied in all tests shall replicate the in-service conditions and the bearings shall be tested as fabricated, excluding the seal between the pot and the piston.

7.5.2 Test machines

The accuracy of load testing machine shall be Class A for the range of the test. The test machine shall be calibrated a minimum of every 24 months. **Witness Point 3** The accuracy of the friction load and the lateral load shall be within 1% of error.

Resolution of peak load for friction load and lateral load shall be within 2% of error.

7.5.3 Geometrical testing

Geometrical parameters to be tested shall be flatness, surface roughness and clearances. These parameters shall comply with the requirements of Clause 7.2.

Flatness shall be measured in all directions using a precision straight edge sliding on the surface and feeler gauges.

7.5.4 Load tests

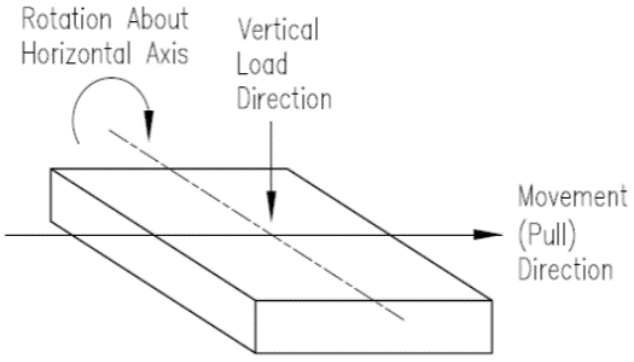
Required load tests for the different type of pot bearings are summarised in Table 7.5.4. The load test parameters shall be supplied by the Contractor in Clause 2 of Annexure MRTS81.1 as per Clause 7.5.1.

Table 7.5.4 – Load test requirements

Bearing type	Compression (Vertical)	Shear (Lateral)	Friction	Rotation	Visual
Fixed	Required	Required	Not Required	Required	Required
Free Sliding	Required	Not Required	Required	Required	Required
Guided Sliding	Required	Required	Required	Required	Required

Compression, shear and rotation loads shall be applied as the axis defined below in Figure 7.5.4.

Figure 7.5.4 – Definition of loads directions in bearing elevation



Note:

1. Axial load shall be applied through the vertical load direction, i.e., perpendicular to the bearing plan.
2. Lateral load shall be applied horizontally. In case of a guided sliding pot bearing, lateral load shall be applied to the direction perpendicular to the guide bar. Lateral load shall only be applied parallel to the guide bar in friction test, and
3. Rotation shall be applied about the horizontal plane.

7.5.4.1 Compression test

The compression test shall be carried out in accordance with Appendix D1.

7.5.4.2 Shear test

The shear test shall be carried out in accordance with Appendix D2.

7.5.4.3 Friction test

The co-efficient of friction shall be determined using a compression load corresponding to the factored down permanent vertical load on the bearing at an ambient air temperature between 5°C and 35°C. The friction and lateral load shall be applied horizontally.

The friction test shall be carried out in accordance with Appendix D3.

The maximum measured co-efficient of friction shall not be greater than the values specified in Table 7.5.4.3 for the relevant stresses on the PTFE.

Table 7.5.4.3 – Maximum allowable coefficient of friction for sliding surface

Bearing pressure	5 MPa	15 MPa	20 MPa	≥ 30 MPa
Coefficient of friction	0.04	0.025	0.02	0.015

Note:

1. Friction values for other bearing pressures shall be linearly interpolated from the above values.

7.5.4.4 Rotation test

The rotation test shall be carried out in accordance with Appendix D4. The direction of rotation is as shown on Figure 7.5.4.

7.5.5 Acceptance criteria for pot bearings

After testing, the bearing shall be visually inspected in accordance with Appendix D5. Critical bearing dimensions and tolerances shall be measured. If all the sampled bearings pass these requirements, the bearings shall be accepted.

