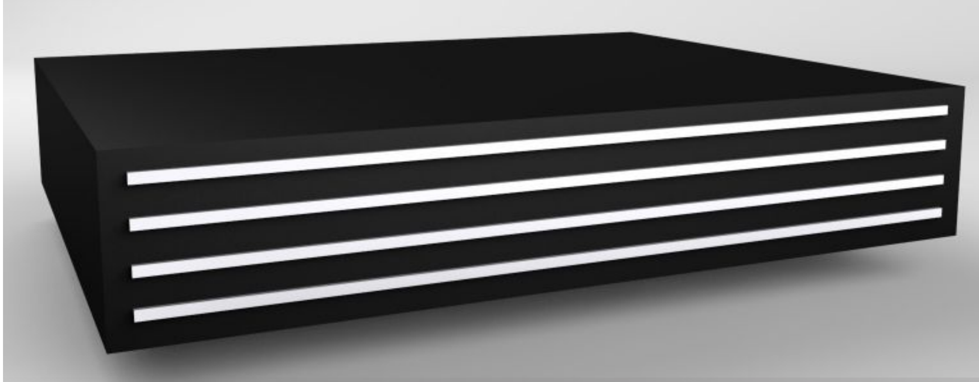
Elastomeric Bearing Pads: Ask the Experts

Two industry experts provide insights and advice regarding the important topic of elastomeric bearings for concrete bridges

by Monica Schultes

Elastomeric bearings allow transfer of vertical loads, horizontal movement, and structural rotation. They are valued for their durability, reliability, low maintenance requirements, and low cost. Because elastomeric bearing pads are crucial for safe and cost-effective concrete bridge design, we posed questions about them to the experts. Their responses were edited for clarity and brevity.



Steel-laminated elastomeric bearings are commonly specified for their versatility and low maintenance. The number and thickness of the steel laminates, the thickness of the internal layers of elastomer, the cover (external layer) thickness of the elastomer, the shear modulus of the elastomer, and plan dimensions of the bearing are among the parameters that must be designed for a steel-reinforced elastomeric bearing. All Photos and Figures: The D.S. Brown Company.

What percentage of bridge bearing pads are elastomeric, either plain or laminated?

Rob Anderson, Scougal Rubber: We see 100% elastomeric bearing pads, unless the bridge is very large and under extreme loading. Steel-laminated (that is, steel-reinforced) elastomeric bearings are manufactured with alternating layers of neoprene or natural rubber and steel sheets; then vulcanization permanently bonds the steel laminates to the rubber.

Ryan Schade, The D.S. Brown Company: Approximately 90% of bridge bearings that we see are elastomeric (plain or steel-reinforced elastomeric pads). We supply both; however, there are a few other types of bearings, some of which we also supply: HLMR [high-load multirotational] bearings for high-load and/or rotation conditions, and cotton-duck-impregnated rubber pads, which are stiffer and utilize a harder elastomer. There are also random-oriented fiber pads, which are exceedingly rare for bridges and are not covered by the American Association of State Highway and Transportation Officials' *AASHTO LRFD Bridge Design Specifications*.[1]

What changes or innovations in bearing pads for concrete bridges have occurred in the last decade?

Scougal: In the past 10 years we have seen higher loads and higher rotations in bridge design.

D.S. Brown: The AASHTO LRFD specifications updated the design methodology so that Method B has evolved into a strain-based design, and Method A now allows slightly increased stresses. Sampling and lot requirements were recently updated in AASHTO M251, *Standard Specification for Plain and Laminated Elastomeric Bridge Bearings*.[2]

What changes are forthcoming?

D.S. Brown: The AASHTO Product Evaluation and Audit Solutions program (formerly the National Transportation Product Evaluation Program [NTPEP]) is expanding to include more agencies that prequalify bearing manufacturers.

Scougal: NTPEP is a worthwhile program, and the independent audits provide a level of confidence similar to plant certification. AASHTO needs to encourage wider participation in the program in order to reap the benefits.

What are the advantages of AASHTO LRFD Method A (Article 14.7.6) versus Method B (Article 14.7.5)?

Scougal: In our opinion, Method A is a simpler design. AASHTO M251 has specific tests for Methods A and B. There are additional tests in AASHTO M251 that are required if specified by the project specifications. The standard tests are relatively easy to do and are completed multiple times a day by the manufacturers, who have the equipment to perform them. The optional tests can be lengthier and more difficult to perform and are very seldom specified.

D.S. Brown: Method A is a simpler and more conservative design. Only specify elastomer durometer for Method A, and only specify shear modulus for Method B. Designers can refer to Section 2.3.1.3 in the AASHTO/NBSA [National Steel Bridge Alliance] *Steel Bridge Bearing Guidelines* (G9.1)[3] for material properties of elastomeric bearings. When specifying shear modulus, follow the noted section commentary on recommended values, as it allows manufacturers to provide standard elastomer compounds and still meet tolerances.

