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MODEL CLAUSES FOR CIVIL ENGINEERING WORKS

SECTION 100 BEARINGS

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MODEL CLAUSES FOR CIVIL ENGINEERING WORKS

BEARINGS - GUIDANCE NOTE FOR THE SPECIFICATION OF BEARINGS

General ***100.1*** *The selection and design of bearings shall consider the whole life costing of bearing assemblies. Often, the maintenance and replacement costs of an assembly can be many times greater than their original capital cost and so a balance has to be struck between (a) the initial construction costs, and (b) the likely disruption costs generated by the replacement of the bearings.*

The manufacturer, who shall be identified in the tender return, shall have a proven track record for supplying quality bearings for similar situations. Other than in exceptional circumstances, the bearings shall be designed by a manufacturer who has the appropriate experience and testing equipment.

Bearings shall (a) support the vertical load, and (b) prevent translation of the bridge deck by resisting the horizontal loads applied to it, unless these are resisted separately by, for example, dowels or guides.

Bearings can be designed to resist both vertical and horizontal loads simultaneously, but often it is preferable to provide separate bearings for the two purposes as this arrangement is simpler to manufacture and replace and is less susceptible to design errors.

Where combination bearings are used, guide strips can be made deeper, at little extra cost, as an additional precaution against the superstructure lifting off and sliding. Note that this would not increase the proportion of the vertical load that can be resisted horizontally by a metal bearing.

Bearings shall be installed in a horizontal plane; this is particularly important for bearings with sliding surfaces. At the same time they shall allow freedom for movements due to temperature and vertical loading (such as rotation due to girder deflection).

For the design of the bearing elements, BS EN 1337-1 clause 5.4 requires the design rotations and translations to be increased by prescribed amounts. To avoid the risk of double-counting or omission by the structure designer or bearing manufacturer, the Bearing Schedule shall state whether or not the values include the increases identified in clause 5.4.

Restraints are required to prevent horizontal movement of the superstructure. Restraints may need to resist impact from road or rail vehicles on the superstructure, including the impact on a bridge parapet produced by a derailment.

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When installing multiple restraints in a particular direction, it is necessary to check that the resultant of the restraint on live loads and effects of temperature change is taken into account.

A bearing is unlikely to function throughout the design working life of the bridge, and so facilities for their replacement shall be provided. In many cases, jacking positions can be accommodated on bearing shelves (where sufficient depth is provided for drainage channels and for examination) and in these cases the shelf should be designed to sustain a 'break out' jacking force of twice the nominal dead loads. The use of flat jacks can obstruct the removal of a bearing.

With laminated elastomeric bearings, where dowels are installed at the fixed end they should be separate from, rather than through, the bearings (when space permits) as this will facilitate the replacement of the bearings. Dowels should be provided with rubber caps to permit a small amount of deflection and rotation. Preferably, horizontal-only pin and guide bearings should be used. Where these bearings are installed at the free end, provided the ratio of vertical to horizontal load is at least 3 to 1 for concrete or 4 for steel to 1, frictional forces may be relied on to transmit longitudinal loads.

Generally, elastomeric bearings should not be glued in place as this will inhibit their maintenance and removal. On the other hand, the vulnerability of the bearings to 'walk' (by creeping or ratcheting) shall be considered: this susceptibility can be exacerbated where (a) the top and bottom contact surfaces are not parallel (hence, these surfaces should be parallel with the bedding material) and, (b) the shear stiffness of the bearing is high compared to the frictional forces. Installing stainless steel keep plates on the bearing shelf around the base of the bearing will prevent it from 'walking'.

The casting of deep longitudinal side guides for impact protection will not inhibit the removal of bearings in the longitudinal direction. Transverse guides should either be a normal height, to reduce the jacking movement required, or, preferably, be removable.

Ideally, bearing assemblies will be capable of being slid out with near to zero jacking movement by bolting into tapped holes in subsidiary plates (which are themselves welded to the location plate or girder flange, or are cast into the concrete soffit).

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Where fixed and free ends are provided, the fixed end should be selected so that the traction and braking forces direct their greatest effect into the soil behind the abutment at the fixed end. However, the design arrangement shall resist the calculated loads for each direction. Consideration should be given to designing free and fixed end abutments individually (to avoid over-design of the free abutment) or renewing/strengthening one of the existing abutments.

