2000

Bearings

2001. DESCRIPTION

This work shall consist of furnishing and fixing bearings in position in accordance with the details shown on the drawings, to the requirements of these specifications or as directed by the Engineer.

2002. GENERAL

i) Bearing plates, bars, rockers, assemblies and other expansion or fixed devices shall be constructed in accordance with the details shown on the drawings.

ii) The bearings may either be supplied directly to the Engineer by the manufacturer to be installed by the Contractor or the Contractor is to supply and install the bearings as part of the contract. In the former case, the manufacturer shall be associated with the installation of the bearings to the full satisfaction of the Engineer, whereas in the latter case, the Contractor shall be solely responsible for the satisfactory supply and installation of the bearing. In the detailed description of the specification, a general reference shall be made to the Contractor or manufacturer and the interpretation shall be as per terms of contract.

iii) The Contractor shall exercise the utmost care in setting and fixing all bearings in their correct positions and ensuring that uniformity is obtained on all bearing surfaces.

iv) Bearings shall be handled with care and stored under cover.

v) When bearing assemblies or plates are shown on the drawings to be placed (not embedded) directly on concrete, the concrete bearing area shall be constructed slightly above grade (not exceeding 12 mm) and shall be finished by grinding.

vi) It shall be ensured that the bearings are set truly level and in exact position as indicated on the drawings so as to have full and even bearing on the seats. Thin mortar pads (not exceeding 12 mm) may even be made to meet with this requirement.

vii) It shall be ensured that the bottoms of girders to be received on the bearings are plane at the locations of these bearings and care shall be taken that the bearings are not displaced while placing the girders.

viii) M.S. bearings sliding on M.S. Plates shall not be permitted. For sliding plate bearings stainless, steel surface sliding on stainless steel plate with mild steel matrix shall be used. The other option shall be to provide PTFE surface sliding on stainless steel.

ix) Some types of bearings which have been successfully used in various bridges in India have been covered by these Specifications. For innovative types of structures or in special cases, special types of bearings to suit the requirements may have to be provided for which special specifications may be laid down by the Engineer.

2003. STEEL BEARINGS

2003.1. Materials

The material for steel bearings shall conform to the requirements

of Section 1000. Some additional requirements for materials for steel bearings are indicated below :

a) Railway axles (R 19) are also acceptable as forged steel for rollers.

b) For the purpose of checking the soundness of cast steel components, castings shall be ultrasonically examined following procedures as per IS:7666 with acceptance standard as per IS:9565. The castings may also be checked by any other accepted method of non-destructive testing as specified in IS:1030. Quality level of castings shall be level 3 as per IS:9565.

The grease for bearings shall conform to the requirements of IS:503 (Grade 4).

2003.2. Construction Operations

a) All work shall conform strictly to the drawings and shall be in accordance with the provisions of this section. Care shall be taken to ensure that all parts of an assembly fit accurately together. The workmanship shall satisfy all relevant provisions laid down in Section 1900.

b) Knuckle pins, rolling surfaces of the rollers and bearing surface of the bearing plates shall be machined and all bolt holes shall be drilled. The whole bearings shall be fitted and finished as required for good quality machined work to the satisfaction of the Engineer. However, in case of bearings which are to be grouted or bedded on a suitable yielding material on any surface which is to be in permanent contact with the grout or the yielding material may be left unmachined.

c) In prestressed concrete construction where launching of girders is employed, in order to avoid slipping or jumping of rollers due to vibration or jolts, adequate measures may be taken to ensure that the roller assembly is not disturbed. It is normal practice to provide rocker bearings on the launching end and place the beam on the rocker end slightly in advance of placing on the roller.

d) During concreting of girders, the bearings shall be held in position securely by providing temporary connection between the top and bottom plates in case of fixed bearings and between top plate, base plate and saddle plate in case of roller-cum-rocker bearing or by any other suitable arrangement which prevents the relative displacement of the components.

e) In prestressed precast girders, where recesses are left on the underside of girders to receive the anchor bolts, grout holes extending to the beam sides or to the deck level shall be provided. The cement sand grout shall have a mix of 1:1.

2003.3. Workmanship

a) Fabrication shall be carried out by an organisation experienced and qualified to undertake precision engineering of this type and be approved by the Engineer.

b) Workmanship shall be of good quality, neatly finished and of good appearance.

c) Castings shall be true to the forms and dimensions shown on the drawings and shall be free from pouring faults, sponginess, cracks, blow holes and other defects on position, affecting their appearance or strength. Warped or distorted castings will not be accepted. Exposed surfaces shall be smooth and dense.

d) All castings shall be cleaned by sand or shot blasting to remove sand or scale and to present a clean uniform surface.

e) All irregularities, fins or risers shall be ground off flush with the adjacent surface. Castings with visible cracks, blow holes or similar blemishes shall be rejected if the imperfections are located in bearing surfaces or cannot be remedied to the approval of the Engineer.

f) Imperfections which are not located in bearing surfaces shall be cleaned out, filled with weld metal of the appropriate composition and ground flush.

g) All surfaces of major components like top plates, saddle plates, base plates, rollers of the bearings shall be machined all over for correct alignment, interchangeability, proper fitting, etc.

2003.4. Tolerances

Tolerances for its individual components or of the assembled bearings shall be as shown on the drawings or subject to the approval of the Engineer.

Unless otherwise specified, the following tolerances shall be maintained :

Diameter of Rollers, Knuckle Pins and Bores

Tolerances on diameter of rollers and all convex surfaces shall conform to K7 of IS:919.

Tolerances on diameter of all concave surfaces shall conform to D8 of IS:919.

Height of Bearings

Tolerances on height of any component casting shall not exceed +0.5mm. No minus tolerance shall be allowed. The edges of all ribs shall be parallel throughout their length.

Base Plate

Tolerance on length and width of the base plate shall not exceed +1.0 mm, tolerance on the thickness of the plate shall not exceed +0.5 mm. No minus tolerance shall be allowed. All rocking, rolling and sliding surfaces shall have a machine smooth finish to 20 micron maximum mean deviation as per IS:3073.

Castings

No minus tolerance shall be allowed in the thickness of any part of the castings. The edges of all ribs shall be parallel throughout their length.

