BEARINGS FOR BRIDGES AND STRUCTURES

TYPE BA
PLAIN SLIDING

TYPE BAR
SLIDING/ROTATION

TYPE BR
LAMINATED RUBBER
In most concrete and steel structures accommodation must be made for relative movement between structural members in order to avoid the build-up of dangerous stresses. The source of this movement may be:

- Thermal expansion and contraction
- Permanent creep and shrinkage
- Post tensioning strain
- Live load deflections
- Earth movement

It is usually desirable to minimise the resistance forces and moments resulting from these movements and this is the primary function of Structural Bearings.

**BEARING TECHNOLOGIES** range of Structural Bearings provide this function by the most efficient methods using well proven concepts combined with modern manufacturing technology and advanced materials.

This is achieved by exploiting the unique low-friction properties of PTFE (polytetrafluoroethylene) and the flexibility, durability and versatility of natural rubber.

This brochure describes 3 of the simpler types of Structural Bearings which are suitable for relatively small movements and rotations.

**BA type**

This range provides low friction sliding movement in one or two directions by means of PTFE* sliding on mirror polished Stainless Steel. For high temperature applications CSB10** metal backed PTFE is used. These bearings do not provide for any significant rotation movement. The standard load range is 100kN-2500 kN. Temperatures above 250 deg C can also be accommodated by the use of special materials.

**BAR type**

The BAR type is offered in a load range of 30kN-250kN to provide a useful though limited amount of rotation in addition to unlimited sliding movement. These bearings are intended for ambient temperature operation only.

**BR type**

This is a range of Laminated Rubber Bearings catering for short to medium span structures in the nominal load range 200kN-3000kN. The movement and rotation limits depend on the number of laminations which are normally limited to 6. They are suitable for ambient temperatures only.

* see page 7
** see page 8
CONSTRUCTION

Type BA Sliding Bearing
- Top plate: Steel BS4360 Gr43A
- Sliding plate: Steel Gr 316
- Dust seal: Expanded neoprene
- PTFE or CSB10
- Bottom plate: Steel BS4360 Gr43A

Type BAR Sliding Bearing
- Top plate: Aluminium alloy 5083H22
- Dust seal: Expanded neoprene
- PTFE or CSB10
- Bottom plate: Aluminium alloy 5083H22
- Natural rubber: BS1154 Z13

Type BR Laminated Rubber Bearing
- Rubber envelope
- Steel shims: BS4360 Gr43A
- Natural rubber: BS1154 Z13

DESIGN AND MANUFACTURE

Bearing Technologies Structural Bearings are designed in accordance with BS 5400 Pt9:1983 where applicable. Material specifications are selected to ensure reliability, longevity and continuity of supply.

Manufacturing is processed in modern well equipped workshops operating to quality assurance systems in terms of SABS ISO 9002.

Special laboratory control procedures are exercised during rubber processing to ensure the properties of the product conform to the design requirements.

A heavy duty corrosion protection system is applied to all exposed steel surfaces. This comprises zinc-rich epoxy primer with subsequent coats of Micaceous Iron Oxide epoxy (MIO). Alternative systems can be used if specified by customers e.g. hot dip galvanising.
SLIDING BEARINGS- Type BA

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Notes:
Maximum seating pressure is 14 MPa
Bearings can be provided with side movement constraints
Tapped holes can be provided for attachment
SLIDING BEARINGS- Type BAR

Notes:
Rotation is about the axis of the longer side
Maximum seating pressure is 7 MPa
Bearings can be provided with side movement constraints
Tapped holes can be provided for attachment
### LAMINATED RUBBER BEARINGS-type BR

**Notes:**
- Assumed rotation about longer axis = 0.005 radians
- Assumed rotation about shorter axis= 0.002 radians
- Load capacity will increase with reduced movement/rotation
- Vertical and shear stiffness accurate to within 25%
- If dead load is less than 40% of total load possible slippage must be considered

#### Maximum Total Vertical Load

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<th>Width (B)</th>
<th>Height (H)</th>
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Notes:
- Assumed rotation about longer axis = 0.005 radians
- Assumed rotation about shorter axis= 0.002 radians
- Load capacity will increase with reduced movement/rotation
- Vertical and shear stiffness accurate to within 25%
- If dead load is less than 40% of total load possible slippage must be considered
LAMINATED RUBBER BEARINGS- type BR

These bearings provide a simple and convenient method of providing for longitudinal and transverse movement and horizontal forces as well as for rotation about both axes. This is achieved by the shear deflection of the rubber layers within the bearing. Unlike sliding bearings where the resistance to movement is from friction and is constant irrespective of the degree of movement, laminated rubber bearings produce a reactive force against the structure approximately in proportion to the extent of their movement. Similarly, the rotation capacity of these bearings is limited by the permissible shear strain within the rubber layers.