The bearings tested shall be rejected if they exhibit any signs of damage (loaded or unloaded) visible to the naked eye such as, but not restricted to:

a) splitting, extrusion or permanent deformation of the elastomer

b) opening, extrusion or permanent deformation of the external seal

c) tearing, cracking or permanent deformation of the PTFE sliding surfaces

d) cracking, indentation or permanent deformation of the internal seal or other part of the bearing

e) abrasive marks indicating abnormal contact between the metal surfaces of the bearing plates or piston and the pot

f) failure or permanent deformations of guide bars, or

g) flow of elastomers.

Bearings failing to meet the acceptance criteria requirements, the dimensional requirements of Clause 7.5.3 or the loading requirements of Clause 7.5.4 shall be rejected. **Nonconformance**

If any one of the representative bearings fail the above requirements, a further sample of one in five bearings from the same batch shall be tested. If no further bearings fail, the remainder of the batch shall be accepted. Should more than one representative bearing fail, whether from the original or secondary sample, all bearings shall be tested for compliance. If the batch consists of two or less bearings, the bearing(s) shall be rejected.

Any rejected bearing shall not be retested and the rejected bearing shall be replaced with a new bearing. All replacement bearings shall be tested for compliance with this Technical Specification.

7.5.6 Reporting of findings

At least 10 working days prior to delivery of the bearings to Site, the Contractor shall provide a NATA-certified report to the Administrator detailing all test results and parameters including the following: **Hold Point 10**

a) the vertical testing load

b) the lateral testing load

c) the rotation used

d) the vertical load used for the rotation test

e) durometer readings of tested bearings

f) a photograph of one in 10 bearings tested in compression

g) a photograph of one in five bearings tested in shear (if applicable)

h) a photograph of one in five bearing tested for the co-efficient of friction (if applicable)

i) a photograph of one in five bearing tested in rotation (if applicable)

j) a photograph of all visible failure types as stated in Clause 7.5.5, and

k) any observations noted during the testing process

This requirement means all test results, including the results of all non-compliant bearings, shall be reported.

7.6 Identification and delivery

All bearings shall be clearly marked in order to identify their type and location in the bridge.

Mating parts of bearings shall be supplied in sets held together at the correct preset and skewed with metal transit clips and / or bolts to prevent misalignment and / or damage of the components during transport and erection. No transit clips and / or bolts shall be removed until after completion of installation in the bridge. Bearings shall be protected in dust and moisture resistant wrappings until after assembly and during transport to site.

8 Supplementary requirements

The requirements of MRTS81 are varied by the Supplementary Requirements given in Clause 3 of Annexure MRTS81.1.

Appendix A – Single Unbonded Layer Bearing Test Method

A1 Compression Test

1. Place the bearing centrally in the test press.
2. Load the bearing at a uniform rate to three times the 'Service Load' (as per Clause 1.1, Annexure MRTS81.1).
3. Inspect the bearing while loaded.
4. Take a photograph of the bearing.
5. Unload bearing.
6. Remove bearing from test press.
7. Visually inspect bearing for:
   a) splitting, indentations or evidence of incomplete vulcanising of the rubber compound.
8. Take durometer reading of elastomer.

The testing of single unbonded layer bearings is not covered in AS 5100.4. The rate at which the bearing is loaded does not affect the intent of the test.

Appendix B – Laminated Elastomeric Bearing Test Method

B1 Compression Quality Assurance Test

Testing shall be completed in accordance with the testing procedure of AS 5100.4, Appendix D Clause D2. A photo of each compressed bearing shall be taken at the maximum load.

B2 Compression Stiffness Test

Testing shall be completed in accordance with the testing procedure of AS 5100.4, Appendix D Clause D3 (a) to (g).

B3 Shear Stiffness Test

Testing shall be completed in accordance with the testing procedure of AS 5100.4, Appendix D Clause D4 (a) to (i).

The procedure which shall be used to determine how the bearings are paired shall be in accordance with Appendix C - Laminated Elastomeric Bearing Pairing Method.

