

Structural Bearing Assemblies

Bridges



Bridge the World with Leading Infrastructure Solutions

D.S. Brown Structural Bearing Assemblies

Since 1963, The D.S. Brown Company has provided bearing assemblies and joint seals for bridges around the globe. Bridges and other large structures are supported on bearing assemblies to transmit forces while accommodating all structural movements.

The selection of an appropriate bearing assembly is based on the magnitude of vertical and horizontal forces transmitted through the bearing assembly, as well as the amount of displacement and rotation of the superstructure elements. In addition, special attention to the bearing assembly design may be necessary when, for example, larger than normal horizontal loading or uplift situations exist.



Walt Whitman Bridge, Philadelphia, PA - Versiflex™ Elastomeric Bearing Assemblies.

D.S. Brown is one of the leading suppliers of structural bearing assemblies. With extensive experience and utilizing the latest technologies, D.S. Brown can efficiently design, manufacture and test Versiflex™ high-load multi-rotational (Versiflex™ HLMR) pot and disc style, spherical, seismic isolation and elastomeric bearing assemblies for all types of construction.

D.S. Brown is available to work closely with bridge owners and engineering design consultants to assist in the design, selection and testing of the proper structural bearing assemblies.



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Cover Bridge Photo: Veterans Memorial Bridge, Portland, ME - Versiflex™ HLMR Disc Bearing Assemblies by The D.S. Brown Company.
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Versiflex™ HLMR Bearing Assemblies

Typical Applications

Versiflex™ HLMR pot-style bearing assemblies are suitable at locations where low-profile, high-load bearing devices are required. Versiflex™ HLMR bearing assemblies are especially suited for curved or skewed bridges and other complex structures where the direction of rotation varies or cannot be precisely determined.

Design Criteria

Required information for the proper design of a Versiflex™ HLMR bearing assembly includes:

- Vertical Load
- Horizontal Load
- Rotation
- Translational Movements

The plan area of a bearing assembly is usually controlled by the average vertical stress on the elastomeric disc.

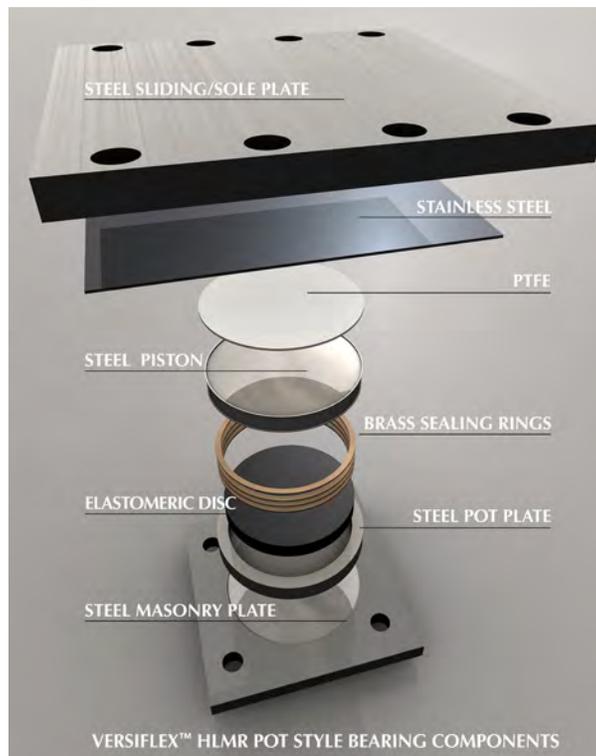
Rotations of up to ± 0.03 radians can be accommodated by Versiflex™ HLMR bearing assemblies. Design rotation is a combination of the effects of live load and construction tolerances.

The use of polytetrafluoroethylene (PTFE) as the low-friction sliding surface in bearing guide systems was previously the standard. With the increased use of seismic design in the bridge industry, larger horizontal loads must pass through the bearing assembly's guide system. Alternative low-friction materials, which provide much higher allowable bearing pressures than PTFE, are recommended for cases where horizontal loads exceed 50 percent of the vertical design load.

For curved bridge structures, the theoretical direction of movement is a chord projected from the mid-point of the deck at the expansion bearing line to the mid-point of the deck at a fixed bearing line. Finite element analysis may also be used to determine a more precise movement direction. All bearing assemblies at any pier or abutment line must be oriented in the same direction.