Forces, movements and deflections are interrelated and are substantially influenced by the practical limitations of various production variables. Calculations based on a number of physical and empirical functions produce results which can be assumed to be accurate only within 25%. Bearing Technologies laminated rubber bearings are designed strictly in accordance with the requirements of BS5400:1983 Parts 9A and 9B. Although this code is conservative, where the deflections and stiffness are critical, it is recommended that testing of sample bearings be carried out to verify the results.

The table on page 5 shows the standard range of type BR laminated rubber bearings indicating approximate load capacities based on assumed rotations, movements and live load/total load ratios. Although intermediate values may be estimated by extrapolation, Bearing Technologies can provide more accurate data based on the details of the actual structure.

HORIZONTAL FORCES

BA and BAR types
Transverse horizontal forces of up to 15%-20% of the vertical load can be accommodated if required by the provision of a longitudinal guide within the bearing.

BR type

Horizontal reaction forces will occur as a result of horizontal movements in addition to any external factors such as wind forces, vehicle braking, acceleration and centrifugal forces. BR type bearings can resist some or all of these forces but it is recommended that one end of the structure span is horizontally restrained to its support by means of steel dowels which should be provided with dowel caps to permit rotation. It is possible to provide BR type bearings with one or more holes passing through the bearing to accept these dowels but the preferred and most economical method is to locate the dowels at points external to the bearings.

Any external horizontal force applied to the bearings may reduce their vertical load carrying capacity.
ATTACHMENT

Horizontal forces can normally be safely transmitted to the supports by friction at the bearing interfaces with the structure. Where this is not possible or where a positive location of the bearing is preferred, the upper and lower steel plates of **BA types** and the upper plate of **BAR types** can be provided with fixing holes for attachment to the structure.

**BR** type bearings will not normally require any special fixing arrangements as the friction force between rubber and concrete or painted steel is usually adequate to transmit any horizontal forces. However, where additional restraint is required the bearings can be secured by epoxy paste or mortar or by recessed steel plates.

INSTALLATION

Correct installation of all types of structural bearings is critical to their performance. The most important aspects of installation are:

- Ensuring intimate surface contact with the structure—there must be absolutely no voids immediately above or below the bearings.
- Cementitious or epoxy grout must be properly mixed and must be of adequate strength.
- Bearing orientation and presets (where applicable) must be carefully checked and adjusted where necessary.
- Horizontal and vertical alignment.
- Where applicable, anchor bars must be substantially encased within the steel reinforcement of concrete members.
- Prevention of contamination, especially slurry, of the exposed stainless steel sliding surfaces.
- Preventing mechanical damage to the corrosion protection system.
- In the case of BAR and BR types it is essential to ensure that their limited rotational capacity is not reduced by out-of-parallel structure interfaces.

FRICION

In BA and BAR type bearings fitted with PTFE the coefficient of friction of the sliding surfaces can be assumed to vary between 0.02 to 0.07 depending on a number of operating variables. The most important is bearing pressure, the C of F reduces with increased specific pressure. Where CSB-10 (DU) material is fitted the C of F range is between 0.04-0.10 at ambient temperatures.
BEARING TECHNOLOGIES

BEARING SELECTION

This is a basic guide for the selection of the most appropriate bearing type.

1. For rigid superstructures where rotation relative to supports during operation approaches zero and interface surfaces are completely parallel and flat—select types BA, BAR or BR.

   (Typical applications are heavy steel structures such as boilers, furnaces, towers, short footbridges, pressure vessels, large machinery, concrete ring beams, floor slabs.)

2. For bridge decks requiring relatively small movements and rotations but where access for eventual replacement is possible—select type BR

   (Typical applications as in 1. above plus short span road and rail bridges, parking decks, shopping malls for loads up to approximately 2500kN)

3. For bridges requiring small rotations but larger movements than can be provided by type BR—select type BAR

   (Typical applications are flexible steel superstructures and pre-cast concrete and in-situ bridge decks.)

4. Where loads, rotations or movements exceed the tabulated values it will normally be necessary to use other types of bearings e.g Pot Bearings-BTA, BTU, BTF series (refer to Bearing Technologies Pot bearing brochure).

   (Typically bridges over 30m spans or loads in excess of 2500kN)

5. For high temperature applications above 100 deg C type BA bearings fitted with CSB-10 material should be used. For temperatures above 250 deg C other suitable bearing materials can be incorporated.

   (Typical applications are boiler/furnace supports, hot flue supports, oven supports.)

