11.4 Common requirements

11.4.1 General

Delete the fourth paragraph and replace with:

All exposed and embedded steel components of joints and bearings shall be protected against corrosion. The corrosion protection system shall either be:

- hot-dip galvanizing in accordance with ASTM A123/A123M, or,
- metalizing to AWS C2.23M/C2.23 with a minimum zinc coating thickness of 0.3 mm, or
- a coating system which is selected from the Ministry's Recognized Product List.

The choice of corrosion system shall be subject to the consent of the Ministry.

The steel/concrete interface for both joints and bearings shall be detailed such that no rust staining of the concrete occurs.

Add the following to the list in the fifth paragraph:

(k) Traffic noise and ride-ability caused by the deck joint system.

Commentary: *Ministry experience has shown that bridge maintenance and rehabilitation is most commonly associated with deck joints and bearings. Designers should consider structural forms, such as integral abutments, continuous girders, and fixed pier joints, which either eliminate or minimize the use of deck joints and bearings.*

Where bearing assemblies are required to support structural steel girders fabricated from atmospheric corrosion resisting steel, the use of similar material for bearing plates may be considered.

11.5 Deck joints

11.5.1 General requirements

11.5.1.1 Functional requirements

All deck joints, except finger joints, shall be sealed. Unless otherwise consented to by the Ministry, expansion joints shall be designed as "finger" plate deck joints when the total movement is in excess of 100 mm. This shall not apply to bridges in regions of high seismicity.

Commentary: *In regions of high seismicity where large relative displacements may occur at deck joints, the joints chosen shall be suitable for the expected displacements.*

Add to the end of the fourth paragraph:

Cover plates over joints on bicycle paths or pedestrian walkways which are greater than 100 mm in width shall be surfaced with a non-skid protective coating which is acceptable to the Ministry.

Add to the fifth paragraph:

Deck joints with skew angles between 32 and 38 degrees shall be avoided by designers.

Commentary: *On bridges with large skews there is the possibility that the skew angle could match the angle used on snow plow blades (which is generally about 35 degrees) and this could result in a blade dropping into a deck joint and damaging it.*

In general, the use of deck joints should preferably be limited to skew angles of 30 degrees or less. The joint type should be carefully selected to accommodate the transverse displacements that are commonly experienced in skewed deck joint applications.

Proprietary joint products must either be listed in the Ministry's Recognized Products List or be consented to by the Ministry prior to use on a Project.

Water ingress into the abutment wall backfill or onto the substructure from the superstructure above shall be prevented. Joints between the superstructure end-diaphragm and the substructure shall be waterproofed with a material selected from the Ministry's Recognized Products List.

Modular deck joints may be used only when consented to by the Ministry.

Commentary: *Ministry experience is that modular joints are expensive and that a significant number of these joints have been replaced with finger joints after 20 to 30 years of service. Others have experienced maintenance problems that are costly to repair. Ministry consent is required on a project specific basis for their use.*

11.5.1.2 Design loads

Delete the third paragraph and replace with the following:

Except for modular joint systems, a horizontal load of 60 kN per metre length of the joint shall be applied as a braking load in the direction of traffic movement at the roadway surface, in combination with forces that result from movement of the joint, to produce maximum force effects. For modular joint systems the horizontal load shall be developed in consultation with the Ministry with the recommended load consented to by the Ministry.

11.5.1.5 Maintenance

Commentary: *When open joint drainage is used, access to the drain trough and other drainage hardware should be provided for inspection and maintenance.*

11.5.2 Selection

11.5.2.1 Number of joints

Commentary: *The main weakness in the various forms of deck joints has been the lack of durability and associated maintenance problems. Minimizing or eliminating deck joints should improve overall lifecycle performance. Where feasible, semi-integral or integral abutments should be considered in consultation with the Ministry.*

Damage to deck joints can be attributed to the increase in traffic volumes, especially heavier vehicles. Impact forces caused by vehicles passing over expansion joints combined with poor detailing has resulted in the leakage of surface run-off and de-icing salts onto the substructure and bearings.

11.5.2.3 Types of deck joints

Commentary: *Ministry experience has shown that a significant proportion of bridge maintenance and rehabilitation is attributable to poorly-performing deck joints. Designers should select joint types with a reliable track record. Good design and correct installation are key to good performance. Where feasible, expansion joints should be located at the abutments for accessibility.*

11.5.3 Design

11.5.3.1 Bridge deck movements

11.5.3.1.2 Open deck joints

Delete paragraph and replace with the following:

Only properly-detailed finger plate joints consented to by the Ministry will be allowed for use as an open deck joint. No other type of open deck joint will be allowed unless consented to by the Ministry. Control of deck drainage is mandatory and shall be detailed in accordance with Clause 11.5.8.

