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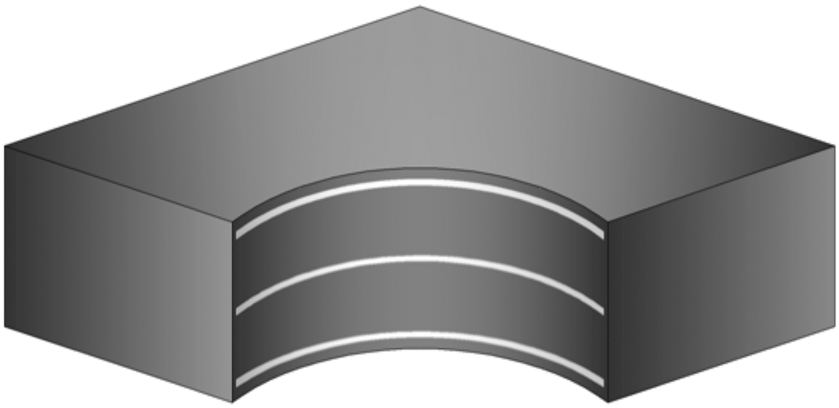
INTRODUCTION — ELASTOMERIC BEARINGS

Introduced nearly 60 years ago, Laminated Steel/Elastomer Bearing Pads are now in service in tens of thousands of bridges and similar structures throughout the world. There is good reason for this. They support vertical loads with minimal compression, allow expansion and contraction of the structure with minimal resistance and provide for normal end rotation of bridge beams. In addition, they are easily installed and maintenance-free. All this is encompassed in a unit having the lowest cost per unit of supported load up to approx. 350 kips (1500 kN).



TYPICAL LAMINATED ELASTOMERIC BEARING

More sophisticated designs can be incorporated into an integrated structural system that channels horizontal loads to strong points and away from weaker ones. Ultimately such systems are used to mitigate the severe loading conditions caused by earthquakes. The Cosmec/Dynamic Rubber Team is pleased to offer Laminated Steel/Elastomer Bearings to suit any owner or State Specifications. With our extensive design experience we can readily provide designs for specialty applications to meet unique design criteria or specific design requirements.

STANDARD BEARINGS — ELASTOMERIC BEARINGS

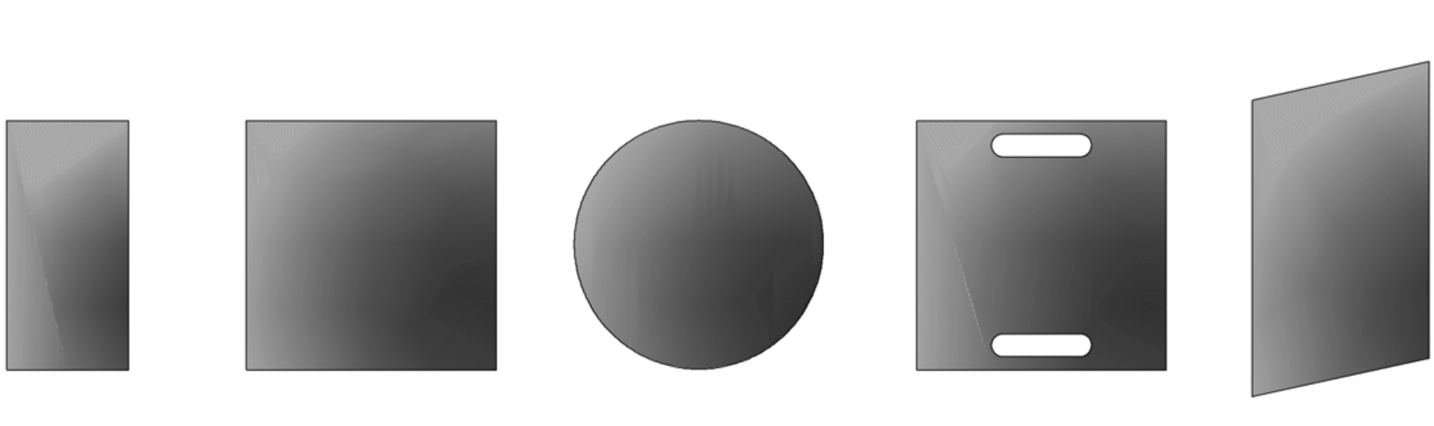
A wide range of loads can be accommodated by varying the plan area, the thickness of internal elastomer layers and the elastomer hardness. Plan areas should be chosen on the basis of bearing seat dimensional limitations as well as loads.