2003.5. Installation of Steel Bearings

2003.5.1. General

a) Bearings shall be placed in the positions as shown on the drawings with all bearing surfaces in full contact and to the tolerances as specified.

b) Roller and rocker bearings shall be placed so that their axles of rotations are horizontal and normal to the direction of movement of the members they support. Upper and lower bearing plates shall be set horizontal in both directions.

c) During installation the bearings shall be pre-set with respect to the bearing axis to account for the movement due to the following :

   i) Temperature variation between the average temperature prevailing at the time of installation and the mean design temperature.

   ii) Shrinkage, creep and elastic shortening.

d) For bridges in gradient, the bearing plates shall be placed in a horizontal plane.

2003.5.2. Placing

a) On supporting structures, pockets shall be provided to receive anchor bolts; one side of the pocket shall project beyond the bearing plate. The pocket shall be filled with mortar of mix 1:1 and the concrete bearing area also shall be finished level by a thin and stiff mortar pad of mix 1:1 (the thickness not exceeding 12 mm) just before placing of bearing assemblies or bottom plate on the concrete seat.

b) In case of precast girders a recess of 6 mm shall be provided on the underside with a level finish for housing the bearing plate. A thin and stiff mortar pad of mix 1:1 with thickness not exceeding 3 mm shall be provided over the top plate before lowering the precast beam in position in order to ensure full and even pressure on the plate surface.

c) It shall be ensured that while placing the girders, the bearings are in their exact positions as indicated on the approved drawing and not displaced therefrom.

d) All concrete surfaces to be in contact with the mortar shall be thoroughly cleaned and kept saturated with water for a period not less than 24 hours before placing mortar and operations are to be carried out when the surface temperatures of the exposed bearings are the minimum practical.

e) No mortar that is more than 30 minutes old after completion of mixing, shall be used.

f) After placing and finishing the mortar, the bearing shall be checked for position and shims or other temporary supports removed and the mortar made good. If the bearing has moved, it or the plate shall be lifted, the mortar removed and the whole procedure repeated.

g) Exposed faces of the mortar shall be cured under damp Hessian for 7 days.

h) Placing of the bearing and mortar shall only be carried out in the presence of the Engineer.

2003.5.3. Checking, cleaning and lubrication : Before erection, each bearing shall be uncrated, disassembled and checked. Any damaged parts shall be made good for approval.

All bearings with sliding surfaces shall be cleaned and lightly lubricated with an approved lubricant immediately before erection.

2003.5.4. Testing

i) The materials to be used in the bearings shall conform to the specifications laid down in clause 2003.1.

ii) If required, a suitable number of complete bearings as specified by an accepting authority shall be tested to 1.25 times the design load. Recovery should be 100 per ceent. Contact surfaces shall be examined by illumination source for any defects, cracks, etc. Segmental rollers shall be tested for design movements.

iii) For large lots (consisting of 12 sets or more), a quality control report shall be submitted as detailed below :

a) Unless otherwise agreed upon by the Engineer and the manufacturer, the latter shall furnish a complete report on the process of quality control. The Engineer may appoint an authorised inspection agency for inspection purpose on his behalf. Such an inspection agency shall also submit reports to the Engineer regarding various tests performed on the bearing or certify the acceptance of the bearings.

b) Test certificates of all raw materials shall be submitted. If manufacturer's test certificates are not available for the raw materials, the bearings manufacturer shall perform the necessary confirmatory tests as per relevant codes of practice and shall furnish the test results.

c) A detailed quality control system including stage by stage inspection, starting from raw materials upto the finished bearing shall be submitted by the bearing manufacturer.

d) The Engineer shall reserve the right to witness such inspection at manufacturer's works with or without prior permission of the manufacturer. For this, the bearing manufacturer shall have in-plant testing facilities as far as possible and practicable.

e) The bearing manufacturer shall maintain a list of consumption of raw material for a period of at least previous one year.

f) Test certificates of bearings manufactured during preceding one year shall be made available at the manufacturer's works.

g) In case the lot size of similar bearings exceeds 12 sets as per the direction of the Engineer, one extra set of bearings for each 24 sets of bearings or part thereof, shall be manufactured and the cost of such extra bearings shall be borne by the user.

h) The Engineer shall select the extra bearing(s) at random and shall perform various tests including destructive testing on it at his discretion, either at the manufacturer's works or at any other approved test laboratory, notwithstanding the test reports submitted.

i) In case there is a major discrepancy regarding material, the engineer shall declare the whole lot of bearings as unacceptable.

j) In case minor defects in fabrication, like welding or machining, is found in the test bearing before destructive testing and if the test bearing is found to be acceptable after destructive testing, the minor defects in the test bearings shall not be a bar to the acceptance of the entire lot.

k) The opinion of the Engineer in cases (i) and (j) above shall be binding on the manufacturer.

2004. SPECIAL BEARINGS

2004.1. Spherical Bearing

This bearing only takes care of vertical load and horizontal force due to sliding friction. The bearing will permit uniaxial translatory movement along longitudinal axis of the bridge and rotation along all axes.

The bearing shall consist of the following parts :

Bottom Plate

A bottom plate with concave surface is integrally cast on circular/ square plate. The bottom plate is connected to the sub-structure by means of tight fitted anchor bolts, which are embedded in concrete. The material of bottom plate shall be cast steel.

Pure unfilled quality dimpled PTFE of specified thickness shall be provided on top of concave surface of bottom plate in order to allow smooth rotation.

Saddle Plate

A saddle plate with square/circular/rectangular top and convex surface at bottom shall be placed in the concave surface of bottom plate. The radius of curvature of the convex bottom of the saddle plate shall be slightly less than that of the concave top surface of the bottom plate to ensure sufficient contact over a small area. Rotation along all axes shall be permitted along the contact surface of the saddle plate and the bottom plate. Pure unfilled quality dimpled PTFE sheet shall be recessed to specified depth of recess over the top of saddle plate. Suitable elastomeric seal shall be provided on the saddle plate to prevent ingress of dirt and moisture. The material of saddle plate shall be cast steel.

Top Plate

The top plate shall have stainless steel plate welded to its bottom which shall slide over PTFE. The assembly shall be connected to

the superstructure by tight fitted anchor bolts. Translatory movements along longitudinal axis of bridge shall be accommodated at the PTFE/ Stainless steel sliding surface. The material of top plate shall be cast steel.

Guide Plate

Guide Plates shall be welded to saddle plate so as to permit only longitudinal movement. The material of guide plates should be cast steel.