Commentary: *Ministry experience has shown that well designed cantilever finger joints require minimal maintenance. Sliding finger joints are susceptible to debris accumulation and wear of the sliding surface. Consideration should be given to designing the joint system so that it can be removed and replaced in sections.*

Bicycle tires present a problem for finger joints. Designers should consider measures to accommodate cyclists on the highway shoulders and in pathways.

11.5.3.2 Components

Commentary: *To engage with a reinforced concrete substrate, anchors should penetrate the reinforcing cage sufficiently to achieve the required joint anchorage. In detailing the joint anchorage, the designer should consider compatibility of the anchor spacing and details with the embedded reinforcement. This will help to ensure correct fit-up of the joint assembly.*

11.5.3.2.4 Bolts

Delete and replace with the following:

All anchor bolts for bridging plates, joint seals, and joint anchors shall be high-strength bolts fully tensioned as specified. Cast-in-place anchors shall be used for all new construction unless otherwise consented to by the Ministry. Expansion anchors shall not be permitted on any joint connection. Drilled-in epoxy anchors will be permitted with the consent of the Ministry. The use of tapered-head countersunk anchor bolts requires Ministry consent.

11.5.6 Joint seals

Only deck joint seals made of natural rubber or virgin neoprene shall be used.

Commentary: *Deck joint seals made of tyfoprene and santoprene have been observed to perform poorly and are not allowed. The use of silicone requires Ministry consent as it is only available at a significant cost premium.*

11.5.8 Open joint drainage

Delete and replace with the following:

"Finger" plate deck expansion joints shall have a drainage trough installed beneath. The drainage trough design shall consider the use of a corrosion-resistant plastic such as high density poly ethylene (HDPE). The trough shall be robust enough to prevent deflection when fully loaded with wet sand. All steelwork supporting the trough shall be galvanized or metallized after fabrication.

Where HDPE material is used for joint drainage, the material shall be UV-resistant. The design shall accommodate the coefficient of thermal expansion of HDPE which is an order of magnitude greater than steel.

Slopes for drainage troughs shall be maximized and where possible, the drainage trough should be sloped at a minimum of 10%. A 50 mm hose bib connection shall be provided to deck level, at the top end of the trough, to allow easy access and attachment for flushing and cleaning of the drainage trough during maintenance.

Commentary: *Deflection plates may be required between the underside of the finger joint and the top of the drainage trough to guide water into the trough.*

11.6 Bridge bearings

11.6.1 General

11.6.1.1 Add the following to the first paragraph:

Elastomeric bearings shall be used whenever possible.

Add to the end of the seventh paragraph the following:

Bearing replacement procedures shall be shown on the Plans, including jacking locations and jacking loads.

Enough space, both vertically and horizontally, must be provided between the superstructure and substructure to accommodate the required jacks for replacing the bearings. While it is difficult to establish a vertical clearance for all situations, a minimum vertical clearance of 150 mm is suggested. For steel girder bridges the web stiffeners of the diaphragms must be located accordingly.

Connections between girders and sole plates and the bearings and sole plates etc., must use bolts or cap screws on at least one interface to facilitate maintenance and replacement.

Proprietary products must be listed in the Ministry's Recognized Products List or consented to by the Ministry prior to use.

Commentary: *Elastomeric bearings accommodate the bi-axial rotational and displacements that are typically required for most bridge bearing applications. By accommodating superstructure displacements with shear strains, elastomeric bearings reduce maintenance requirements. Ministry experience is that correctly-designed elastomeric bearings have performed well and are a cost-effective solution.*

The inaccessibility of bearings creates a major problem for their inspection and maintenance. In the past little consideration has been paid to bearing accessibility. A suitable gap should always be provided between the top of the bearing seat and the soffit of the diaphragm, and as many sides of the bearing should be accessible as possible.

The use of concrete shear keys with appropriate rebar detailing may be considered for lateral seismic load restraint. Shear keys can be used in addition to the anchor bolt details. Shear keys are considered to be more cost-effective and require less maintenance than guided bearings.

The designer shall ensure compatibility between the various structural elements (shear keys and their allowable gaps, joints, and bearings).

Where practicable, a single line of bearings in lieu of a double row of bearings over the piers may result in a reduction in construction costs.

For seismic load applications the use of a base isolation system in accordance with Section 4 can be considered.

11.6.3 Sliding surfaces

11.6.3.4 Attachment

11.6.3.4.1 PTFE layer

Commentary: *Sheet polytetrafluorethylene (PTFE) should preferably be confined in a recess in a rigid metal backing plate for one half of its thickness. Sheet PTFE may be bonded or unbonded however, unbonded PTFE offers the advantage of ease of replacement.*

Delete the third sentence and replace with the following:

Sheet PTFE which is not confined must be bonded by an Approved method to a rigid metal surface.

11.6.4 Spherical bearings

11.6.4.1 General

Spherical bearings shall be installed concave part down to prevent accumulation of water and dirt.