B4 Specification requirements

B4.1 Compression Stiffness Testing

Compression stiffness values shall be ± 25% of the 'Calculated compression stiffness at zero shear' of the design value, for the specific bearing, as specified in Clause 1 of Annexure MRTS81.1.

Inspect the bearing in the loaded and unloaded state to ensure there is no signs of misplaced or misaligned steel plates, bond failure or surface defects, such as tears or splits. Should any of these be observed, they shall be reported on the test report.

B4.2 Shear Stiffness Testing

Shear stiffness values shall be ± 20% of the 'Mean shear stiffness' of the design value as specified in Clause 1 of Annexure MRTS81.1.

Appendix C – Laminated Elastomeric Bearing Pairing Method

To determine the pairs of bearing to be used for the shear stiffness test as required by AS 5100.4, Clause D3 (a), the following procedure will be used:

a) List all the bearings in ascending compression stiffness order.

b) If bearings have the same compression stiffness value, the order of the bearings shall be determined by the ascending bearing number.

c) Determine the number of bearing pairs to be tested which shall be a minimum of 20% per batch of bearings:

   i. divide the total number of bearings by five to get the raw number

   ii. round up to the next even number

   iii. divide by two to calculate the number of pairs.

Table C(a) – Example of how to determine the number of bearings to be tested

	Method to determine the number of bearing to be tested	**Example calculated number**
Total number of bearings to test	-	34
20% of total	$\frac{Total\ number\ of\ bearings}{5}$	6.8
Number for Shear Testing	Round up to next even number	8
Pairs for Shear Testing	$\frac{Actual\ Number\ of\ Shear\ Bearings}{2}$	4

d) From the generated list in Step (a) and Step (b), select the first and last pair of bearings.

e) At regular intervals on the list, select the remaining number of pairs.

Table C(b) – Example of selecting pairs

Number of bearings	**Bearing number**	**List of compression values**	**Paired bearings**
1	106	389.00	**1**
2	36	393.21	
3	18	395.68	1
4	10	398.19	2
5	111	406.00	3
6	5	410.47	4
7	57	410.66	5
8	123	411.82	6
9	14	414.72	7
10	55	416.33	8
11	54	421.43	**2**

Number of bearings	Bearing number	List of compression values	Paired bearings
12	39	422.13	
13	4	422.39	1
14	58	424.60	2
15	48	427.25	3
16	79	427.81	4
17	94	430.14	5
18	29	433.74	6
19	113	434.52	7
20	59	436.19	8
21	41	440.67	9
22	76	441.10	**3**
23	7	441.31	
24	93	441.68	1
25	122	442.59	2
26	63	449.42	3
27	86	453.39	4
28	91	456.81	5
29	80	458.33	6
30	24	458.78	7
32	78	459.29	8
33	126	460.13	**4**
34	101	466.37	

Appendix D – Pot Bearing Testing Method

The nominated bearings shall be tested to the requirements of Table 7.5.4 with the loads supplied in Clause 2 of Annexure MRTS81.1.

The testing of pot bearings is not covered in AS 5100.4. All loads are to be applied at a constant and steady rate (unless stated otherwise). The speed at which the bearing is loaded does not affect the intent of a visual inspection for the test.

D1 Compression Test

In reference to AS 5100.4 Clause 13.2 (a):

1. place the bearing centrally in the test press
2. load the bearing at a uniform rate over a minimum period of one minute to the 'Maximum Ultimate Compression Load' (ULC_{max})
3. hold vertical load for one minute
4. visually inspect the bearing, checking for any rubber and PTFE extrusion
5. unload the bearing
6. load the bearing at uniform rate over a minimum period of one minute to the ULC_{max}
7. hold vertical load for three minutes
8. visually inspect the bearing, inspecting for any rubber extrusion
9. take a photograph of the bearing, and
10. unload the bearing.