Components

As shown in the illustration, the Versiflex™ HLMR bearing assembly consists of a shallow steel cylinder, or pot, which contains a tight-fitting elastomeric disc thinner than the depth of the cylinder. The pot is a one-piece machined component. A machined steel piston fits inside the cylinder and bears directly on the elastomeric disc. Flat brass rings are used to seal the elastomer between the piston and pot components. This assembly resembles a hydraulic cylinder where the elastomer behaves like a viscous fluid, flowing as rotation occurs.



Structural Steel

Components are typically fabricated from either 50 ksi (345 N/mm²) or 36 ksi (250 N/mm²) material. All exposed steel surfaces are to be metalized or painted to prevent corrosion.

Elastomeric Disc

Typically manufactured from 50 durometer neoprene.

Sealing Rings

Rectangular in shape and manufactured from half-hard brass.

PTFE

Low-friction material stable to 500°F (260°C).

Stainless Steel

Polished to a 10 micro inch or less RMS (mirror) Finish.

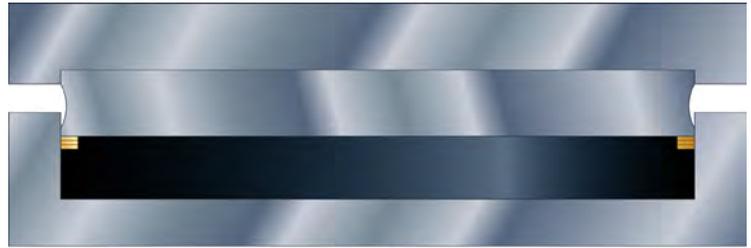
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Versiflex™ HLMR Bearing Assemblies

Fixed Design (PF Series)

Fixed bearing assemblies are designed to transmit horizontal forces in any direction through contact between the piston and the inside of the pot wall. Horizontal movement is restricted in all directions while accommodating rotational movement of the bridge superstructure.



FIXED*

Multi-Directional Design (PM Series)

The addition of a PTFE and stainless steel sliding surface between the piston and the sole plate creates a bearing assembly that allows horizontal movement in any direction. A multi-directional bearing assembly does not resist externally-applied horizontal forces.



MULTI-DIRECTIONAL*

Uni-Directional Design

The addition of guide bars to the multi-directional bearing device allows for horizontal movements in a single direction and the capability to resist externally-applied horizontal forces in the orthogonal direction. Orientation of the guide bars in a direction parallel to the structural movement is critical.



UNI-DIRECTIONAL CENTER-GUIDED*

Center-Guided (PMCG Series)

The Center-Guided system consists of a single guide bar along the centerline of the bearing assembly. Center-Guided gearing devices are not recommended where the horizontal force exceeds 30 percent of the vertical force.

Edge-Guided (PMG SERIES)

The Edge-Guided system utilizes two (2) guide bars which are external to the rectangular pot plate. An inverted pot assembly is typically detailed to economically provide uniform bearing along the guide bars.



UNI-DIRECTIONAL EDGE-GUIDED

*NOTE: Masonry plate excluded for clarity.

Versiflex™ HLMR Bearing Assemblies

Manufacturing Capabilities

High-load bearing assemblies require precision machining to provide long-term, maintenance-free performance. The D.S. Brown Company utilizes state-of-the-art CNC machining equipment in its manufacturing process to assure that manufacturing tolerances are maintained.

Load Testing Capabilities

Bridge owners often require the use of proof testing to verify performance. Proof tests commonly specified include vertical and horizontal load testing, rotation testing and coefficient-of-friction testing.

The D.S. Brown Company utilizes some of the largest, most versatile calibrated test presses in the United States. Vertical forces up to 7 million pounds (3175 tonnes) can be achieved, and bearing assemblies up to 75 inches (1900 mm) by 65 inches (1700 mm) in plan and 15 inches (381 mm) in height can be tested.

Horizontal load tests and coefficient of friction tests are conducted using a double-acting hydraulic cylinder with a capacity of 1.3 million pounds (590 tonnes) in tension. The maximum horizontal displacement is ± 18 inches (455 mm) at a maximum travel speed of 6 inches (150 mm) per minute. Static and dynamic coefficients of friction are determined by recording horizontal force and displacement on an X-Y plotter.

