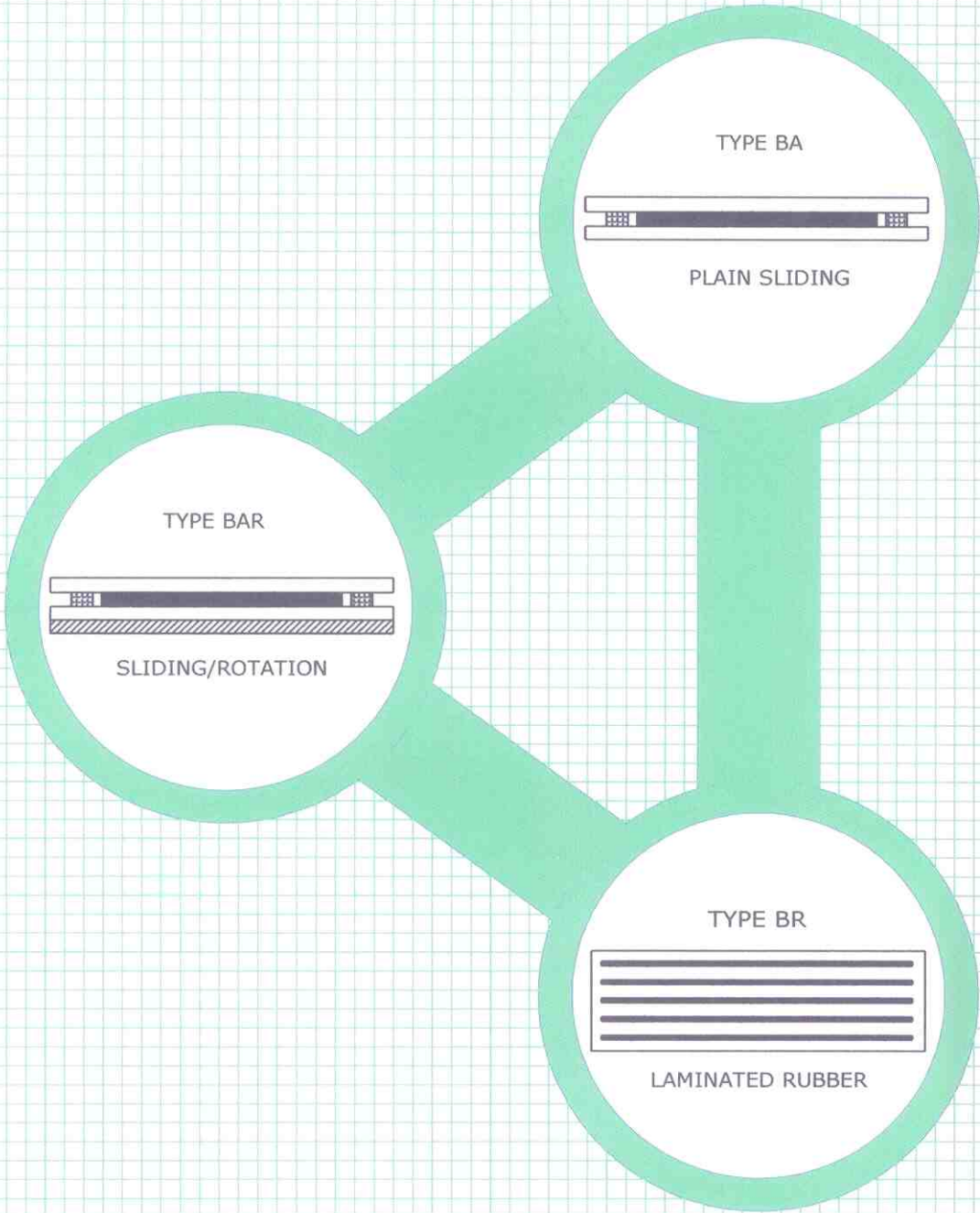


BEARINGS FOR BRIDGES AND STRUCTURES



STRUCTURAL BEARINGS

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

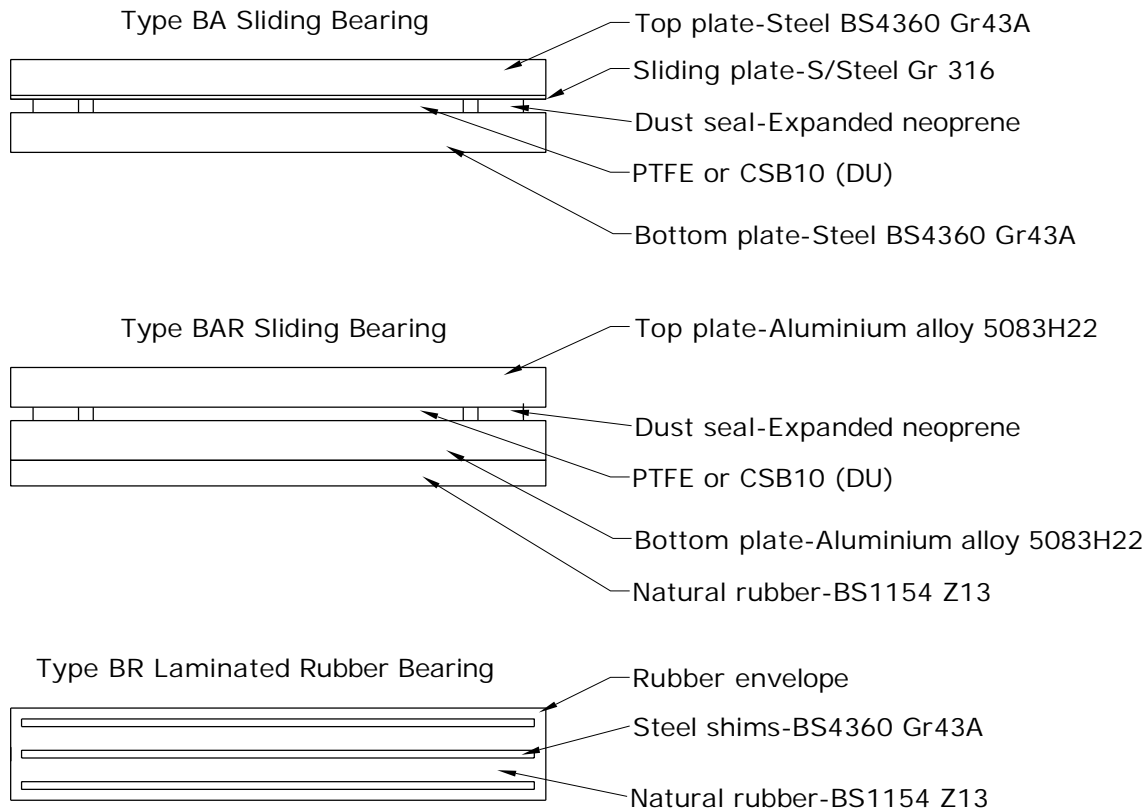
The BAR type is offered in a load range of 30kN-250kN to provide a useful though limited amount of rotation in addition to unlimited sliding movement. These bearings are intended for ambient temperature operation only.