Changing the elastomer hardness and increasing the effective thickness by adding layers are methods of varying the resistance to horizontal movement and the amount of such movement.

Beam end rotations up to about 0.02 radians can readily be accepted by adding to the effective elastomer thickness.

Bearings can be molded in rectangular, square, circular or other shapes. Note that custom shapes, clipped corners, slotted, skewed and tapered bearings may carry cost premiums due to mold modifications.

Plain Elastomeric Pads, without internal shim plates, can also be supplied by Cosmec. These Plain Elastomeric Pads can be molded the same as Laminated Bearing Pads.



EXAMPLES OF POSSIBLE LAMINATED BEARING SHAPES

DESIGN ALTERNATIVES—ELASTOMERIC BEARINGS

Tapered bearings can be provided. The taper can be accomplished by using a tapered steel plate (Fig. 1), or for slight tapers, by tapering the elastomer layers. Special loadings can sometimes be met by inclined mounting of bearings.

A particularly common variation is shown in Fig. 2. This hybrid Elastomeric/Sliding Bearing provides a stainless-steel-on-PTFE slip plane on top of a conventional Elastomeric Bearing. Daily movements are taken within the elastomer; greater movements cause greater shear force in the elastomer, which overcomes the friction at the PTFE/stainless steel interface thereby accommodating these greater, less frequent movements through sliding.

FIGURE 1

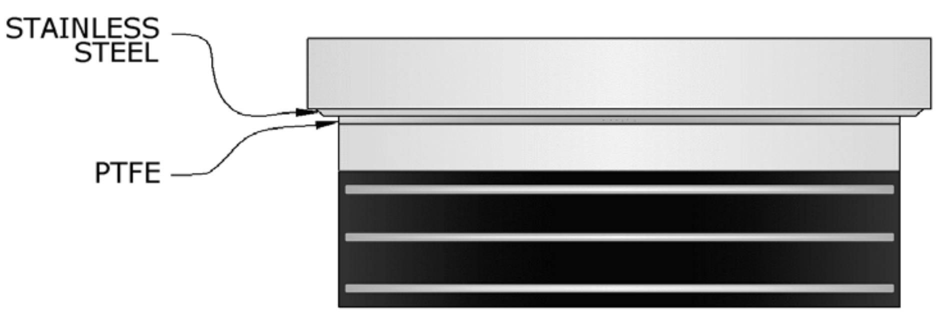


FIGURE 2

Customized ancillary plates (or “Load” plates) can be vulcanize-bonded to bearings to provide specialized mounting and anchoring systems (See Figs. A through C). They can be shaped and/or drilled to most requirements. If they are to be welded in place, they must be detailed to mitigate excessive heat transfer to the elastomer. Our Engineering Staff will be pleased to advise you on any special project application or requirements.