What recommendations do you have for bridge designers?

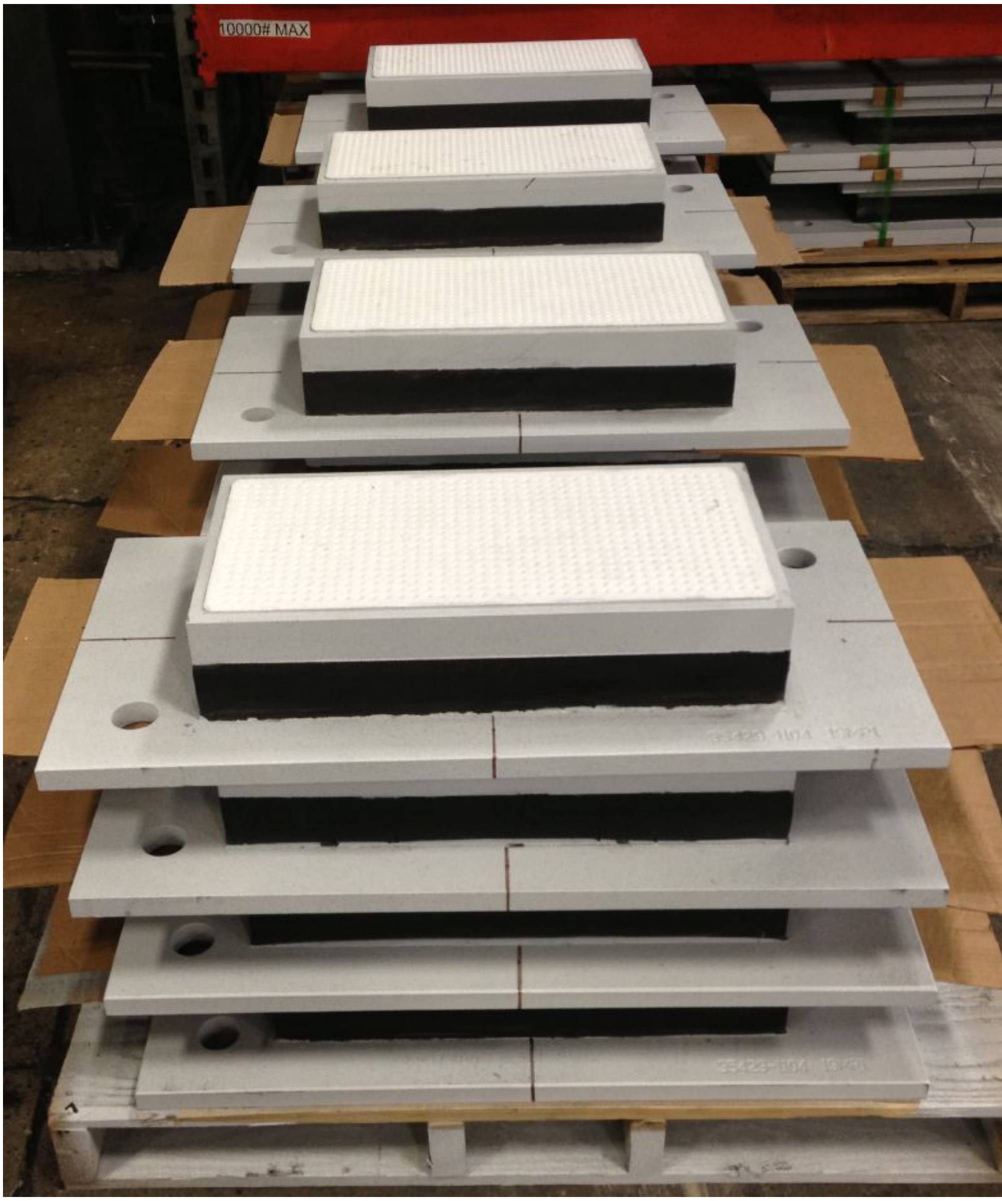
D.S. Brown: Use available reference guidelines where possible, which include all state specifications, standard drawings where available, AASHTO LRFD Sections 14 and 18, and AASHTO/NSBA G9.1. The PCI e-learning courses on bridge bearings [see sidebar] are also great references. For unique details, check with bearing manufacturers to ensure that they are feasible and economical.