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



DESIGN AND MANUFACTURE

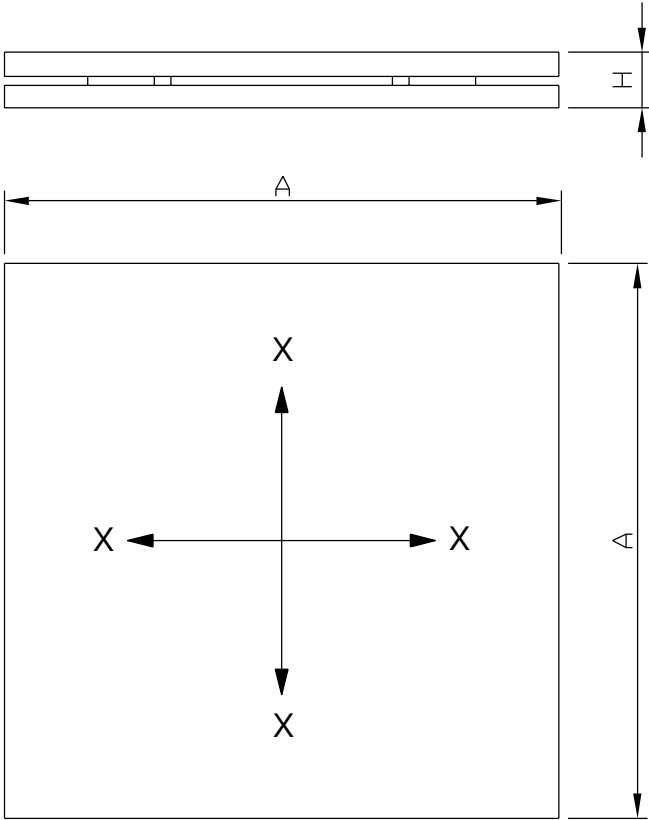
Bearing Technologies Structural Bearings are designed in accordance with BS 5400 Pt9: 1983 where applicable. Material specifications are selected to ensure reliability, longevity and continuity of supply.