Having determined the most appropriate bearing type the bearing size should be matched to the calculated loads using serviceability limit state (SLS) loading. All bearings can be overloaded for short periods without distress and the load limits indicated in the tables are conservative.

A further factor to consider in the bearing type choice is the durability of the materials used in the bearings. Whereas the durability of stainless steel, PTFE and CSB-10 can be assumed to match the life of the structure, all elastomers will eventually deteriorate after, say, 20-40 years. Nevertheless the rubber compounds used are formulated to produce the optimum overall performance over very long periods.

The above notes are generalized and are intended for rough guidance only. Customers are urged to consult Bearing Technologies or their representatives before final selections are made.

Footnote: CSB-10 is a proprietary bearing material manufactured by CSB Bearings Co. It comprises a steel or bronze (CSB11) backing an interlayer of porous tin/bronze which is impregnated with PTFE/lead and an overlay of the same mixture. It has greatly superior mechanical properties and heat resistance to pure PTFE with much reduced wear rates although sliding friction is slightly higher.
LAMINATED RUBBER BEARINGS-PRINCIPLES OF OPERATION

SHEAR MOVEMENT
Horizontal movement is provided by the shear deflection of the rubber. The greater the total rubber thickness the greater the movement provided. The steel shims are vulcanised to the rubber to substantially increase the vertical load capacity of the bearing compared with that of a solid rubber block of the same total thickness.

ROTATION
Laminated rubber bearings can also provide for rotation of the bridge deck about all axes. The combination of shear deflection and rotation angle determines the maximum vertical load capacity of the bearing. In addition, the ratio of live load to permanent load also influences the vertical load capacity. These factors are considered in the load and movement limits shown in the table on page 5 which are calculated for SLS loading according to BS5400 Pt9.1 requirements.

STIFFNESS
The vertical and horizontal stiffness of laminated rubber bearings are an important consideration for bearing selection. The respective values for each bearing size are shown in the table on page 5 and should be considered in determining maximum acceptable deflections and fixing arrangements.
LAMINATED RUBBER BEARINGS-TESTING

TEST EQUIPMENT
All laminated rubber bearings are load tested on a remotely controlled testing machine specially designed for this purpose. Bearings are tested two together placed either side of a thrust plate. The machine comprises vertical and horizontal hydraulic rams capable of simultaneous operation (see page 11). BS5400 Pt9.2 specifies "quick tests" on all bearings produced. This comprises loading the bearing to maximum design load (usually SLS). The bearings are visually examined for uniformity of shim spacing whilst under load and subsequently are examined for any visual defects. In addition a 10% sample of each batch is tested for vertical and horizontal stiffness. Where specified by customers an overload test comprising 150% of design load and movement may be carried out in addition to the above tests. The rubber compound (usually natural rubber to BS1154) is batch tested for physical properties.
The machine is specially designed to test laminated rubber bearings for vertical and horizontal stiffness.

The controls are activated by a computerized program which is stored in memory and is specific to each bearing design.

The vertical load is applied by a hydraulic cylinder. The rate of loading is infinitely variable. Vertical deflections of bearings under test are monitored by 4 linear transducers whose signals are integrated in the software programs to record accurate measurements.

Load range is 0-2500 kN.

Horizontal loads up to 200kN are applied by a hydraulic cylinder which is directly connected to a load cell whose signals are transmitted to the central computer. Deflections are also monitored by a linear transducer.

The machine can be programmed to apply either deflections or loads.
OTHER STRUCTURAL BEARING TYPES AVAILABLE

BD series
- Sliding
- High rotation about 1 axis
- Up to 5000kN

BT series
- Sliding
- Rotation about all axes
- Up to 20000kN

BA series
- Plain sliding
- No rotation
- Up to 2000kN

BP series
- Pipe support bearings
- Rotation up to 0.04 radians
- Up to 60kN
- Unlimited movement

BV series
- Horizontal guide
- No transverse rotation
- No vertical load capacity

BK series
- Strip bearings
- Up to 350kN/meter
- Movement <10mm

BR series
- Laminated rubber bearings
- Limited rotation and movement
- Up to 4000kN

These products are supplied by:

Technoslide (Pty) Ltd
Unit G9, Pinelands Site
Ardeer Road
Modderfontein 1645
South Africa
PO Box 450
Modderfontein 1645
Tel: +27 (0)87 150 2755
Fax: +27 (0)11 608 0824
E-Mail: info@technoslide.com

Bearing Technologies
13 Regent Place
Westville 3629
South Africa
Tel: +27 (0)31 266 0487
Fax: +27 (0)86 689 7107
E-Mail: microse@mweb.co.za

BT is constantly developing these products and reserves the right to change dimensions, specifications and designs at any time without prior notice.