

Technical Direction

Bridge

BTD 2018/01 | RMS 18.734 – 01 February 2018

Bridge Bearings

Summary:	Audience:
This bridge technical direction provides design requirements for bridge bearings which are additional to or supplement those of AS 5100 Bridge design.	<ul style="list-style-type: none"> • Bridge designers and drafters • Project managers • Asset managers • Industry partners.

Background

The revised AS 5100 Bridge Design Set, including AS 5100.4 *Bridge design – Bearing and deck joints* was published in March 2017 and consequently some Roads and Maritime Services bridge technical directions relevant to the design of bridge bearings are now out of date.

Recent design reviews have highlighted several issues for which requirements additional to those of AS 5100 need to be considered when designing bridge bearings.

Information

This bridge technical direction supersedes the following Roads and Maritime technical directions:

- CBE1997/05
- CBE1998/08
- BPC2005/04
- BTD2007/12.

This technical direction applies to bearings used in bridges and related road structures.

Approvals:

Owner:	Wije Ariyaratne Director Bridges and Structures	Review Date:	
Authorised by:	Chris Harrison Director of Engineering	Effective Date:	1 February 2018

A. Durability and materials

The costs of bridge bearing maintenance or replacement can be significant over the life of the bridge. The initial choice of bearing materials plays a major role in minimising bridge maintenance costs.

To achieve durable bearings, the following must apply:

- A1 Durable bridge bearing materials must be used for bridges subject to severe environmental exposure conditions in coastal and near-coastal locations. Bearings less prone to deterioration such as laminated elastomeric bearings should be used in such environments
- A2 Exposed steel components of bearings on bridges located within 1 km from the coastline or in atmospheric corrosivity category C4 or worse, as detailed in AS 4312 *Atmospheric corrosivity zones in Australia*, must be made of stainless steel
- A3 Where spherical bearings are used in environments where chloride and/or fluorine particles are airborne, such as industrial environments, hard chromium-plated sliding surfaces must not be used. Where applicable, such an environment must be clearly specified on the design drawings
- A4 Pot bearings with metallic internal seals must not be used for bridges exceeding the traffic limitations specified in Clause 13.1 of AS 5100.4 *Bridge design - Bearings and deck joints*. Where the bridge is subject to the applicable traffic limitations, a note of this effect must be shown on the design drawings
- A5 The thickness of unreinforced elastomeric pad and strip bearings must not be greater than 25 mm
- A6 Unreinforced elastomeric bearings must not be used to support spaced precast pretensioned concrete plank girders.

B. Provisions for replacement of bearings in new bridges

Clause 7.3 of AS 5100.4 specifies a minimum design life of 50 years for bearings, excluding easily replaceable components. Maintenance or replacement of bearings is expected during the lifespan of bridges. Although a service life of 100 years is generally achievable for unreinforced elastomeric strip bearings, damage or deterioration may occur due to external effects such as fire.

Except for unreinforced elastomeric strip bearings under approach slabs, the following must apply:

- B1 Bridge bearings must be designed and detailed to allow their easy replacement or removal
- B2 Provisions must be made in the design of bridges for the jacking up of superstructures to allow bearing replacement under traffic. The lift from jacking must not exceed 10 mm, except for bridges with spaced precast pretensioned concrete plank decks where a larger lift may be required. In all cases bridge designers must specify the maximum permissible lift on the design drawings
- B3 Bridge superstructures must be able to accommodate the differential displacements associated with the specified maximum lift, assuming that the deck will not be lifted at other piers and abutments
- B4 Jacking must be a separate design load case with the following design parameters and conditions considered:
 - All marked traffic lanes on the bridge must be open to traffic
 - Shoulders must be closed to traffic
 - The traffic speed on the bridge must be reduced to 40 km/h
 - The dynamic load allowance must be taken as 0.1
 - The design traffic load must be SM1600 as specified in AS 5100.2
 - Load factors, and accompanying lane factors must be as specified in AS 5100.2
 - The heavy load platform (HLP) loading need not be considered

- Jacks must be located on the top of bridge abutments and pier headstocks. The design of abutment and pier headstocks must allow for the provision of temporary packers during jacking
 - For bridges with Roads and Maritime spaced precast pretensioned plank girders, the width of the abutment and pier headstocks must be designed with sufficient width to accommodate lifting jacks. If wide headstocks are not accepted by Roads and Maritime Services for aesthetic or other reasons, temporary jacking frames primarily resting on the top of the headstocks and secured in position may be permitted. The details of the temporary jacking frames must be included in the design drawings and marked as “FOR INFORMATION ONLY”
 - The ends of all girders at any pier or abutment must be jacked up uniformly using hydraulically linked jacks and a control mechanism to ensure that the same vertical displacements occur at each jack at all times during the jacking operations. Temporary restraints must be provided to prevent uncontrolled movement of the superstructure during jacking
 - The contact pressure between concrete bearing surfaces and hydraulic jacks must be checked in the design. As a minimum, steel plates must be placed between the concrete bearing surface and the hydraulic jacks.
- B5 Jacking provisions including the location of jacking points, and the calculated jacking forces for both ultimate and serviceability limit state loads for each jacking point, must be shown on the bridge design drawings. Any changes during construction to the original details must be included on the work-as-executed (WAE) records to assist future bearing replacement
- B6 Provisions must be made for safe access to bearings for maintenance or replacement in conformity to *BTD 2008/02 Access for Inspection, Monitoring and Repair or Replacement of Bridge Components*.