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.

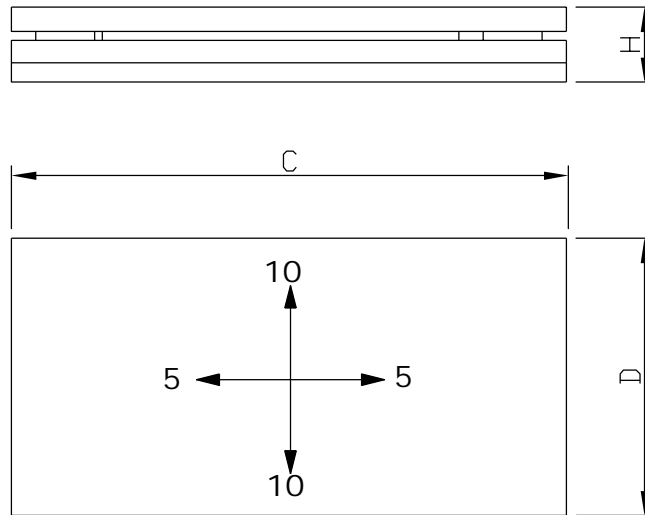
A heavy duty corrosion protection system is applied to all exposed steel surfaces. This comprises zinc-rich epoxy primer with subsequent coats of Micaceous Iron Oxide epoxy (MIO). Alternative systems can be used if specified by customers e.g.hot dip galvanising

SLIDING BEARINGS- Type BA



Brg ref	Max load kN	X mm	A mm sq	H mm
BA10/15/15	100	15	123	25
BA15/15/15	150	15	137	25
BA20/15/15	200	15	149	30
BA30/20/20	300	20	190	30
BA50/20/20	500	20	221	30
BA75/20/20	750	20	253	34
BA100/25/25	1000	25	300	38
BA150/25/25	1500	25	345	44
BA200/30/30	2000	30	403	50
BA250/30/30	2500	30	436	54

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


Brg ref.	Max load kN	C plate mm	D plate mm	H height mm	Rotation radians
BAR3/10/5	30	115	70	25	0.006
BAR5/10/5	50	140	80	25	0.007
BAR7/10/5	70	165	85	30	0.005
BAR12/10/5	120	195	105	30	0.004
BAR18/10/5	180	250	125	35	0.003
BAR25/10/5	250	300	150	40	0.003

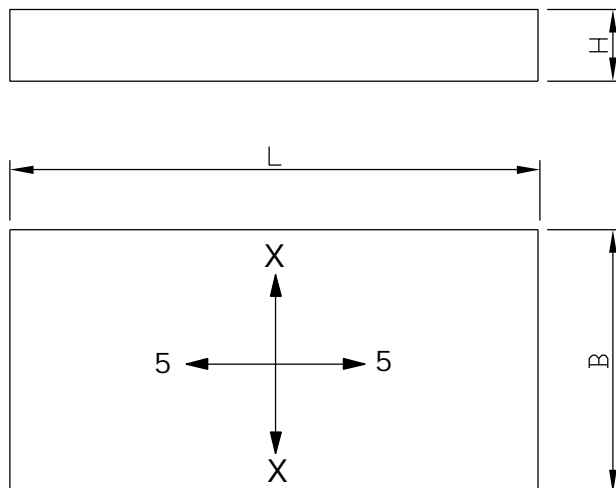
Notes:

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


Ref. No.	Length L	Width B	Height H	Maximum Total Vertical Load						max. move. mm	vertical stiffness kN/mm	shear stiffness kN/mm
				LL/Total=0,2		LL/Total = 0.4		LL/Total = 0.6				
				no move no shear	max move max shear	no move no shear	max move max shear	no move no shear	max move max shear			
BR2001	200	150	22	283	215	256	190	234	170	11	207	1.82
BR2002	200	150	35	298	216	271	193	248	173	18	103	1.12
BR2003	200	150	48	304	209	277	187	255	169	25	69	0.81
BR2501	250	190	22	535	406	480	354	433	311	11	531	2.88
BR2502	250	190	35	584	434	529	384	482	342	18	265	1.77
BR2503	250	190	48	606	434	551	386	504	346	25	177	1.28
BR2504	250	190	61	618	424	563	379	516	341	32	133	1.00
BR3001	300	225	24	759	576	679	501	612	438	13	637	3.64
BR3002	300	225	39	837	623	757	551	690	490	21	318	2.18
BR3003	300	225	54	871	625	791	556	724	498	29	212	1.56
BR3004	300	225	69	889	612	810	547	742	491	38	159	1.21
BR3501	350	250	24	1043	781	924	669	824	574	13	1061	4.72
BR3502	350	250	39	1194	890	1076	782	975	691	21	530	2.83
BR3503	350	250	54	1259	913	1141	809	1040	721	29	354	2.02
BR3504	350	250	69	1295	907	1177	808	1076	723	38	265	1.57
BR4001	400	300	26	1422	1061	1256	903	1115	770	14	1288	5.82
BR4002	400	300	43	1657	1240	1491	1087	1350	958	24	644	3.42
BR4003	400	300	60	1755	1281	1589	1134	1448	1010	34	429	2.43
BR4004	400	300	77	1809	1278	1643	1136	1502	1017	43	322	1.88
BR5001	500	375	30	2174	1622	1918	1378	1701	1171	17	1518	7.58
BR5002	500	375	51	2561	1920	2305	1684	2088	1484	29	759	4.33
BR5003	500	375	72	2716	1985	2459	1758	2242	1566	42	506	3.03
BR5004	500	375	93	2799	1978	2543	1760	2326	1576	55	379	2.33
BR6001	600	450	30	3088	2174	2640	1743	2261	1379	17	3088	10.91
BR6002	600	450	51	4068	3024	3620	2606	3241	2252	29	1544	6.24
BR6003	600	450	72	4460	3286	4012	2881	3633	2538	42	1029	4.37
BR6004	600	450	93	4671	3367	4223	2975	3844	2643	55	772	3.36

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.

FRICTION

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 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.)

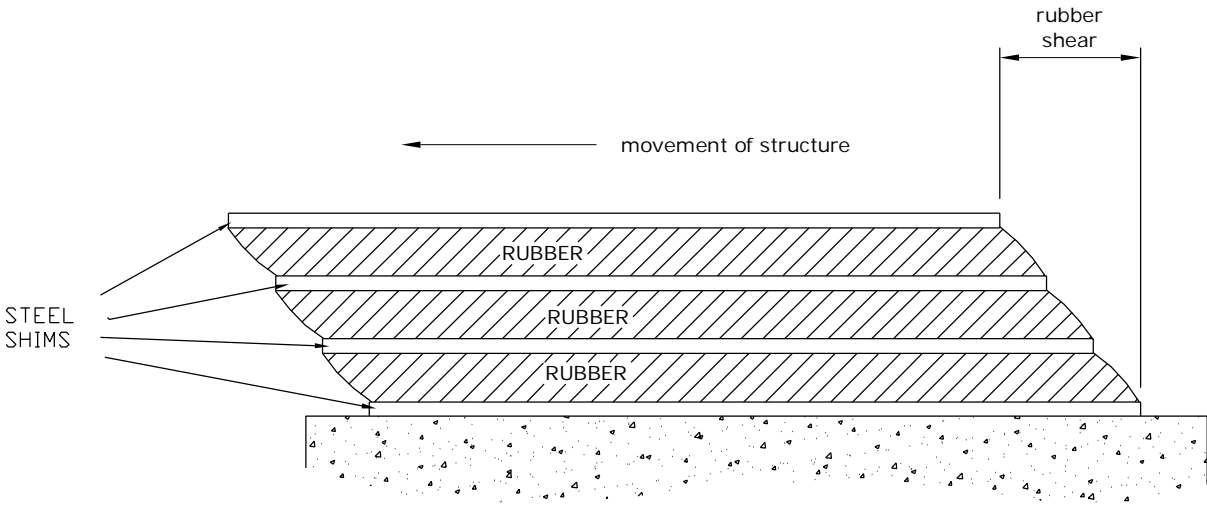
Having determined the most appropriate bearing type the bearing size should be matched to the calculated loads using serviceability limit state (SLS) loading. All bearings can be overloaded for short periods without distress and the load limits indicated in the tables are conservative.

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.

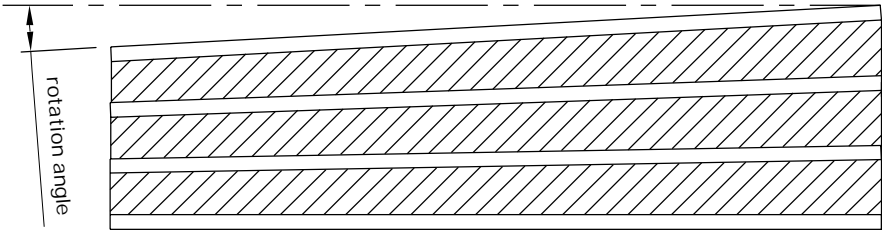
Footnote: CSB-10 is a proprietary bearing material manufactured by CSB Bearings Co. It comprises a steel or bronze (CSB11) backing an interlayer of porous tin/bronze which is impregnated with PTFE/lead and an overlay of the same mixture. It has greatly superior mechanical properties and heat resistance 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.



