Specifications for steel-reinforced elastomeric bearings for bridges have seen steady improvement over the past half-century.

product expert series

BEARING STRAIGHT

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BRIDGE MOVEMENT HAPPENS.

The earliest simple-span steel bridges used various types of steel bearing assemblies to accommodate movements of the superstructure, which unfortunately often became maintenance problems because of corrosion issues. As design tools improved, engineers were given an opportunity to construct longer, multi-span continuous bridge systems that increased the load, movement and rotation demands on the bearing assemblies.

The construction of larger bridges led to the introduction of new bearing systems, such as elastomeric bearings, in the late 1950s and various styles of high-load multi-rotational bearings over the next two decades. These new systems often performed better than steel bearings, and now with more than 50 years of service history, steel-reinforced elastomeric bearings have proven to be a cost-effective, durable and maintenance-free solution for many bridge projects.

Steady Improvement

The design codes for these new bearing systems lagged their introduction into the market by several years, and consequently there has been a steady improvement in the content of the AASHTO bridge design and construction specifications since the late 1950s. Many readers may remember the original DuPont de Nemours and Company's *Design of Neoprene Bearing Pads* publication, which was introduced in 1959 and governed the design of elastomeric bearings until the mid-1980s. Most recently, in 2009, significant changes were made to the steel reinforced elastomeric bearing design provisions in the AASHTO *LRFD Bridge Design Specification* based on a comprehensive research project conducted at the University of Washington. These changes include a simplification of the more liberal Method "B" design procedure, which evaluates shear strains in the bearing caused by axial force, rotation and shear displacement. The total allowable shear strain of 5.0 is slightly higher than the value implicit in earlier versions of the AASHTO specification, which results in a wider range of use for steel reinforced elastomeric bearings.

Although elastomeric bearings are often thought to only accommodate loads from smaller structures, steel-reinforced elastomeric bearings can be economically designed today for vertical loads in excess of 1,000 kips with rotations below 0.02 radians and translations less than +/- 4 in. Cost-effective designs can also be fabricated to even higher vertical loads if translations are limited to +/- 2 in. and horizontal loads are carried through external devices like shear blocks. High-load multi-rotational bearings are often specified on structures with larger rotation and translation demands.

The Right Design

Steel-reinforced elastomeric bearings can be fabricated using polyisoprene (natural rubber) or polychloroprene (Neoprene). However, natural rubber is the best material to meet all of the requirements for low-temperature, AASHTO Zone "E" environments. Although larger sizes can be fabricated, practical limits on the plan area and height of the complete molded assembly, including any external bonded steel plates, is approximately 48 in. by 48 in. and 15 in. in height. Elastomeric layer thicknesses should be determined based on the shape factor necessary to produce an acceptable design, and do not need to be rounded to common fractional units. Elastomeric bearings are typically detailed with rectangular shapes, which provide the most cost-effective solution. However, for bridges on curved alignments or short-span highly skewed structures where the direction of movement and live load rotation may not be along the same axis, a bearing with a circular plan area could be considered. A circular steel-reinforced elastomeric bearing is also a good

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solution at skewed abutment supports with limited space to fit a rectangular bearing assembly; fabrication costs for a circular bearing are no more than 5% to 10% more than an equivalent rectangular bearing assembly.

Shifting Focus

One of the most visible changes made to the AASHTO Method "B" design specification for steel-reinforced elastomeric bearings is the shift away from hardness—50 or 60 "Shore A" Durometer—as the defining material property to shear modulus (G). Although the test for hardness is quick and simple, the results do not correlate very closely to the more important shear modulus. This material property directly impacts the design and performance of elastomeric bearings, as it defines the capacity of the bearing to handle vertical loads, rotation and horizontal deformations. It is important to note that when shear modulus is used to specify the elastomeric material, hardness requirements should not be specified to allow bearing manufacturers flexibility with compound development. Current AASHTO provisions require selection of a shear modulus between 0.080 and 0.175 ksi, and engineers should be aware that a variation of +/-15% from the value selected is permitted.

The only feature of high-load multi-rotational bearings not easily incorporated with elastomeric bearings is the offsetting of expansion bearing assemblies to account for varying temperatures at the time of installation. This can be solved by resetting the bearings at a later time or designing the bearings for an amplified amount of longitudinal movement, which allows girders to be set on the bearings at a range of temperatures around the mid temperature. The AASHTO commentary suggests using 65% of the thermal movement range as the design horizontal displacement, which allows for installations within +/-15% of the average of the maximum and minimum design temperatures (i.e., mid temperature). If the girders can be set on the bearings at the mid temperature, or if provisions are made for jacking the bridge superstructure to reset the bearings, then the design horizontal displacement can be reduced to 50% of the thermal movement range.

If you believe a steel-reinforced elastomeric bearing assembly can be used on your next project, additional information on selection guidelines, cost-effective details and inspection/maintenance recommendations can be found in the NSBA *Steel Bridge Design Handbook*, Chapter 18 – Bearing Design. MSC