11.6.6 Elastomeric bearings

Commentary: *See Clause C11.6.6 at the end of this Section for additional commentary on the design of elastomeric bearings.*

11.6.6.1 General

The design of unreinforced and steel reinforced elastomeric bearings for compressive deformation shall account for the different deformation responses in all layers of elastomer.

11.6.6.2 Materials

11.6.6.2.2 Elastomers

Commentary: *Table 11.5 in S6-14, Physical Properties of Polyisoprene and Polychloroprene, lists requirements for the physical properties of polyisoprene and polychloroprene but does not provide properties required for design, e.g., shear modulus and the relationship between compression stress, shape and compression strain. For design purposes AASHTO LRFD Bridge Design Specifications refer to shear modulus which is the most important physical property of the elastomer in bridge bearings. The designer is responsible for incorporating appropriate properties with the bearing design.*

11.6.6.3 Geometric requirements

Contrary to part (a), h_e shall be less than 25 mm and greater than 15 mm.

The shape factor must always be checked.

Commentary: *Problems with plain bearings that are too thin or too thick have been observed. Therefore, the allowable thickness has been amended here.*

The geometric requirements for laminated bearings are conservative and may reduce efficiency of the bearings as part of a seismic base isolation system (i.e. the bearings may be too stiff for seismic isolation if the geometric requirements are satisfied). The geometric requirements may be relaxed as long as stability of the bearings under different load combinations is checked explicitly and verified by testing in accordance with Clause 4.10 of S6-14.

The bearing pressure requirements for continuous strips may be waived where the bearing is used as a temporary bearing pad.

11.6.6.5 Fabrication

11.6.6.5.2 Laminated bearings

Add after first sentence the following:

Steel reinforced elastomeric bearings shall have at least two steel reinforcing plates and the minimum cover of elastomer for the top and bottom steel reinforcing plates and along the edges shall be 5 mm. Allowable tolerances on the cover amount shall be + 3 mm, - 0 mm.

Commentary: *It is recommended that a minimum cover of 5mm be specified with a tolerance of + 3 mm and – 0 mm on this amount.*