2004.2. Pin Bearing

Pin bearing shall ensure fixity by arresting translatory movement. The pin bearing shall not take any vertical load. It will take care of the longitudinal horizontal force of the entire superstructure unit as well as transverse horizontal force developed at the fixed end.

A pin bearing shall consist of a short height structural built-up column embedded in pier cap and the protruding length inside soffit of deck shall have rocker plates on all four sides, which permit rotation.

Pin bearing shall resist horizontal force from any direction and will permit rotation but will not bear any vertical load. The material of pin bearing including rocker plates shall be high tensile steel conforming to IS:961.

2004.3. In general the sliding spherical and pin bearing shall conform to BS:5400, Parts 9.1 and 9.2 and all relevant clauses of this specification. Bearings shall be guaranteed for design loads and movements. The term bearing shall include the entire assembly covering all the accessories required for operation, erection and dismantling for replacement. All bearings shall be of replaceable type. These bearings should be based on their design to the specifications mentioned/international specifications. The manufacturer should get their design approved from appropriate authority and the manufacturer should be associated with installation of bearings.

2004.4. Materials

All materials, particularly the following, shall be original, unused or non-re-cycled conforming to relevant specifications :

- Cast Steel, Mild Steel, Stainless Steel shall conform to Clause 2003.1.
- Copolymer Poly Tetra Fluora Ethylene (PTFE) unfilled quality shall have required properties as per BS:5400 and thickness shall be as specified.
- Anchor Bolts shall be as per relevant IS specifications.

2004.5. Seating of Pin Bearing

i) Backing plate with studs welded on the face opposite to the seating of manufacture shall be delivered by the manufacturer.

ii) This backing plate shall be accurately positioned on the reinforcement grid of the pedestal and levelled.

iii) Studs shall be tack welded/tied to the reinforcement to keep the backing plate in proper location during casting.

iv) Depth of embedment of the backing plate in the concrete shall be as per relevant drawing.

v) The round base of the pot (bottom) of the pin bearing assembly shall be connected to the backing plates by anchor screws after concreting of pier cap/pedestal.

vi) In order to ensure successful transfer of large horizontal forces to be resisted by the Pin bearing, great care shall be taken in detailing the reinforcement in the sub-structure and the super-structure adjacent to the studs in the backing plate.

2004.6. Acceptance Test on Spherical Bearings

1. All bearings shall be checked for overall dimensions
2. All bearings shall be load tested to 1.25 times design vertical load
3. A pair of bearings selected at random shall undergo testing in order to determine coefficient of friction which shall be less than 0.05.
4. Two bearings selected at random shall be tested for permissible rotation.

2004.7. Acceptance Test on Pin Bearings

1. All bearings shall be checked for overall dimensions.
2. All bearings shall be load tested (if required, for design horizontal load only)

2005. ELASTOMERIC BEARINGS

The term "bearing" in this case refers to an elastomeric bearing consisting of one or more internal layers of elastomer bonded to internal steel laminates by the process of vulcanisation. The bearing shall cater for translation and/or rotation of the superstructure by elastic deformation.

2005.1. Raw Material

Chloroprene (CR) only shall be used in the manufacture of bearing.

Grades of raw elastomer of proven use in elastomeric bearings, with low crystallization rates and adequate shelf life (e.g. Neoprene WRT, Bayprene 110, Skyprene B-5 and Denka S-40V) shall be used.

No reclaimed rubber or vulcanized wastes or natural rubber shall be used.

The raw elastomer content of the compound shall not be lower than

60 per cent by its weight. The ash content shall not exceed 5 per cent. (as per tests conducted in accordance with ASTM D-297, sub-section 10).

EPDM and other similar candidate elastomers for bridge bearing use shall not be permitted.

Properties

The elastomer shall comform to the properties specified in Table 2000.1

TABLE 2000-1. PROPERTIES OF ELASTOMER

	Propertiy	Unit	Test Method, IS specification reference		Value of the characteristic specified
1.	Physical Properties				
1.1.	Hardness	IRHD	IS:3400 (Part II)		60 + 5
1.2.	Minimum Tensile Strength	MPa	IS:3400 (Part I)		17
1.3.	Minimum Elongation at break	Per cent	IS:3400 (Part I)		400
2.	Maximum Compression Set	Per cent	IS:3400 (Part X)		
			duration (h)	temperature (deg C)	
	CR		+0 to 24.2	100±1	35
3.	Accelerated Ageing				
			IS:3400 (Part IV)		
			duration (h)	temperature (deg C)	
	CR		70	100±1	
3.1	Max change in Hardness	IRHD			+15
3.2.	Max change in Tensile Strength	Per cent			-15
3.3.	Max change in Elongation	Per cent			-40

Shear modulus of the elastomer bearing shall neither be less than 0.80 MPa nor greater than 1.20 MPa.

The adhesion strength of elastomer to steel plates determined

according to IS:3400 (Part XIV) method A shall not be less than 7 kN/m.

For elastomeric bearings (CR) used in adverse climatic conditions the following ozone resistance test shall be satisfied :

The ozone resistance of elastomer shall be proved satisfactory when assessed by test according to IS:3400 (Part XX). The strain, temperature, duration and ozone concentration of the test shall be 20 per cent, 40 ± 1 degree Celsius, 96 h and 50 pphm by volume respectively.

No cracking detected by visual observation at the end of the test shall be considered satisfactory. No specific tests for assessment of low temperature resistance may be deemed necessary.

NOTE : For use of elastomer in extreme cold climates, the Engineer may specify special grade of low temperature resistant elastomer in conformity with operating ambient temperature conditions. The specifications of such special grade elastomer including the tests for low temperature resistance shall be mutually agreed to by the Engineer and the producer supplier and are outside the purview of these specifications.

Laminates of mild steel conforming to IS:226 shall only be permitted to be used. Use of any other material like fibre glass or similar fabric as laminates shall not be permitted.

The manufacturers of elastomeric bearings shall satisfy the Engineer that they have in-house facilities for testing the elastomer for carrying out the following tests in accordance with the relevant provisions of ASTM D-297.

a)	Identification of polymers	:	to confirm the usage of Chloroprene (Appendix X-2)
b)	Ash content test	:	to determine the percentage (sub-section 34)
c)	Specific gravity test	:	(sub-section 15)
d)	Polymer content test	:	(sub-section 10)

The Engineer shall invariably get the test (a) performed within his presence or in the presence of his authorised representative to satisfy the requirement. In case of any disputes regarding interpretation of results the Engineer may carry out test as per ASTM S-3452-78 (Chromatography test) at the manufacturer's cost in a recognised test house.