For bridges wider than two tracks, consideration should be given to lateral movements generated by temperature changes - particularly for steel decks, which generate the greatest temperature differential with the substructure. Consideration should also be given to differential temperature effects within the superstructure.

Collision loads and uplift effects on bridges shall be considered (see BD 60/04, GC/RT5112 and BS EN 1991-2).

Where plate girders are used in a half-through type bridge, normally the bearings provide the end restraint to rotation about the longitudinal axis - as required by design standards. It may be appropriate to offset the bearing from the girder web to help resist the applied moments in this type of bridge (particularly where a heavy trimmer is also supported): in such cases, analysis is required to check for any adverse affects.

BS EN 1337 gives no specific guidance on the design of bearings for fatigue. Steel bearings that have been designed for strength, (particularly welded bearings) should be checked to BS EN 1993-2. For designs based on more empirical methods, consideration should be given to the need for additional testing under railway loading conditions.

Selection ***100.2*** *The designer should provide a performance specification for the bearings.*

Bearing type ***100.2.1*** *The suitable type(s) of bearings can be selected from catalogues, price lists and discussions with manufacturers. The complete range of types should be considered (see **100.3**) to determine whether types other than those commonly used (for example, laminated elastomeric rather than metal) would be acceptable and provide economy in whole life cost. Provided that the bearing is protected from oil and salt/chemical attack, the working life of a bearing can be expected to be about half that of the bridge. However, the cost of replacing bearings is particularly high (even when discounted to present day values), and this should be borne in mind when selecting and designing bearings.*

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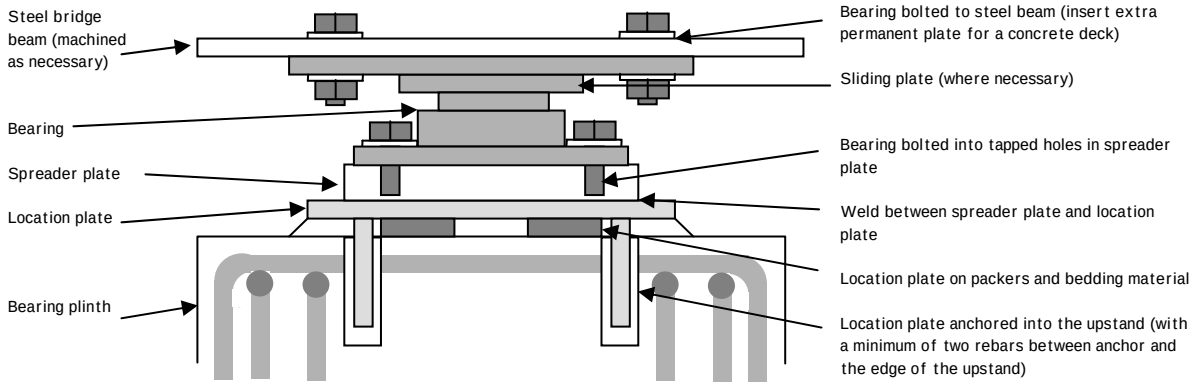
Design by manufacturers ***100.2.2*** *Previous practice was for the designer to request a sole manufacturer to detail the bearings. This practice enabled the designer to finalise the associated structural details (such as the packer/distribution plates to the superstructure, bearing course levels, plinth heights and plan dimensions, reinforcement and holding down details, ballast wall heights), but effectively eliminated competition. This practice shall not now be followed, except on grounds of technical compatibility.*

The following procedure introduces the necessary element of competition, but it requires additional time for selection of the bearing and for checking compatibility at the interface between the bearing and structure:

- *Examine catalogues to identify a typical range of bearing sizes for the particular application.*
- *Determine the structural fixing details, making an allowance for a typical gap.*
- *Modify the structural details to match the chosen bearing: the modification of the details shall be done by the designer (and not arbitrarily on site).*

Typical arrangement for a steel superstructure



A 'space' should be left on the Contract Drawings between the superstructure and substructure, and only essential information regarding clearances, etc., provided to the Contractor. The dimensions of the 'space' should allow for the examination, maintenance and replacement of the bearings, and the areas set aside for placing jacks to enable the bearings to be replaced should be identified. The Contractor can then select the manufacturer and determine the bearing and structural details. The use of bearing plinths, whose level is readily adjustable, allows flexibility in the selection of the bearings.

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