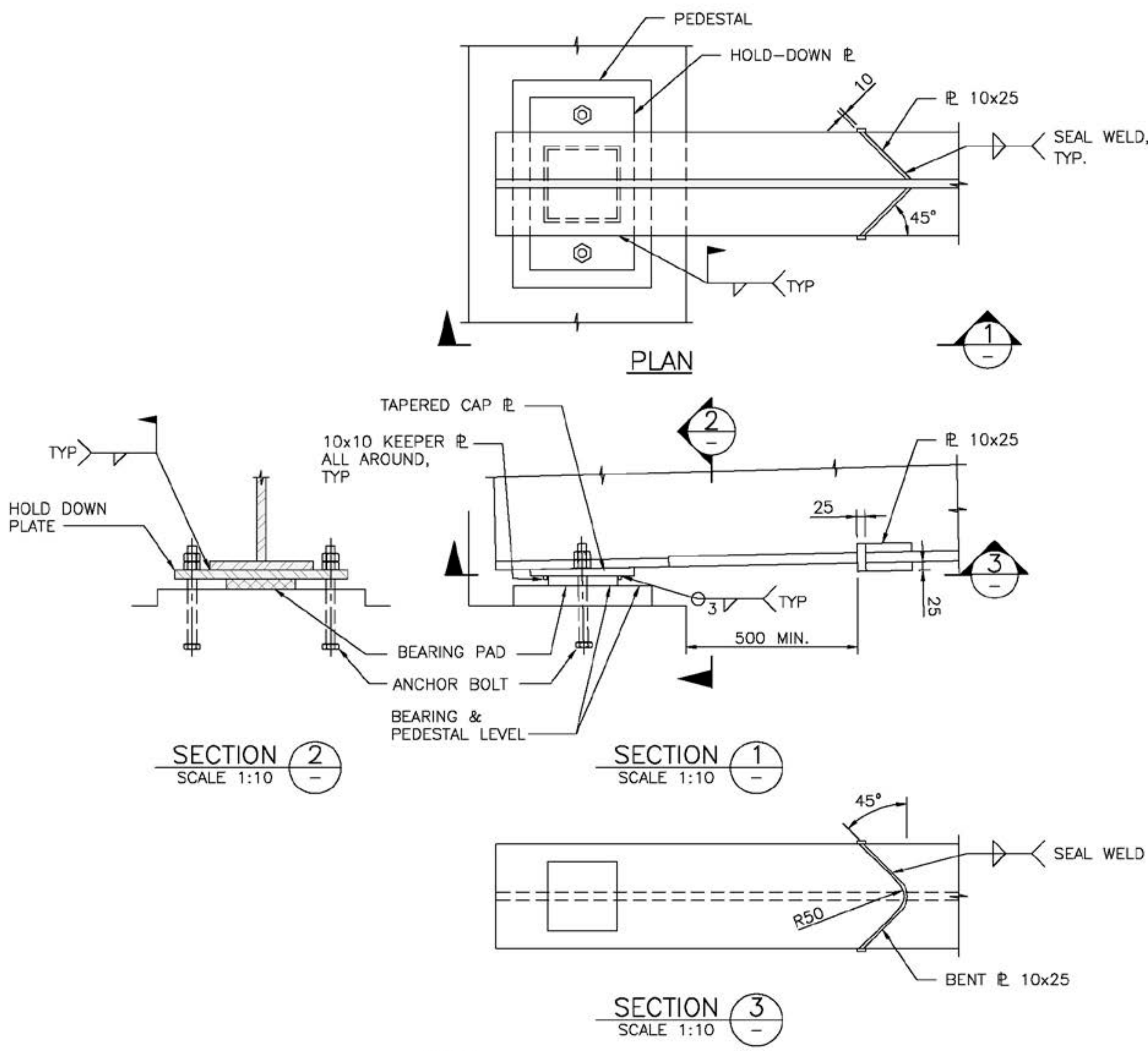
11.6.6.6 Positive attachment

Add the following:

The recommended attachment details for elastomeric bearings under non-seismic loadings shall be as shown in Figures 11.6.6.6 (a) and 11.6.6.6 (b) below.

The holes for anchor bolts in hold-down plates shall be slotted at expansion ends.

Figure 11.6.6.6 (a)
Bearing hold down details for steel girders

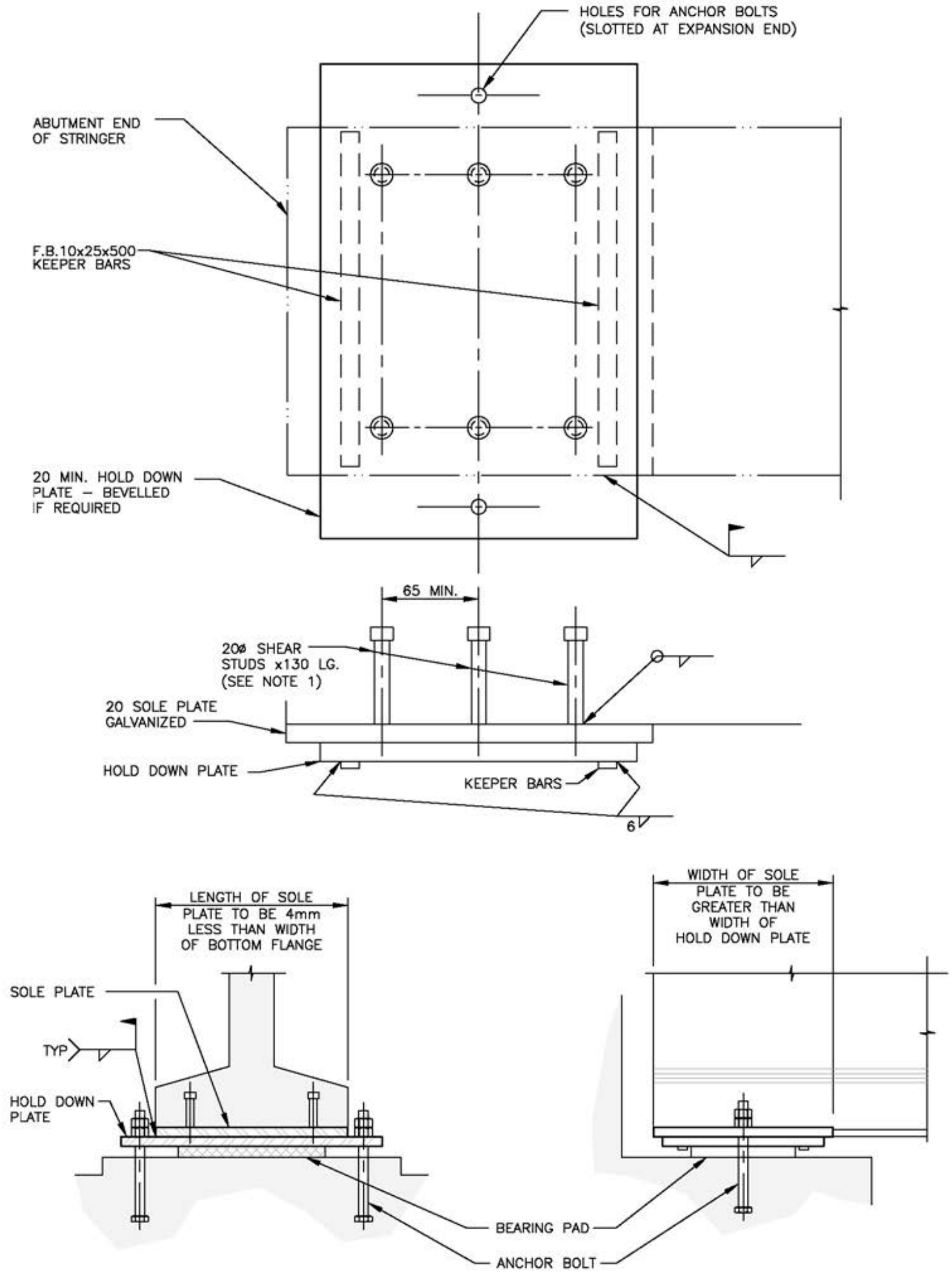


NOTES:

1. HOLES FOR ANCHOR BOLTS IN HOLD-DOWN PLATES SHALL BE SLOTTED AT EXPANSION ENDS.
2. FIELD WELD SHALL BE COATED WITH EITHER AN APPROVED GALVANIZING AGENT OR PAINT PRODUCT AFTER ERECTION.
3. WATER DEFLECTOR REQUIRED ON EXTERIOR GIRDERS, OPTIONAL FOR INTERIOR GIRDERS.

BEARING DETAILS AND BOTTOM FLANGE WATER DEFLECTOR ℄

11.6.6.6.(b)
Bearing hold down details for concrete girders



NOTES:

1. LENGTH OF STUDS TO BE ADJUSTED SUCH THAT THE STUD HEAD LIES BETWEEN LAYERS OF STRANDS.
2. GRIND OFF GALVANIZING ON EDGES OF SOLE PLATE AND TOP OF HOLD DOWN PLATE TO ACCOMMODATE WELDING. PAINT WELDS AND EXPOSED STEEL WITH AN APPROVED GALVANIZING AGENT AFTER ERECTION.

11.6.6.7 Bearing Pressure

Add the following:

The bearing pressure requirements for laminated bearings may be relaxed if the laminated bearings are used as part of a seismic base isolation system. However, the strain requirements for the laminated bearings under different load combinations shall be satisfied and verified by analysis and testing in accordance with Clause 4.10.

Commentary: *In Clause 4.10, design of elastomeric bearings for seismic base isolation is based on a strain approach. The equivalent shear strains in the rubber due to different load combinations are limited to the allowable values. The strain based design typically results in bearing sizes somewhat less conservative than those based on the bearing pressure requirements. This will increase efficiency of the bearings for seismic isolation.*

11.6.10 Load plates and attachment for bearings

11.6.10.2 Tapered plates

Unless otherwise consented to by the Ministry, bearings shall be installed level using tapered sole plates to account for differential slopes between the girders and the bearing seat.

Commentary on elastomeric bearings

C11.6.6 Elastomeric bearings

C11.6.6.8 Design procedure

C11.6.6.8.a Preamble

The following information is based on the AASHTO LRFD Bridge Design Specifications and is intended to provide assistance to designers for design of elastomeric bearings. The information is presented in the following format:

- *selection of design properties for elastomer,*
- *calculation of compressive deformations,*
- *determination of horizontal shear forces; and*
- *bearing testing.*

C11.6.6.8.b Elastomeric properties

If the elastomer is specified by hardness on the Shore A scale, a range of shear modulus, G, shall be considered to represent the variations found in practice as given in the following table (reproduced from Table 14.7.6.2-1 of the AASHTO LRFD Bridge Design Specifications):

Table C11.6.6.8b
Shear Modulus, G(1)

	Hardness (Shore A)	
	50	60
Shear Modulus @ 23℃ (MPa)	0.66-0.90	0.90-1.38
Creep deflection @ 25 years divided by instantaneous deflection	0.25	0.35

Notes:

(1) Reference Table 14.7.6.2-1, AASHTO LRFD Bridge Design Specifications

The shear modulus shall be taken as the least favourable value from the range in design.

If the elastomer is specified explicitly by its shear modulus, that value shall be used in design and shall be verified by shear test using the apparatus and procedure described in Annex A of ASTM D4014 (see Clause 18.2.5.3 of AASHTO LRFD Bridge Construction Specifications). The shear modulus *obtained from testing shall fall within 15 percent of the value specified in the contract documents.*

C11.6.6.8c Shape factor

The shape factor of an elastomeric layer shall be taken as the plan area of the layer divided by the area of perimeter free to bulge. For rectangular bearings without holes, the shape factor of a layer may be taken as:

$$S_i = \frac{LW}{2h_{ri}(L+W)} \qquad \textit{(Equation [1])}$$

Where:

L = *length of a rectangular elastomeric bearing (parallel to longitudinal bridge axis) (mm);*

W = *width of the bearing in the transverse direction (mm); and*

h_{ri} = *thickness of i^{th} elastomeric layer in a laminated bearing (mm).*

For circular bearings without holes, the shape factor of a layer may be taken as:

$$S_i = \frac{D}{4h_{ri}} \qquad \textit{(Equation [2])}$$

Where:

D = *diameter of a circular elastomeric bearing.*

If holes are present, their effect shall be accounted for when calculating the shape factor because they reduce the loaded area and increase the area free to bulge. Suitable shape factor formulae for an elastomeric layer with holes are:

For rectangular bearings:

$$S_i = \frac{LW - \Sigma\frac{\pi}{4}d^2}{h_{ri}(2L+2W+\Sigma\pi d)} \qquad \textit{(Equation [3])}$$

For circular bearings:

$$S_i = \frac{D^2 - \Sigma d^2}{4h_{ri}(D + \Sigma d)}$$ *(Equation [4])*

Where:

d = *the diameter of the hole or holes in the bearing (mm).*

C11.6.6.8.d Vertical compressive deformation

Instantaneous vertical compression deformation

If the elastomer is specified by hardness, the average total instantaneous vertical compressive deformation of a laminated bearing shall be taken as:

$$\delta = \sum \varepsilon_i h_{ri}$$ *(Equation [5])*

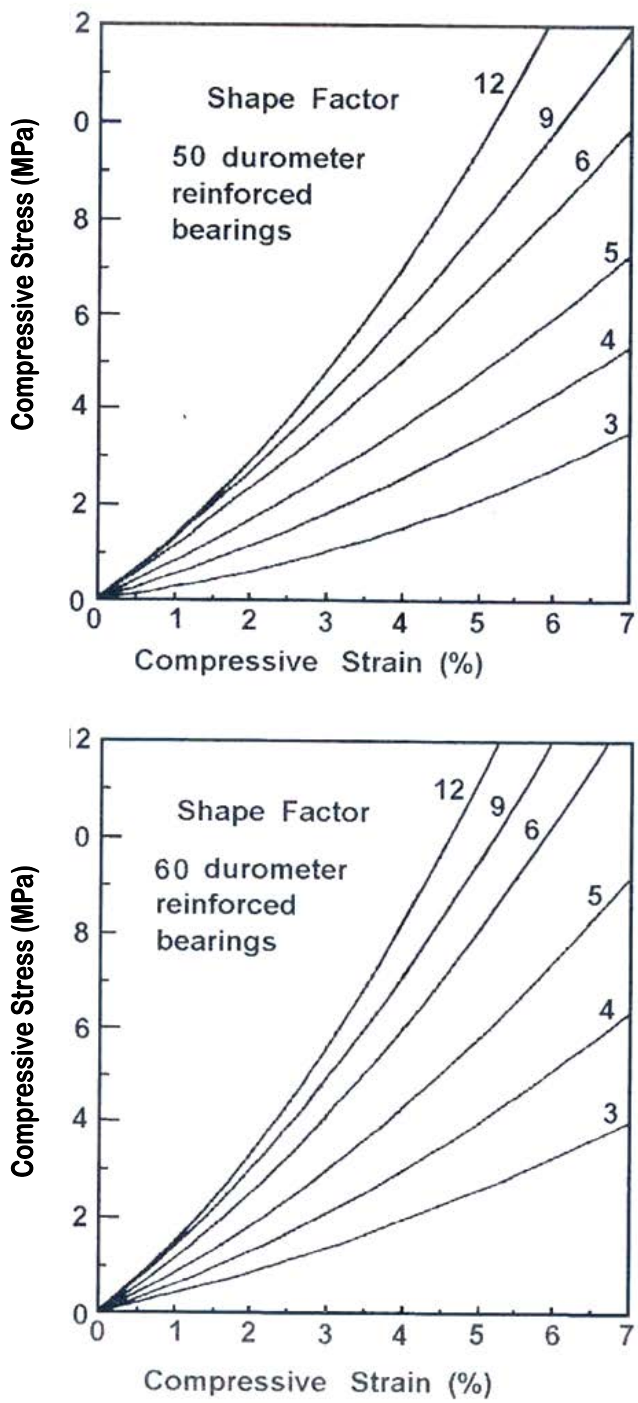
Where:

ε_i = *instantaneous compressive strain in i^{th} elastomer layer of a laminated bearing;*

h_{ri} = *thickness of i^{th} elastomeric layer in a laminated bearing (mm).*

In the absence of material specific data from testing, the following figure (reproduced from Figure C14.7.6.3.3-1 of the AASHTO LRFD Bridge Design Specifications) may be used to estimate vertical compressive strain of an elastomeric layer in a laminated bearing:

Figure 1
Vertical compressive stress-strain curves for elastomeric layer
(reproduced from Figure C14.7.6.3.3-1 of the
AASHTO LFRD Bridge Design Specifications)



If material-specific data from testing are available, the average total instantaneous vertical compressive deformation of a laminated bearing may be estimated as follows:

$\delta = \sum \delta_i$ *(Equation [6])*

Where:

δ_i *is the vertical compressive deformation of i^{th} elastomeric layer and given by*

$$\delta_i = \frac{\sigma_c h_{ri}}{E_0(1+2kS_i^2)} = \frac{\sigma_c h_{ri}}{4G(1+2kS_i^2)} \quad \textit{(Equation [7])}$$