The elastomer specimen to conduct the test shall be obtained from the bearings selected at random for destructive test. Remaining part of the test bearing shall be preserved by the Engineer for any test to be done in future, if required.

2005.2. Fabrication

Bearing with steel laminates shall be cast as a single unit in a mould and vulcanised under heat and pressure.

Casting of elements in separate units and subsequent bonding shall not be permitted, nor shall cutting from large size cast be permitted.

Bearings of similar size to be used in particular bridge project shall be produced by identical process and in one lot as far as practicable. Phased production may only be resorted to when the total number of bearings is large enough.

The moulds used shall have standard surface finish adequate to produce bearings free from any surface blemishes.

Steel plates for laminates shall be sand blasted, clean of all mill scales and shall be free form all contaminants prior to bonding by vulcanisation. Rusted plates with pitting shall not be used. All edges of plates shall be rounded.

Spacers used in mould to ensure cover and location of laminates shall be of maximum size and number practicable. Any hole at surface or in edge cover shall be filled in subsequently.

Care shall be taken to ensure uniform vulcanising conditions and homogeneity of elastomer through the surface and body of bearings.

The bearings shall be fabricated with the tolerances specified in Table 2000-2.

TABLE 2000-2 TOLERANCES

	ITEMS	TOLERANCES
1.	Overall plan dimensions	-0, + 6 mm
2.	Total bearing thickness	-0, + 5 mm
3.	Parallelism	
a)	Of top surface of bearing with respect to the bottom surface as datum	1 in 200
b)	Of one side surface with respect to the other as datum	1 in 100
4a.	Thickness of individual internal layer of elastomer	± 20 per cent (max. of 2 mm)
b)	Thickness of individual outer layer	-0, + 1 mm
5a.	Plan dimensions of laminates	-3mm, +0
b)	Thickness of laminates	±10 per cent
c)	Parallelism of laminate with respect to bearing base as datum	1 in 100

The vulcanising equipment/press shall be such that between the plattens of press the pressure and temperature are uniform and capable of being maintained at constant values as required for effecting a uniform vulcanisation of the bearing.

The moulding dies utilised for manufacturing the bearings shall be so set inside the platten of the press so that the pressure developed during vulcanisation of the product is evenly distributed and the thickness maintained at all places are within acceptable tolerance limits taking into consideration the shrinkage allowance of vulcanizate.

The raw compound which has been introduced inside the metal dies for vulcanisation shall be accurately weighed each time and it must be ensured that sufficient quantity has been put inside the die for proper flow of material at every place so that a homogeneous and compact bearing is produced without any sign of sponginess or deficiency of material at any place.

Before any vulcanizate of any batch of production is used for producing vulcanised bearings, test pieces in the form of standard slab and buttons shall be prepared in accordance with prescribed standards and salient properties tested and recorded regularly against each batch of production to monitor the quality of the products.

2005.3. Acceptance Specifications

The manufacturer shall have all the test facilities required for the process and acceptance control tests installed at his plant to the complete satisfaction of the Engineer. The test facilities and their operation shall be open to inspection by the Engineer on demand.

All acceptance and process control tests shall be conducted at the manufacturer's plant. Cost of all materials, equipment and labour shall be borne by the manufacturer unless otherwise specified or specially agreed to between the manufacturer and Engineer.

Acceptance testing shall be commenced with the prior submittal of testing programme by the manufacturer to the Engineer and after obtaining his approval.

Any acceptance testing delayed beyond 180 days of production shall require special approval of the Engineer and modified acceptance specification, if deemed necessary by him.

All acceptance testing shall be conducted by the Inspector with aid of the personnel having adequate expertise and experience in rubber

testing provided by the manufacturer, working under the supervision of the Inspector and to his complete satisfaction.

Lot by lot inspection and acceptance shall be made.

2005.3.1. Acceptance lot : A lot under acceptance shall comprise all bearings, including the pair of extra test bearings where applicable of equal or near equal size produced under identical conditions of manufacture to be supplied for a particular project.

The size and composition of acceptance lot shall be got approved by the Engineer.

For the purpose of grading levels of acceptance, testing lots shall be classified as follows :

i) A lot size of 24 or larger number of bearings shall be defined as a large lot

ii) A lot size of less than 24 bearings shall be defined as a small lot

When the number of bearings of equal or near equal size for a single bridge project is large and phased production and acceptance is permitted, the number of bearings supplied in any single phase of supply shall comprise a lot under acceptance. When such phased supply is made, each such lot shall be considered as a large lot for the purpose of acceptance testing.

2005.3.2. Levels of acceptance inspection : The level of acceptance testing shall generally be graded into the following two levels depending on lot size :

Level 1 acceptance testing

Level 2 acceptance testing

Acceptance testing Level 1 is a higher level inspection and shall be applicable to large lots only, unless otherwise specified. This shall involve manufacture of two extra bearings for each lot to be used as test bearing and eventually consumed in destructive testing.

Acceptance testing Level 2 shall be applicable to small lots only, (i.e. less than 24 lots) for which one extra bearing shall be manufactured. Out of the lot one bearing shall be selected at random for carrying out material tests. This bearing shall be excluded from the lot accepted.

Acceptance inspection level 1 may be specified at the sole discretion of the engineer taking into account the special importance of bridge project for small lots also under the purview of special acceptance

inspection. The cost of extra bearings, in such cases shall be borne by the user, while the cost of all other materials, equipment and testing shall be borne by the manufacturer.

2005.3.3. Testing : Acceptance testing shall comprise general inspection, test on specially moulded test pieces and test on complete bearings or sections for measurement of various quality characteristics detailed below :

2005.3.3.1. Acceptance testing level 1

General Inspection

1. All bearings of the lot shall be visually inspected for any defects in surface finish, shape or any other discernible superficial defects.
2. All bearings of the lot shall be checked for tolerances specified in Table 2000-2.
3. All bearings of the lot shall be subjected to axial load to correspond to σm (i.e. average compressive stress) = 15 MPa applied in steps and held constant while visual examination is made to check for discernible defects like :
   a) Misalignment of reinforcing plates
   b) Poor bond at laminate/steel interface
   c) Variation in thickness of elastomer layers
   d) Any surface defects
   e) Low stiffness

Deflection under loads between σm=5 MPa and σm=15 MPa shall be measured and recorded for all bearings with sufficient accuracy ($\pm$ 5 per cent), Variation in stiffness of any individual bearing from the mean of the measured values for all such bearings of the lot shall not be larger than 20 per cent (of the mean value).