Installation Considerations

Versiflex™ HLMR bearing assemblies must bear on an even and level surface. The two most common ways to achieve a level bearing seat are:

- Grout the bearing into place
- Provide a lead or fabric underlayment between the bridge seat and the masonry plate

When the grouting method is not utilized, the use of metal shims or blocks to adjust the level or elevation of the bearing assembly is to be avoided. Careful attention should be given to the strength of concrete and reinforcement around the bearing because of the large concentration of load carried by the bearing devices.

In some cases, the masonry plate size will be increased to meet required concrete pressure limits. Where required, expansion bearing assemblies may be provided with an initial offset, so the slide plate can be set to allow structure shortening due to post-tensioning, creep or other causes.

Unless strictly supervised by a D.S. Brown representative, bearing assemblies should not be dismantled on-site.



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Versiflex™ Elastomeric Bearing Assemblies

Typical Applications

For nearly 50 years, elastomeric bearing assemblies have been used in the construction of new bridges and the rehabilitation of existing structures.

Other applications include: buildings and arenas, shear-key bumpers, seismic isolation protection and vibration devices for machinery.

General

Versiflex™ elastomeric bearing assemblies are custom molded using neoprene or natural rubber and are categorized into three basic designs: non-reinforced, laminated and sliding bearing assemblies. Rotation and displacement of elastomeric bearing devices are accommodated by deformation of the elastomer. Bearing assemblies may be molded with holes, slots, skewed ends, clipped corners and/or sealing ribs and may also be circular in shape.

Non-Reinforced Design

Non-reinforced bearing devices are best specified when the load, rotation and horizontal deflection are minimal. Top and/or bottom steel load plates can be vulcanize-bonded to the bearing device during the molding process.

Laminated Design

The addition of internal steel plates (or laminates) increases the vertical load bearing capacity and the amount of horizontal deflection which can be accommodated by the bearing device.



Laminated bearing assemblies are molded to any shape or size. The internal steel plates are vulcanize bonded to alternating layers of elastomer during the molding process. Laminated bearing assemblies may also be manufactured with top and/or bottom steel load plates which are also vulcanize-bonded. An elastomer cover layer is necessary to protect the internal plates from the environment.

Sliding Design

For applications where horizontal displacements exceed ± 2 inches (50 mm), sliding elastomeric bearing assemblies may provide an economical solution. The addition of a low-friction sliding surface allows a standard laminated elastomeric bearing device to accommodate unlimited horizontal displacement without increasing the height of the bearing assembly.



A slide bearing assembly consists of an upper and lower component. The upper component consists of a steel load plate attached to the superstructure and a polished stainless steel sheet welded to the load plate. The lower component consists of a low-friction PTFE sliding surface, steel backer plate, molded elastomer and bottom steel load plate. All components of the bottom assembly are vulcanize-bonded during the molding process. Slide bearing devices may be guided or free to move in any direction.

Manufacturing Capabilities

Versiflex™ elastomeric bearing assemblies and all associated steel components are molded and manufactured to precise tolerances. Versiflex™ elastomeric bearing assemblies can be produced up to 75 inches (1900 mm) by 65 inches (1700 mm) in plan and 18 inches (455 mm) in height. In addition to physical property tests on the polymer compounds, specified testing is also performed in-house, including vertical and horizontal load testing, rotation testing, peel testing and coefficient-of-friction testing.