FIGURE A

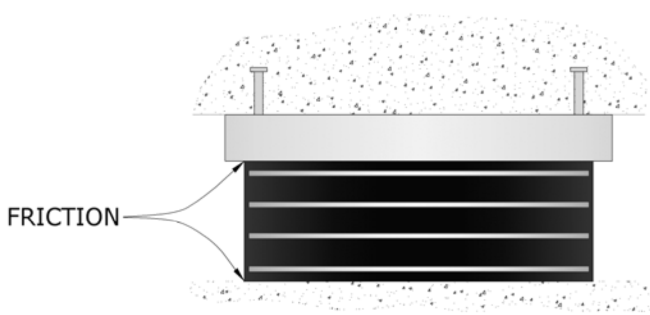


FIGURE B

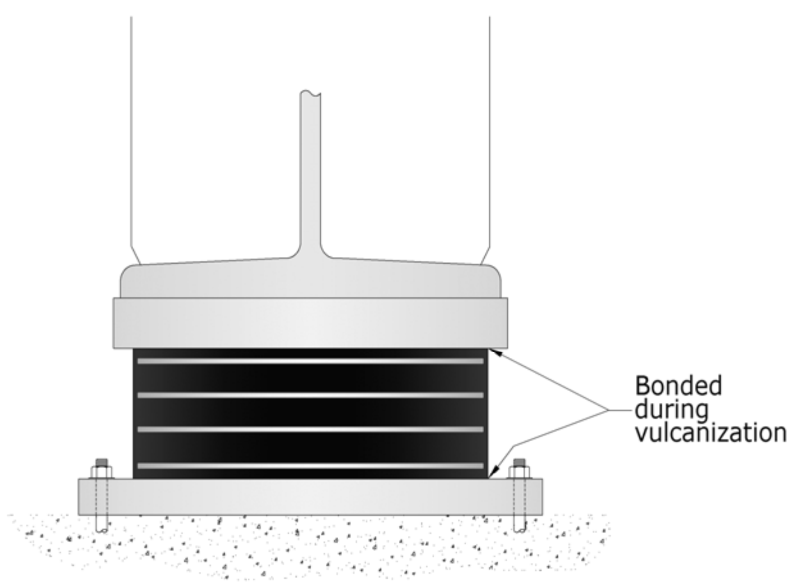


FIGURE C

DESIGN — ELASTOMERIC BEARINGS

While AASHTO Specifications allow two design approaches (Methods A and B, Section 14) many States have super-imposed their own limitations on the design process. Local requirements should be checked before commencing design.

However the following formulae offer simple predictions of the performance of bearings with fully bonded layers*:

$$K_1 = \frac{E_c A}{t \cdot n \cdot \beta} \qquad K_2 = \frac{GA}{t \cdot n}$$

Where:
- L is bearing length
- B is bearing width
- D is diameter of a circular bearing
- K_1 is the spring rate in compression
- K_2 is the spring rate in shear
- A is plan area of the bearing
- t is the thickness of the individual elastomer layers
- n is the number of individual elastomer layers
- G is the shear modulus of the elastomer (see Table 1)
- E_C is the compression modulus of the elastomer

Also note that:

$$E_C = E_O (1 + 2kS^2)$$

Where:
- E_O is Young's Modulus for the elastomer (see Table 1)
- K is a numerical factor (see Table 1)
- S is the shape factor, defined as the loaded area divided by the force area.

In the interest of longevity, compression strain should be limited to 15% and shear strain to 50%.

To insure stability, total bearing thickness should not exceed the smaller of L/3, B/3 or D/4 for Laminated Bearings.

* *If either, or both faces of an individual elastomer layer are not bonded to a steel plate, then compression will be modified by the β factor. The β factor is 1 for a fully bonded layer, 1.4 for a layer bonded on one face, and 1.8 for an unbonded layer. (Note that the β factor does not apply to shear calculations).*

TABLE 1

Hardness (Shore A)	Young's Modulus E_0	Shear Modulus G	k Factor
50	312 psi (2.2 MPa)	100 psi (0.68 MPa)	0.73
60	635 psi (4.4 MPa)	150 psi (1.04 MPa)	0.57
70	1040 psi (7.2 MPa)	245 psi (1.69 MPa)	0.53