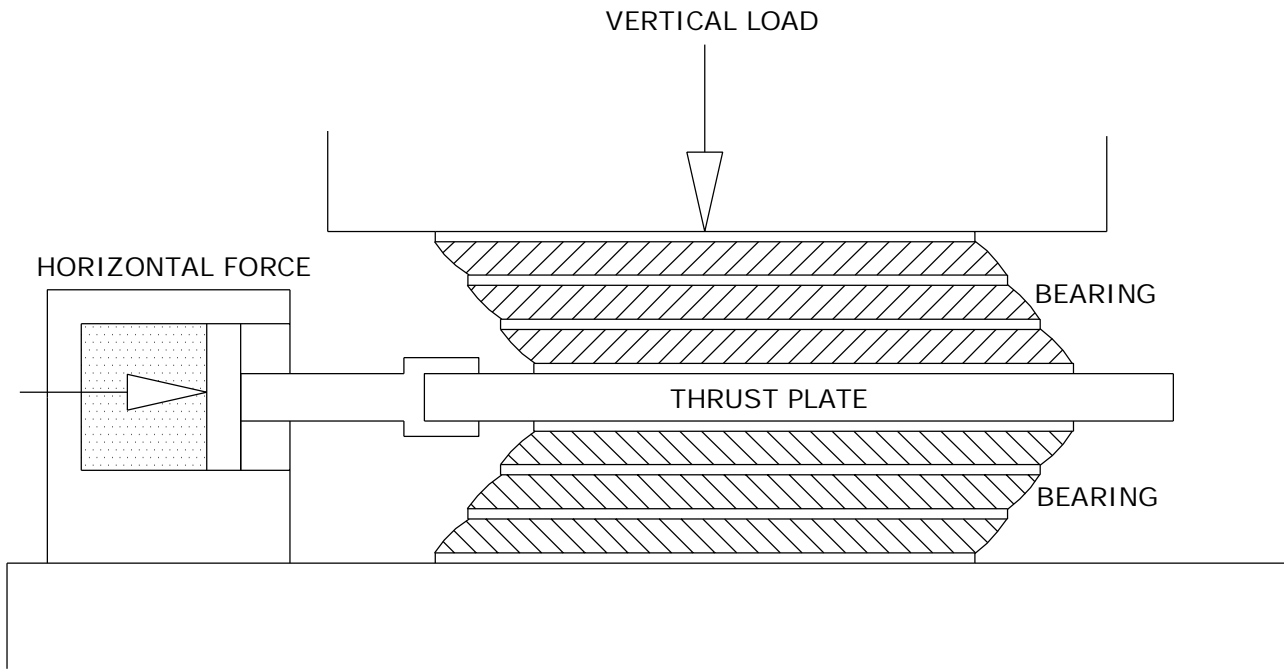
ROTATION

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.

2500 kN RUBBER BEARING TESTING MACHINE



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.

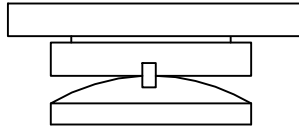


Horizontal loads up to 200kN are applied by a hydraulic cylinder which is directly connected to a load cell whose signals are transmitted to the central computer. Deflections are also monitored by a linear transducer.

The machine can be programmed to apply either deflections or loads.

OTHER STRUCTURAL BEARING TYPES AVAILABLE

BD series



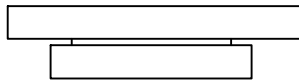
Sliding
High rotation about 1 axis
Up to 5000kN

BT series



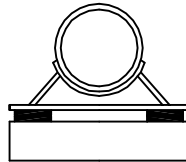
Sliding
Rotation about all axes
Up to 20000kN

BA series



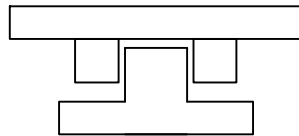
Plain sliding
No rotation
Up to 2000kN

BP series



Pipe support bearings
Rotation up to 0,04 radians
Up to 60kN
Unlimited movement

BV series



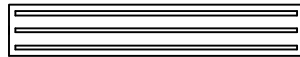
Horizontal guide
No transverse rotation
No vertical load capacity

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:

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