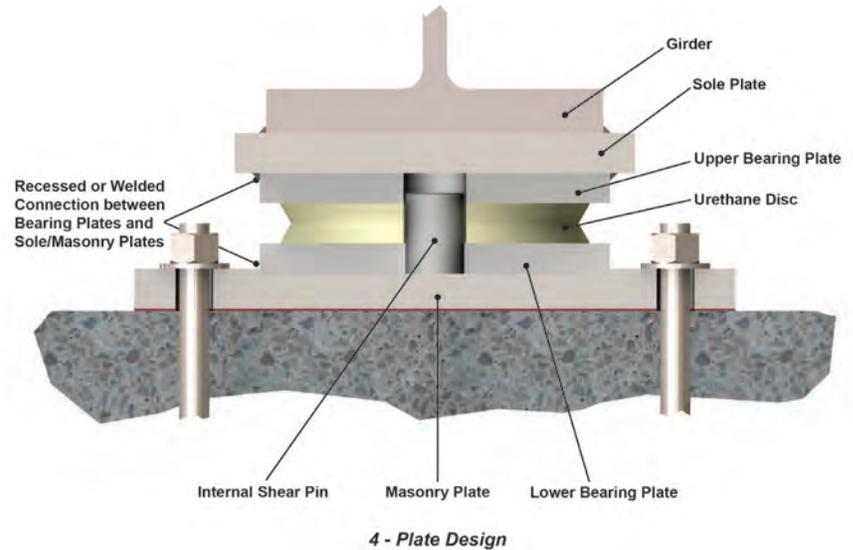
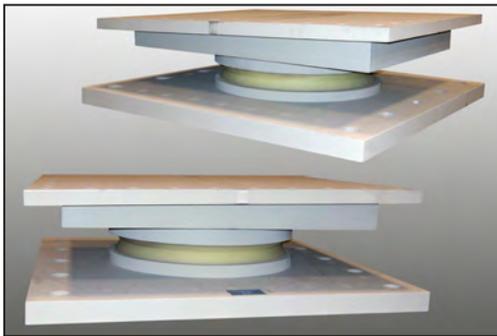
Versiflex™ HLMR Disc Bearing Assemblies

General

Versiflex™ HLMR Disc Bearing Assemblies consist of an elastomeric disc made of unconfined polyether-urethane polymer to accommodate rotation between two metal plates. The vertical loads are transferred by the elastomeric disc. Horizontal shear forces are transmitted between upper and lower plates by a dowel pin mechanism in the center of the bearing.

Advantages

- Multi-rotational
- Lower Profile (Vertical Height)
- Cost Efficient



Seismic Isolation Bearing Assemblies

Typical Applications

D.S. Brown Seismic Isolation Bearings are ideal for protecting critical structures from ground movement in all seismic zones and soil types. These proof-tested lead-core elastomeric bearings are maintenance-free and designed to operate throughout the full lifecycle of bridges, buildings, towers and piers.

General

Lead-Rubber Isolation Bearings consist of three components: rubber, steel plates and a lead core. Rubber provides flexibility allowing deformation of the bearing and memory to allow the bearing to recover after deformation. The internal steel plates provide vertical stiffness to handle the dead and live loads of the structure but their horizontal orientation allows movement in the lateral direction. The lead core provides damping by deforming plastically when the isolator moves laterally. The lead core also dissipates kinetic energy of an earthquake by transferring into heat energy during deformation. Lead is capable of multiple deformations without failing.



Advantages

- Maintenance-free
- Proven performance (shake-table + real earthquakes)
- Effective isolation in all seismic zones and soil types

The isolation bearing system works by lengthening the fundamental period of the structure, thereby reducing the acceleration input into the building, bridge or equipment. The damping achieved by the isolation system further reduces the acceleration input and reduces the displacements across the isolation system.

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Dolphin - Palmetto Interchange Project FL, USA

Versiflex™ HLMR Pot Bearings
Assemblies



D.S. Brown Signature Projects

The following list highlights some signature projects by The D.S. Brown Company.

Blennerhassett Bridge, Parkersburg, WV

Bobsled and Luge Facility, Lake Placid, NY

Boston I-93 Central Artery “Big Dig”, Boston, MA

Champlain Bridge, Chimney Point, VT

Dolphin-Palmetto Interchange, Miami-Dade County, FL

Eggner’s Ferry Bridge, Trigg County, KY

Golden Gate Bridge (South Approach), San Francisco, CA

High Five Interchange, Dallas, TX

Hollywood International Airport, Fort Lauderdale, FL

Pearl Harbor Memorial Bridge, New Haven, CT

San Rafael Bridge, Richmond, CA

Throgs Neck Bridge, Queens, NY

Veterans Memorial Bridge, Portland, ME

Walt Whitman Bridge, Philadelphia, PA



Golden Gate Bridge (South Approach) CA, USA

Lead Rubber Seismic Isolation
Bearings