Tests on specially moulded test pieces

1. Test pieces shall be moulded by the manufacturer with identical compound and under identical vulcanising conditions as used in the manufacture of the bearings of the acceptance lot. The process shall be open to inspection by the Engineer.
2. Test pieces offered for inspection shall be identified by suitable markings and duly certified by the manufacturer.
3. The quality characteristics to be tested are listed below. The specification references in parenthesis shall define the corresponding specification for test piece, test method and criterion for acceptance.

   Composition (see Note 1 below)
   Hardness (Table 2000-1 , 1.1)

Tensile strength (Table 2000-1 , 1.2)
Elongation at Break (Table 2000-1 , 1.3)
Compression Set (Table 2000-1 , 2)
Accelerated Ageing (Table 2000-1 , 3)
Adhesion Strength (Clause 2005.1)
Ozone Resistance (see Note 2 below)

Note 1.

For acceptance testing the properties enumerated in Clause 2005.1 and specific gravity of elastomer of test pieces from test bearing shall be compared with those for corresponding specially moulded test pieces furnished by the manufacturer. The following variations shall be deemed maximum acceptable :

Specific Gravity ± 0.2

Ash Content ± 0.5 per cent
Hardness (Table 2000-1 , 1.1)
Tensile strength (Table 2000-1 , 1.2)
Elongation at Break (Table 2000-1 , 1.3)
Compression Set (Table 2000-1 , 2)
Accelerated Ageing (Table 2000-1 , 3)
Adhesion Strength (Clause 2005.1)

Note 2.

Ozone resistance test can be waived by the Engineer for bearings of CR when satisfactory results of ozone resistance tests on similar grade of elastomer may be available from process control records or development test data furnished by the manufacturer.

Where such process control data are not available or the frequency of testing not deemed adequate, ozone resistance test shall be mandatory for acceptance of bearings of CR.

However, such tests may not be insisted for bearings not located under adverse conditions of exposure and where the test on accelerated ageing could be considered as adequate.

Process and acceptance control tests for ozone resistance by an independent testing agency shall be acceptable.

Tests on Complete Bearings or Sections

1. Two bearings shall be selected at random from the lot as test bearings. These bearings shall be excluded from the lot accepted.

2. The following tests shall be conducted on test bearings :

Test for determination of shear modulus
Test for determination of elastic modulus
Test for determination of shear modulus (short term loading)
Test for determination of adhesion strength
Test for determination of ultimate compressive strength

The test specifications and acceptance criteria shall conform to those given in Appendix 2 of IRC:83 (Part II).

2005.3.3.2. Acceptance testing level 2

General Inspection. This shall conform to the provision in Clause 2005.3.3.1 in all respects.

Test on specially moulded test pieces. This shall conform to the provisions in Clause 2005.3.3.1 in all respects.

Test on complete bearings. Test for determination of shear modulus shall be conducted using two bearings of the lot selected at random and conforming to relevant provisions of Clause 2005.3.3.1. These bearings shall however be part of the lot accepted. The remaining tests stipulated in aforesaid clause shall be carried out on all bearings selected at random which shall be excluded from the lot accepted.

2005.3.4. Special acceptance inspection : Special acceptance inspection may comprise the following :

1. Acceptance testing by an independent external agency with separate or supplemental test facilities provided by it.
2. Acceptance testing on test pieces prepared from the surface or body of the test bearings instead of specially moulded test pieces.
3. Acceptance tests not covered by these specifications but according to the specifications laid down by the Engineer.

Special acceptance inspection may be specified under the following conditions :

a) Special contract agreement

b) Unsatisfactory evidence of process or acceptance control

2005.3.5. Inspection certificate : A lot under inspection shall be accepted by the Inspector and so certified, when no defect is found with respect to any of the quality characteristics tested on samples drawn from the lot according to specifications laid down in Clause 2005.3.3 covering general inspection tests on specially moulded test pieces and on complete bearings.

In case of any bearing with defect, the lot shall be rejected by the Inspector and so certified.

In case any bearing is found to be defective with respect to any quality characteristic, discerned by general inspection tests specified in Clauses 2005.3.3.1 and 2005.3.3.2, tests on specially moulded test pieces and complete bearings as applicable according to Clauses 2005.3.3.1 and 2005.3.3.2 shall nevertheless be completed. If the said lot, rejected by general inspection, satisfies the acceptance criteria in respect of these other tests, the lot and individual bearings found defective shall be clearly identified in the inspection certificate.

The manufacturer shall obtain from the inspector, authorised by the Engineer, immediately on completion of his inspection, an inspection certificate which shall include the details of a lot or lots accepted/rejected by him and records of all test measurements.

2005.3.6. Quality control certificate : The manufacturer shall certify for each lot of bearing under acceptance:

That an adequate system of continuous quality control was operated in his plant.

That the entire process remained in control during the production of the lot of bearings under acceptance as verified from the quality control records/charts which shall be open to inspection of Engineer/ Inspector on demand.

A certified copy of results of process control testing done on samples of elastomer used in the production of the lot shall be appended and shall include at least the following information :

Composition of compound - raw elastomer and ash content, the grade of raw elastomer used (including name, source, age on shelf), test results of hardness, tensile strength, elongation at break, compression set, accelerated ageing, etc.

A higher level certification of the process quality control shall be called for at the sole discretion of the Engineer in special cases e.g. where adequate inspection of bearings similar to those comprising the lot under inspection produced in the same plant is not available with the Engineer or in case of any evidence of process or acceptance control being deemed unsatisfactory. The higher level certification shall comprise submittal of a complete quality control report as given

in Appendix 3 of IRC:83 (Part II) supplementing the quality control certificate.

2005.3.7 Acceptance : The manufacturer shall furnish the following to Engineer for the acceptance judgement :

1. Quality control certificate as laid down in Clause 2005.3.6.
2. Inspection certificate as laid down in Clause 2005.3.5.

The manufacturer shall furnish any supplementary information on the system of quality control and/or process and acceptance control testing as may be deemed necessary by the Engineer.