Scougal: Bearing design is finding a balance between stiffness and flexibility. Steel plates are added for greater stiffness, and for greater flexibility additional rubber is used. When designers follow the AASHTO LRFD specifications in Section 14, the results are typically conservative and apply to most construction and installation settings. Some states have their own design and testing specifications. It is recommended that designers follow one and not pick and choose from different specifications, which makes it confusing for the manufacturer.

Are there poor practices that could be avoided?

D.S. Brown: There can be a lack of information on stud placement and embedded plate details. The bridge designer should specify the locations to ensure there are no conflicts with reinforcement. Verify that connection bolt locations do not conflict with bearing plan dimensions. For bearings that are bonded to external plates, identify the bond (for example, vulcanized) and provide adequate spacing between other plates, keepers, and shear blocks to allow for mold placement and removal.

Scougal: It is important to have sufficient information on shop drawings. Verify that the pad orientation and thickness agree with what is shown on the plans.



A low-friction polytetrafluoroethylene (PTFE) dimpled sheet, which is used as a sliding top surface on laminated elastomeric bearings. Dimples on PTFE surfaces function as reservoirs that receive lubricant before assembly.

What are the recommended solutions for bearings under wide elements like box beams or for multistemmed members?

D.S. Brown: In our experience, these tend to be shorter spans and do not need to accommodate significant movement or rotations, which allows engineers to utilize continuous plain elastomeric pads or pads butted together. Elastomeric bearings require loads to be evenly distributed. If the beam width is smaller than the bearing width, adequate steel plate thickness will be required to distribute the load to counteract plate bending. For that reason, we recommend that when PTFE [polytetrafluoroethylene] sliding surfaces are used, they should have plan dimensions similar to the bearing to avoid a significant bending moment on the distribution plate. PTFE is a low-friction material, so it is used when larger movements are needed for elastomeric bearings (movement beyond what you would want to design the bearing to handle in shear).

What factors affect the service life of elastomeric bearings?

Scougal: It is important to select the best bearing type for your project. Whether your bridge requires a pot bearing, spherical, disc, elastomeric, cylinder, or seismic isolator is determined mainly by forces and movement.

D.S. Brown: The life expectancy of elastomeric bearings is typically much longer than other types of bearings. They are also economical for small-to-moderate loads, rotations, and movements, and they are relatively low maintenance as compared to other types. Installation can impact elastomeric bearing service life. Damaging the coating on external steel, damaging the external rubber layers which exposes internal laminates to the elements, scratching stainless steel or PTFE, or setting the girders at the wrong temperature or not resetting the pads when necessary can shorten the life span of the bearing pad. Trying to position the bearings by hitting them or other methods that crack or gouge the elastomer cover also shortens their life spans.

Conclusion

Ultimately, the goal is to design and detail bridge bearings that are cost effective, functional, and durable. With that in mind, take advantage of the expertise available to the industry through manufacturers and industry resources.

References

1. American Association of State Highway and Transportation Officials (AASHTO). 2020. *AASHTO LRFD Bridge Design Specifications*. 9th ed. Washington, DC: AASHTO.
2. AASHTO. 2022. *Standard Specification for Plain and Laminated Elastomeric Bridge Bearings*, M 251M/M 251. Washington, DC: AASHTO.
3. AASHTO/National Steel Bridge Alliance (NSBA) Steel Bridge Collaboration. 2023. *Steel Bridge Bearing Guidelines*. 2nd ed. G9.1-2022. Chicago, IL: NSBA. https://www.aisc.org/globalassets/nsba/aashto-nsba-collab-docs/g-9.1-2022-steel-bridge-bearing-guidelines.pdf.

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PCI eLearning Module on Bridge Bearings

Elastomeric bearings are commonly specified for their low cost and minimal maintenance requirements compared with mechanical-type bearings. However, proper design and installation are needed to avoid problems like crushing, delamination, and slippage of the bearing pads. In an effort to educate the design and construction community on the importance of properly specifying and installing bearing pads, the PCI Committee on Bridges has added this topic to their selection of online courses.

Elastomeric bearing pads have been used for decades for transferring loads on all types of concrete bridges. The terms "elastomeric bridge bearing," "pot bearing," and "elastomeric bearing" are often used interchangeably. The AASHTO LRFD specifications provides two methods by which bearings may be designed: Method A or B. To help designers with the proper selection, the first PCI course (T450) focuses on the simplified Method A, and the next course (T455) addresses Method B. The T455 module includes design examples and commentary as well as pitfalls to avoid for all types of rail and highway structures.

For more information, visit https://oasis.pci.org/Public/Catalog/Home.aspx?Criteria=177&Option=738&tab=2

The addition of a low-friction sliding surface such as polytetrafluoroethylene (PTFE) allows a laminated elastomeric bearing to accommodate greater horizontal displacement. This type of bearing configuration is often used for precast concrete bridges.