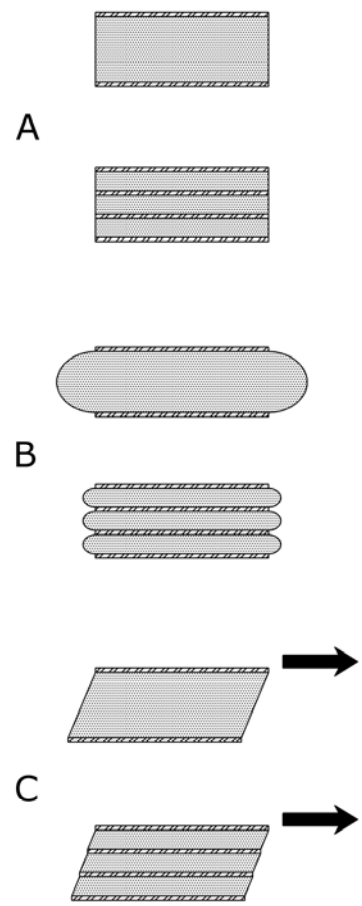


Diagram showing the effect of steel reinforcing plates.

A. Unloaded bearings with & without reinforcing plates.

B. The same bearings with vertical load applied.
The reinforced unit has greater stiffness.

C. The same bearings with horizontal load applied.
Reinforcing plates do not affect shear.

MATERIALS — ELASTOMERIC BEARINGS

The elastomers used in our bearings conform to State and/or AASHTO Specifications for bearings. Their minimum physical characteristics are as shown in Table 2. Additional physical characteristics may be required. Use of polychloroprene (neoprene) or polyisoprene (natural rubber) is influenced by factors such as temperature, cost and slippage. Other elastomers may be recommended for special applications.

TABLE 2

Material Properties	ASTM Standards	Test Requirements	Polyisoprene (Natural Rubber)	Polychloroprene (Neoprene)	Units
Physical Properties	See AASHTO M251 Section 8.8.4	Min. Shear Modulus	79.8 (0.55)	79.8 (0.55)	psi (MPa)
	ASTM D412	Min. Tensile Strength	2,248 (15.5)	2,248 (15.5)	psi (MPa)
	ASTM D412	Min. Ultimate Elongation	450	400	Percent
Low Temperature Brittleness	ASTM D746 Procedure B	Grade 0 to 2	No Test Required	No Test Required	
		Grade 3 - Test @ -40^{o} F (-40^{o} C)	Passes	Passes	
		Grade 4 - Test @ -54.4^{o} F (-48^{o} C)	Passes	Passes	
		Grade 5 - Test @ -70.6^{o} F (-57^{o} C)	Passes	Passes	

Reinforcing plates (or shims), typically are made from rolled mild steel such as ASTM A570 or A1011 (or equivalent). Other metals can be supplied on special order.

STRUCTURAL DESIGN — ELASTOMERIC BEARINGS

Bearings are normally mounted with their short side parallel to the girder axis for maximum rotation capacity. However orientation at any angle in the horizontal plane will not affect the shear resistance.

Friction is usually sufficient to keep bearings in place, but if minimum loads are light, then a slippage check must be made; use a friction coefficient of 0.2 between elastomer and steel or pre-cast concrete. A coefficient of 0.3 may be used for elastomer against broom-finished concrete or similar roughened surface.

If positive location is required, vulcanized bonding to steel plates is suggested (see Fig. C). Various installation arrangements are shown in Figures A through C.

INSTALLATION — ELASTOMERIC BEARINGS

Seating on flat, broom-finished concrete, free of voids, or on mill-finished steel plate is satisfactory. If a grout pad is specified it should be a high-strength non-shrink material. Epoxy grout may serve to correct seating inaccuracies. By placing the bearing and beam before the epoxy has set, excess epoxy will be extruded from high spots and remain in voids. Loading subsequent to the epoxy setting, will then be distributed evenly.

If formwork is erected around a bearing for poured-in-place construction, allowance must be made for bearing compression to avoid jamming the formwork.

Note that if the welding of attachment plates is contemplated, caution must be exercised to prevent temperatures exceeding 250° F/130° C at the rubber/steel interface. Temperatures above this may damage the elastomer.

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