The compression test is deemed invalid if the test load is less than 95% of the ULC_{max} during Step 6.

D2 Shear Test

In reference to AS 5100.4 Clause 13.2 (b):

1. select two bearings with same dimensions and load characteristics (a 'dummy bearing' may need to be manufactured to carry out this test)
2. place one bearing centrally in the test press with a shear plate located on top. The guide bar of the bearing shall be positioned perpendicular to the horizontal load
3. place the second bearing 'upside down' on the shear plate so that the guide bar is positioned in the direction of the horizontal load
4. load the bearings at a uniform rate over a minimum period of one minute to the 'Maximum Ultimate Compression Load' (ULC_{max})
5. apply the 'Maximum Ultimate Shear Load' (ULS_{max}) to the shear plate in a perpendicular direction to the guide bar of the bottom bearing
6. hold the compression load and shear loads for three minutes
7. monitor the applied loads for any reduction in load

8. visually inspect the bearing, checking for any rubber and PTFE extrusion
9. take a photograph of the bearing
10. reduce the compression load to 'Minimum Ultimate Compression Load' (ULC_{min})
11. check and adjust the horizontal load to maintain ULS_{max}
12. hold the compression and shear loads for three minutes
13. monitor the applied loads for any reduction in load
14. visually inspect bearing, checking for any rubber and PTFE extrusion
15. take a photograph of the bearing
16. remove the shear load, and
17. remove the compression load.

D3 Friction Test

1. Select two bearings with same dimensions and load characteristics (a 'dummy bearing' may need to be manufactured to carry out this test).
2. Place one bearing centrally in the test press with a shear plate located on top. The guide bar of the bearing shall be positioned in the direction of the horizontal load.
3. Place the second bearing 'upside down' on the shear plate so that the guide bar is positioned in the direction of the horizontal load.
4. Load the bearings to 'Maximum Serviceability Compression Load' (SLC_{max}).
5. Gradually apply a horizontal force sufficient to produce a displacement in the range of 2.5 mm to 25 mm per minute as appropriate.
6. Visually inspect the bearing while loaded.
7. Record the horizontal load when the bearing slide plate begins to move.
8. Take a photograph of the bearing.
9. Repeat Step 2 to Step 7 until five readings are taken.
10. Remove the horizontal force.
11. Remove the compression load.
12. Calculate the average horizontal load.
13. Calculate the Co-Efficient of Friction (μ):

$$F = \mu R$$

where F = (Average Horizontal Load)/2
μ = Co-efficient of Sliding Friction Value
R = Applied Vertical Load

14. Calculate the Bearing Pressure ($P_{bearing}$), and

$$P_{bearing} = \frac{SLC_{Max}}{PTFE\ Contact\ Area}$$

15. Plot a graph from the values in Table 7.5.4.3 to determine if the co-efficient of friction of the bearing does not exceed the maximum allowable.

D4 Rotation Test

1. In reference to AS 5100.4 Clause 13.2 (c).
2. Place the bearing centrally in the test press.
3. Place the rotation plate (machined to the specified rotation) on top of the bearing.
4. Load the bearing at a uniform rate to 0.7 times the 'Maximum Ultimate Compression Load' (ULC_{max}).
5. Hold the compression load for three minutes.
6. Visually inspect the bearing, checking for any rubber and PTFE extrusion.
7. Take a photograph of the bearing, and
8. Remove the compression load.

D5 Visual Inspection

1. Remove bearing from test press.
2. Dismantle bearing and inspect for:
    a. splitting, extrusion or permanent deformation of the elastomer
    b. opening, extrusion or permanent deformation of the external seal
    c. tearing, cracking or permanent deformation of the PTFE sliding surfaces
    d. abrasive marks indicating abnormal contact between the metal surfaces of the bearing plates or piston and the pot
    e. failure or permanent deformation of guide bars, and
    f. flow of elastomers.
3. Take a durometer reading of elastomer.