In case of any evidence of process or acceptance control testing being deemed unsatisfactory by him, Engineer at his sole discretion may call for a special acceptance of the lot according to specifications laid down by him, without any prejudice to his right to reject the lot. The entire cost of such supplementary inspection shall be borne by the manufacturer.

The Engineer shall be the sole authority for acceptance of a lot on scrutiny of the certificates alongwith any supplementary evidence and complete satisfaction therewith.

In case of rejection of a lot, the Engineer shall reserve the right to call for special acceptance inspection for the succeeding lots offered for inspection, according to the specifications laid down by him. The entire cost of such tightened inspection shall be borne by the manufacturer.

2005.4. Cerification and Marking

Bearings shall be transported to bridge site after final acceptance by Engineer and shall be accompanied by an authenticated copy of the certificate to that effect.

An information card giving the following details for the bearings, duly certified by the manufacturer shall also be appended :

Name of manufacturer
Date of manufacture
Elastomer grade used
Bearing dimensions
Production batch no.
Acceptance lot no.
Date of testing

Specific bridge location, if any
Explanation of markings used on the bearing

All bearings shall have suitable index markings identifying the information. The markings shall be made in indelible ink or flexible paint and if practicable should be visible after installation. The top of the bearing and direction of installation shall be indicated.

2005.5. Storage and Handling

Each elastomeric bearing shall be clearly labelled or marked. The bearing shall be wrapped in a cover. They shall be packed in timber crates with suitable arrangement to prevent movement and to protect corners and edges.

Care shall be taken to avoid mechanical damage, contamination with oil, grease and dirt, undue exposure to sunlight and weather to the bearings during transport and handling prior to and during installation.

2005.6. Installation

Installation of multiple bearings one behind the other on a single line of support shall be of identical dimensions.

Bearings must be placed between true horizontal surfaces (maximum tolerance 0.2 per cent perpendicular to the load) and at true plan position of their control lines marked on receiving surfaces (maximum tolerance $\pm$ 3 mm).

Concrete surfaces shall be free from local irregularities (maximum tolerance $\pm$ 1 mm in height).

Design shall be checked for the actual inclination in seating if larger inaccuracies than those specified are permitted.

For cast-in-place concrete construction of superstructure, where bearings are installed prior to its concreting, the forms around the bearings shall be soft enough for easy removal. Forms shall also fit the bearings snugly and prevent any leakage of mortar grout. Any mortar contaminating the bearings during concreting shall be completely removed before setting.

For precast concrete or steel superstructure elements, fixing of bearing to them may be done by application of epoxy resin adhesive to interface, after specified surface preparation. The specifications for adhesive material, workmanship and control shall be approved by the Engineer. Care shall be taken to guard against faulty application and consequent behaviour of the adhesive layer as a lubricant. The bonding

by the adhesive shall be deemed effective only as a device for installation and shall not be deemed to secure bearings against displacement for the purpose of design.

As a measure of ample safety against accidental displacement, the bearings shall be placed in a recess as shown in Fig. 9 of IRC:83 (Part II).

2005.7. Seating of Elastomeric Bearings on a Non-Horizontal Plane

Installation of elastomeric bearings on a Non-Horizontal Plane shall be as follows :

i) Elastomeric bearings shall be delivered with MS backing plate fastened to the bearing from the manufacturer.

ii) Template of 6 mm M.S. plate and of size same as bearing holding base plate with matching holes for the anchor screws shall be used. Anchors shall be fitted to the templates with the anchor screws but with MS washers in place of elastomer washers. The above template assembly shall be fitted in the formwork at its proper location and in a vertical plane.

iii) After casting of the pedestal and removal of the formwork, the template is to be removed.

A. Installation with face plate and without template in-situ casting

i) The sub-assembly of elastomeric bearing with the MS backing plate shall be fitted to the embedded anchors with anchor screws and elastomeric washers replacing the steel washer.

ii) A clearance is required between the stainless steel face of the elastomeric bearing and that of the vertical face of the face plate with stainless steel top installed on the projection below the soffit. This shall be achieved by inserting removable steel sheeting of thickness as per the drawing, during preparation of the formwork before casting of the superstructure.

iii) The face plate with stainless steel top and pack plate shall be assembled with the anchors with elastomeric washers and anchor screws. The assembly shall be fitted in the formwork at its proper location and in a vertical plane. The removable steel shims shall be removed at an appropriate time after the casting of the super-structure.

B. Installation with face plate and with template in-situ casting

i) Template of 6 mm MS plate and of size same as face plate with stainless steel top and matching holes for the anchor screws shall be used. Anchors shall be fitted to the templates with the anchor screws but with MS washers in place of elastomer washers. Separate screws may be used in case of inconvenience of in the length of original anchor screws. The above template assembly shall be fitted in the formwork for the super-structure at its proper location and in a vertical plane.

ii) After removal of the superstructure formwork, the template shall be removed.

iii) The face plate with the required thickness of pack plate shall be loosely fitted to the anchors embedded in the projection below the superstructure, with elastomer washers and anchor screws.

iv) The sub-assembly of elastomeric bearing with the MS backing plate shall be fitted to the embedded anchors in the pedestal with anchor screws and elastomeric washers replacing the steel washer this time.

v) The required clearance between the stainless steel face of the elastomeric bearing and that of the vertical face plate installed on the projection below the soffit shall be checked. After adjustment of the required working clearance the small gap between the vertical face of the projection below the soffit and the back of the face plate (with pack plates, if any) shall be grouted with epoxy grout.

2006. POT BEARINGS

2006.1. General

2006.1.1. Pot type bearings shall consist of a metal piston supported by a disc or unreinforced elastomer confined within a metal cylinder to take care of rotation. Horizontal movement, if required, shall with a system of sealing rings be provided by sliding surfaces of PTFE pads sliding against stainless steel mating surfaces. The pot bearings shall consist of cast steel assemblies or fabricated structural steel assemblies.

2006.1.2. Provisions of IRC-83 (Part I) shall be applicable for all metallic elements. Provisions of IRC:83 (Part II) shall be applicable for all elastomer elements. When any items are not covered by IRC:83 (Parts I and II), the same shall be as per guidelines given hereunder and BS:5400 (Sections 9.1 and 9.2), except that no natural rubber shall be permitted. If there is any conflict between BS on the one hand and IRC on the other, the provisions of IRC will be guiding.