Where:

σ_c = *average compressive pressure at SLS (MPa);*

h_{ri} = *thickness of i^{th} elastomeric layer in a laminated bearing (mm);*

S_i = *shape factor of i^{th} elastomeric layer in a laminated bearing;*

E_0 = *elastic modulus of elastomer typically taken as 4G (MPa);*

G = *shear modulus of elastomer (MPa); and*

k = *elastomer material coefficient for compressive deflection.*

In the absence of test data, the compressive deflection of a plain elastomeric bearing may be estimated as 3 times the deflection estimated for steel-reinforced bearings of the same shape factor (Figure 1 and Equation 7) in accordance with Clause 14.7.6.3.3 of AASHTO LRFD Bridge Design Specifications.

Creep vertical compressive deformation

The effects of creep of the elastomer shall be added to the instantaneous deflection when considering long-term deflections. In the absence of material-specific data, the values given in Supplement Table C11.6.6.8b may be used.

C11.6.6.8.e Horizontal forces

The factored horizontal force due to shear deformation of an elastomeric bearing shall be taken as:

$$H_u = GA\frac{\Delta_u}{h_{rt}} \qquad \text{(Equation [8])}$$

Where:

G = *shear modulus of the elastomer (MPa);*

A = *plan area of the elastomeric bearing (mm2);*

Δ_u = *factored shear deformation (mm); and*

h_{rt} = *total elastomeric thickness (mm).*

If an elastomer is specified by its hardness, the upper bound value of shear modulus in the range shall be used in estimating the horizontal force transmitted from the bearing to the substructure. The effects of cold temperature on shear modulus shall also be considered. Unless material-specific data from testing are available, the effects of cold temperature may be considered in accordance with Clause 14.7.5.2 the AASHTO LRFD Bridge Design Specifications. The horizontal force resulting from shear deformation of the elastomer shall be considered in the design of the substructure unless a low friction sliding surface is provided. If the horizontal force transmitted is governed by the sliding surface, a conservative estimate of the friction force shall be considered (see Clause 14.7.5.2 of AASHTO LRFD).

C11.6.6.8.f Bearing testing

The elastomeric bearings shall be tested in accordance with the requirements specified in the Ministry of Transportation and Infrastructure Template Special Provisions: Appendix - Supply, Fabrication and Installation of Bearing Assemblies.

A copy of the Special Provisions and Appendix - Supply, Fabrication and Installation of Bearing Assemblies is available at:

http://www.th.gov.bc.ca/publications/eng_publications/bridge/bridge_standards.htm#provisions

C11.6.6.8g Commentary

The above information provides additional design aids for elastomeric bearings, particularly for selection of design properties for elastomer, *calculation of vertical compressive deformation in the elastomer, and horizontal shear force resulting from shear deformation in the elastomer. This information is based on the design provisions of the AASHTO LRFD Bridge Design Specifications.*

The design provisions for elastomeric bearings in the AASHTO LRFD Bridge Design Specifications are almost identical to those in the AASHTO Standard Specifications. In AASHTO, it is recognized that shear modulus, G, of the elastomer is the most important material property for design. Hardness has been widely used in the past because the test for it is quick and simple. However, hardness is at best an approximate indicator of the engineering properties of the elastomer and correlates only loosely with shear modulus. Therefore, AASHTO allows two ways of specifying material properties for elastomer. One method is to specify hardness on the Shore A scale, and a range of shear modulus values corresponding to the specified hardness should be considered to cover the expected variations found in practice. The shear modulus shall be taken as the least favorable value from the range in design, e.g. lower bound shear modulus for calculating vertical compressive deformation of the elastomer and upper bound shear modulus for estimating horizontal shear force transmitted by the bearing to the substructure. The other method is to specify the shear modulus explicitly. In this case, shear tests using the apparatus and procedure described in Annex A of ASTM D4014 shall be conducted to verify that the shear modulus values obtained from testing fall within 15 percent of the value specified.

Equations [1] and [2] are the shape factors for rectangular and circular bearings without holes. The shape factor of an elastomeric layer is the loaded area of the bearing in plan divided by the area of the layer which is free to bulge, and is an approximate measure of this bulging restraint. The shape factor, S, is an important design parameter for elastomeric bearings because the vertical compressive strength and stiffness of the bearing are approximately proportional to S and S2. Holes are discouraged in reinforced elastomeric bearings. If holes are present, Equations [3] and [4] should be used to calculate the shape factors for rectangular and circular bearings.

Figure 1 is reproduced from Figure C14.7.6.3.3-1 of the AASHTO LRFD Bridge Design Specifications. The figure shows vertical compressive stress-strain curves for elastomeric layers with different values of shape factor for 50 or 60 durometer reinforced elastomeric bearings. These curves are based on the lower bound value of shear modulus for a given hardness.