2006.1.3. Combination bearings using any judicious combination and sliding element shall be permitted. As for example :

Name	Rotation Element	Sliding Element	Generally for
Pot	Pot	None	Vertical Load
Elastomer	Elastomer	None*	Horizontal Buffer
Pot PTFE	Pot	PTFE-SS**	Vertical Load and Horizontal Load
Spherical Knuckle PTFE	Spherical Knuckle	PTFE-SS**	Vertical Load and Horizontal Load
Elastomer PTFE	Elastomer	PTFE-SS**	Transverse Guide
Elastomer SS**	Elastomer	SS-SS**	Transverse Guide

* Elastomer shall permit movement by shear
** Stainless Steel

For special and innovative bridges, new combinations beyond what is shown may be required. The same may be used after approval by the Engineer.

2006.2. Fabrication

i) The surface mating with the PTFE in the sliding pair shall be corrosion resistant stainless steel. Normally, the stainless steel shall form the upper component. The stainless steel shall overlap the PTFE after full movement on all sides. If stainless steel sheet is used, it should be bonded by continuous welding along the edges. Adhesive or any other bonding can be approved by the Engineer. The surface shall be prepared by thorough cleaning to remove grease, dust or any other foreign substance.

ii) PTFE modular sheets of the sliding pair shall be located by confinement assisted by bonding. Confined PTFE shall be recessed into the metal backing plate. The shoulders of the recess shall be sharp and square to restrict the flow of PTFE.

iii) The thickness of the PTFE shall not be less than 4.5 mm with projection above the recess not exceeding 2.0 mm. When the piston is subjected to tilting, the seal must slide along the wall and alter its shape according to the angle of tilt. At the same time, it must be sufficiently rigid to bridge the gap between the piston and the wall of the pot. However, the percentage of plan area of the lubrication cavities to the gross area shall not exceed 25 per cent. The depth of the cavity shall not exceed 2.0 mm.

iv) The diameter to thickness ratio of the confined elastomer shall not exceed 15. The surface of the confined elastomer shall be smooth.

v) A seal shall be provided to prevent extrusion of the confined elastomer between the piston and the pot wall. The seal should stay functional under the loads and rotations acting on it. Additional seal shall be provided to prevent entry of dust into the pot. Sealing rings for pot bearings shall be fabricated from stainless steel. When the piston is subjected to tilting, the seal must slide along the wall and alter its shape according to the angle of tilt. At the same time, it must be sufficiently rigid to bridge the gap between the piston and the wall of the pot.

vi) The hardness of the piston and pot wall at their contact region shall be minimum 350 BHN to reduce wear. The surface finish of the pot base in contact with the confined elastomer shall be very smooth.

vii) All bearings shall be installed with anchor and anchor screws or some similar device such that while replacing, the bearings can be removed with minimum lifting of the superstructure.

viii) The external surfaces of the assemblies shall be completely cleaned by sand blasting. After sand blasting, dust shall be removed from the surface using clean and dry compressed air or a clean brush after which suitable coating shall be applied.

ix) Pot bearings including all parts as shown on the drawings shall be fully shop assembled at the manufacturer's works to ensure proper fitting of all parts.

2006.3. Materials

a) Steel

i) Structural steel shall conform to IS:226 and IS:2062, as applicable.

ii) Cast steel shall conform to Gr 280-520W of IS:1030. 0.3 to 0.5 per cent copper may be added to increase the corrosion resistance properties.

ii) Stainless steel shall conform to AISI:304 or XO4Cr18Ni1O of IS:6911 for ordinary applications. For applications with adverse/corrosive environment, the stainless steel shall conform to AISI:316L or O2Cr17Ni12Mo2 of IS:6911.

b) PTFE

PTFE (poly tetra fluoro ethylene) shall be of unfilled pure virgin quality. It shall be free sintered. The mechanical properties of unfilled PTFE shall comply with Grade A of BS:3784.

c) Elastomer

The confined elastomer inside pot will have the following properties :

a)	Hardness	IRHD	IS:3400 (Part II)	50 + 5
b)	Min tensile strength	MPa	IS:3400 (Part I)	15.5
c)	Min elongation at break,) Max compression set and) Accelerated ageing)		shall be as per Table 2000-I "Properties of Elastomer"	

For other details, refer to Clause 2005.1.

2006.4. Workmanship

2006.4.1. Welding

All welding shall conform to IS:9595 with electrodes of suitable grade as per IS:814. Preheating and post weld stress relieving shall be done as per IS:9595.

2006.4.2. Cast steel assemblies : Cast steel for pot bearing assemblies shall conform to requirements of relevant IS. Castings shall be true to the forms and dimensions shown on the drawings, and shall be free from pouring faults, sponginess, cracks, blow holes and other defects affecting their appearance or their strength. Warped or distorted castings shall not be accepted. Exposed surfaces shall be smooth and dense.

All irregularities, fins or risers shall be ground off flush with the adjacent surface. Castings with visible cracks, blow holes, or similar blemishes shall be rejected if the imperfections are located on bearing surfaces or cannot be remedied to the satisfaction of the Engineer.

Imperfections which are not located on bearing surfaces shall be cleaned out, filled with weld metal of the appropriate composition and ground flush with adjacent surfaces.

2006.4.3. Structural steel assemblies : Defects arising from the fabrication of the steel shall be inspected by the Engineer, who will decide whether the materials may be repaired by the Contractor or will be rejected. The cost of repairs or replacement shall be borne by the Contractor.

All steel whether fabricated or not, shall be stored above the ground on platforms, skids, or other supports, and adequately protected against corrosion. Excessively rusted, bent or damaged steel shall be rejected.

All plates shall be flat and rolled bars and shapes straight before marking out or being worked . Straightening shall be done by methods which shall not damage the material. Sharp kinks and bends shall be the cause for rejection.

Steel may be flame cut to shape and length so that a regular surface, free from excessive gouges and striations is obtained. Flame cutting by hand shall be done only with the approval of the Engineer.

Exposed corners shall be machined or ground.

2006.4.4. Tolerances

i)	Plan dimensions	:	-0 to +5 mm
ii)	Overall height	:	-0 to +3 mm
iii)	Height of elastomer	:	$\pm$ 5 per cent
iv)	Height of any steel component		
	a) Machined	:	-0 to +1 mm
	b) Unmachined	:	Class 2 of IS:4897
v)	Stainless steel sliding surface		
	a) Flatness	:	0.0004L, where L = length in direction of measurement
	b) Surface Finish	:	Ra $\leq$ 0.25 pm as per IS:3073

2006.4.5. Painting

i) All non-working surfaces shall be coated with two coats of epoxy primer and one or more coat each of epoxy intermediate and finish, total thickness $\leq$ 0.150 µm or any other painting scheme as approved by the Engineer.

ii) Silicon grease shall be applied at the PTFE/SS interface after testing.

iii) Anchor sleeves shall be cement coated at the manufacturer's works.

2006.5. Test

2006.5.1. Raw materials : Necessary test certificates for all raw materials as in Clause 2006.3 above shall be furnished by manufacturers. Reference may also be made to Clause 2005.1 for tests on elastomers.

2006.5.2. Test on casting : Tests specified in IS:1030 shall be performed. Castings shall be ultrasonically tested and certificates submitted. Quality level of castings shall be level 3 as per IS:9565.

2006.5.3. Test on welding : All welding shall be tested by Dye Penetration method. But welding shall be tested by Ultrasonic method. Soundness of welding shall be certified by the manufacturer.

2006.5.4. Acceptance test on bearing

i) All bearings shall be checked for overall dimensions.

ii) All bearings shall be load tested to 1.1 times maximum design capacity including seismic force. Bearing tested at higher loads cannot be used.

iii) A pair of bearings selected at random will undergo testing in order to determine the coefficient of friction "μ". The coefficient of friction shall be ≤ 0.05 at the design load.

iv) Two bearings selected at random shall be tested for permissible rotation.

2006.6. Installation of POT-cum-PTFE Bearings

2006.6.1. General

i) Care shall be taken during installation of the bearings to permit their correct functioning in accordance with the design scheme.

ii) To prevent contamination, dismantling of the bearings at site shall not be done.

iii) The load shall be transferred onto the bearings only when the bedding material has developed sufficient strength. The props for the formwork shall only be removed after lapse of appropriate time. In special cases, this can be ensured by suitable devices like jacks, etc.

iv) Temporary clamps and shims (introduced to maintain working clearance) shall be removed at an appropriate time, before the bearing is required to permit movement.

v) Permitted installation tolerance of the bearing from plane of sliding shall be maintained.

vi) Cement based non-shrink grout with air releasing additive and epoxy based grout, whichever is specified shall be first tried at the site. For the proprietary grout mixes, appropriate instructions from the manufacturer shall be followed specially with regard to the following :

a) Preparation->concrete cleaning, roughening, pre-soaking, etc.

b) Forms->sturdiness, leak proofing, shape, header funnel vents, etc.

c) Bearing Base->cleaning, etc.

d) Placement->mixing, consistency, time period, finishing, etc.

e) Protection->curing, ambient temperature, etc.

2006.6.2. In-situ casting of superstructure

i) Formwork around the bearing shall be carefully sealed to prevent leakage.

ii) Sliding plates shall be fully supported and care taken to prevent tilting, displacement or distortion of the bearings under the weight of wet concrete.

iii) Bearings shall be protected during concreting operation. Any mortar contaminating the bearing shall be completely removed before it sets.

2006.6.3. Seating of bearing

A. Using Template

i) Template with required rigidity and matching holes corresponding to the base of the bearing shall be used.

ii) All the anchors shall be fitted to the lower face of the template using the anchor screws but with steel washer replacing the elastomer washers. Separate screws may be used in case of inconvenience in the length of the original anchor screws.

iii) The template assembly shall be located with regard to level and alignment. It shall be ensured that the top of the anchors lie in a horizontal plane at the required elevation. The anchors shall be tied/welded to reinforcements to avoid displacement during concreting.

iv) Concreting of the pedestal/pier cap shall be done to a level leaving a gap of 25-50 mm below the template.

v) The template and steel washers shall be removed prior to placement of the bearing assembly with temporary clamps. The bearing assembly shall be fitted to the anchors with the help of anchor screws and elastomer washers. Level at the bearing shall be checked.

vi) The gap below the bearing assembly shall be grouted with cement based grout. Reference may be made to Clause 2006.6.1 (vi).

B. Without Template with Gap

i) Pockets commensurate with the sizes of the anchors shall be kept in pedestals during concreting of the same. The pedestal shall be cast approximately 25 mm short of the required finished level.

ii) Anchors shall be fitted to the bearing bottom with elastomer washers and anchor screws. The bearing assembly shall be seated in the location on steel chairs/packs. The anchors fitted below the bearing shall go into pockets in the bed block. Level and alignment of the bearing shall be checked. It shall be ensured that the bearing sits in a horizontal plane.

iii) The gap below the bearing assembly including anchor pockets shall be grouted with cement based grout. Reference may be made to Clause 2006.6.1 (vi).

C. Without Template without Gap

Elongated pockets commensurate with the sizes of the anchors shall be kept in pedestals during concreting of the same. The geometry and location of the anchor pockets (with tapered funnel extension, if required) shall be such that after placement of the bearing the pockets can be successfully grouted. The pedestal shall be cast 5 mm - 15 mm short of the required finished level. The required level shall be achieved by chipping before placement of the bearing. Careful control shall be exercised to cast at the exact finished level or 1mm - 3 mm down from the required finished level.

D. Seating of bearings shall be as per manufacturer's instructions.

2007. INSPECTION AND TESTING

Where any patents are used, the manufacturer's certificate with test proofs shall be submitted alongwith the design and got approved by the Engineer before their use in work.

2008. TESTS AND STANDARDS OF ACCEPTANCE

The materials shall be tested in accordance with these specifications and shall meet the prescribed criteria.

The work shall conform to these specifications and shall meet the prescribed standards of acceptance.

2009. MEASUREMENTS FOR PAYMENT

Bearings shall be measured in numbers, according to their capacities and particular specifications given on the drawings.

The quantity of elastomeric bearings shall be measured in cubic centimetres of finished dimensions.

2010. RATE

The contract unit rate of each type of bearing shall include the cost of supplying and fixing the bearings in position complete as specified on the drawings or as decided by the Engineer.

The rate shall also include the cost of samples and their testing when desired by the Engineer.

In case of steel bearings the rate shall include the cost of all nuts,

bolts, the cost of all tests prescribed in the specifications and shown on the drawings.

Where the Department supplies the bearings, the rate for fixing them shall include the cost of anchor bolts, their fixing, transport of bearings from the place of supply to the site, handling and placing them in position as per direction of the Engineer.