Equation [7] is commonly used to calculate instantaneous vertical compressive deformation of an elastomeric layer in a laminated bearing (see Goodco catalogues, papers on elastomeric bearing design, and AASHTO Guide Specifications for Seismic Isolation Design). The material constants used in the equation should be verified by testing, or lower bound values should be used if hardness is specified for the elastomer.

Unreinforced elastomeric pads frequently slip at the loaded surfaces under applied compressive load resulting in a significant increase in the compressive deflection. This is accounted for by applying a factor of 3 to the deflection estimated for steel-reinforced bearings of the same shape factor.

If the elastomer is specified by hardness, the upper bound value of its shear modulus should be used in estimating the horizontal force transmitted from the bearing to the substructure. Shear modulus increases as the elastomer cools, but the extent of stiffening depends on the elastomer compound, temperature, and time duration. It is, therefore, important to specify a material with low-temperature properties that are appropriate for the bridge site. The effects of cold temperature on shear modulus should be considered in estimating the horizontal force transmitted from the bearing to the substructure. Unless material-specific data are available from testing, such effects may be considered in accordance with Clause 14.7.5.2 of the AASHTO LRFD Bridge Design Specifications. The upper bound horizontal force resulting from bearing shear deformation shall be considered in design of the substructure unless a low friction sliding surface is provided. If the horizontal force transmitted is governed by the sliding surface, a conservative estimate of the friction force shall be used.

Quality control test shall be conducted on all elastomeric bearings.

CSA-S6-14 does not include any testing provisions for elastomeric bearings, except for elastomeric bearings used as part of a seismic base isolation system.

The AASHTO LRFD Bridge Construction Specifications specify both short-term and long-term compression proof load tests for elastomeric bearings. Short-term compression proof load test is required for every bearing where the bearing is loaded in compression to 150% of its rated service load. The load is held for 5 minutes, removed, then reapplied for a second period of 5 minutes. The bearing is then examined visually when under the second loading. Long-term compression proof load test is required only for one random sample from each lot of bearings. The long-term compression test is similar to the short-term test except that the second load is maintained for 15 hours.

In the current Ministry Special Provisions template, a compression load test is required for every laminated bearing. The compression test specified in the Ministry's 'Appendix – Supply, Fabrication and Installation of Bearing Assemblies' as part of the Special Provisions template is somewhat different from that specified in AASHTO. The compression test specifies sequences of loading and unloading in increments and requires measurement of not only axial load (average pressure) but also axial deformation at different steps. Therefore, this test is more involved than the compression tests required in AASHTO, but it provides additional information on bearing axial stiffness. The *time required for this test will be longer than the AASHTO short-term compression test, but significantly shorter than the AASHTO long-term compression test. Previous experience indicates that any bulging suggesting poor laminate bond will show up almost immediately after application of the vertical load, and the test requirement in the Ministry Special Provisions template would be adequate.*

The advantages of short-term compression testing can be seen from the following figures:

Figure C11.6.6.8.f.1
Splitting along a bulge (above the number 50)

Figure C11.6.6.8.f.2
"Roll out" of the bottom of the bearing along the right face, possibly because the thickness of the lowest layer of rubber was too thick

Figure C11.6.6.8.f.3
Loss of bonding between two layers of rubber. Note the coin inserted into a crack

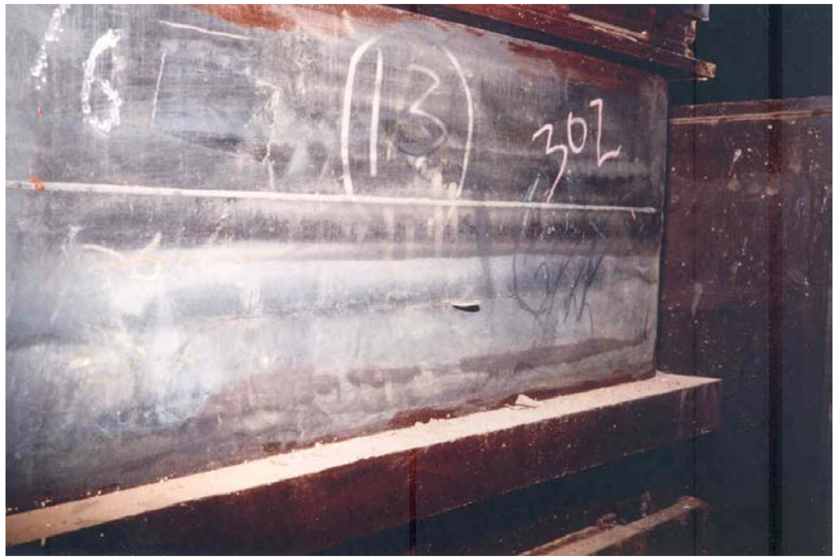


Figure C11.6.6.8.f.4
Evidence from the bulges that the top plate is bent along the right face

Figure C11.6.6.8.f.5
Loss of bond between two rubber layers