C. Bearing attachment plates

For bearing attachment plates the following must apply:

- C1 Pot and spherical bearings must be connected to the bridge superstructure and substructure using steel attachment plates. The average thickness of each plate must not be less than 20 mm
- C2 Attachment plates may be tapered to correct lack of parallelism caused by various effects including longitudinal grade, cross-fall of the carriageway and hog or camber of the superstructure. Notwithstanding the average thickness requirements in item C1, the minimum thickness must not be less than 10 mm
- C3 Pot and spherical bearings must be designed so that the fasteners connecting the bearing to the attachment plates can be replaced without lifting the bridge superstructure
- C4 Bearing attachment plates and anchor bolts must not obstruct movements and rotations of the bearing and must allow its removal and replacement.

D. Bearing mortar pads and concrete substrates

The formula in Item (d) of Clause 17 of AS 5100.4 for calculating the design ultimate bearing force ϕV_{mp} of mortar pads and reinforced concrete substrates assumes the following:

- The mortar pad is an integral part of the reinforced concrete substrate
- The concrete strut below the bearing is adequately confined by means of anti-bursting reinforcement.

The following must apply:

- D1 ϕV_{mp} must be the lesser of the magnitudes of design ultimate bearing force of the mortar and the concrete calculated separately using the respective 28-day compressive strengths and the capacity reduction factors
- D2 For non-uniform contact stress at the bearing/mortar pad interface, ϕV_{mp} must be determined using a reduced effective loaded area A_1 so that the centroid of the equivalent uniform stress block coincides with that of the non-uniform stress block. A_1 may be determined from first principles or selected using the applicable tables in EN1337-2 *Structural bearings. Sliding elements*
- D3 The load dispersion angle through bearing components used in the calculation of A_1 must be 45° , unless a larger angle can be justified by a suitable analytical method that takes into account the characteristics of the bearing components, attachment plates, mortar pad and concrete substrate. The load dispersion angle must not be larger than 60° under any circumstances
- D4 As a simplified alternative to item D3, the load dispersion angle may be taken as 45° where the mean ultimate limit state contact stress – based on vertical load only – is equal to or greater than 50 MPa, and as 60° where that stress is equal to or less than 30 MPa. Where the ULS contact stress is between 50 MPa and 30 MPa, the dispersion angle may be determined using linear interpolation.
- D5 The mean ULS contact stress on the reduced effective loaded area A_1 must not exceed 55 MPa
- D6 The thickness of mortar pads and the reinforcement of the concrete substrate must conform to Clause 17 of AS 5100.4 *Bridge design - Bearings and deck joints*
- D7 Where the thickness of mortar pads or the reinforcement of the concrete substrate specified in Clause 17 of AS 5100.4 cannot be met, such as for bridge rehabilitation works, the design bearing stress on the contact area must conform to Clause 12.9 of AS 5100.5 *Bridge design – Concrete*.

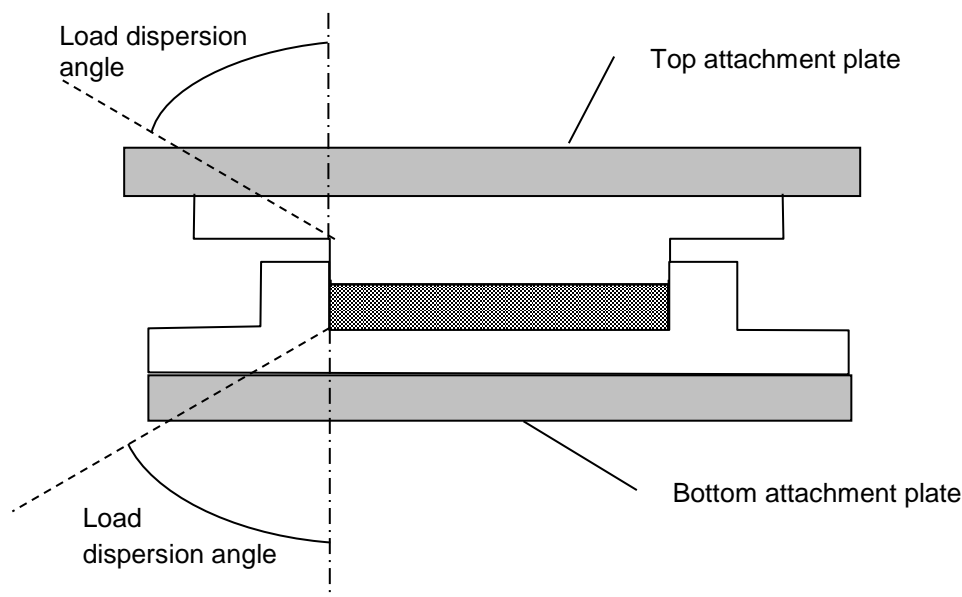


Figure 1: Illustration of load dispersion angle

References:

AS 4312 *Atmospheric corrosivity zones in Australia*

AS 5100.2 *Bridge design - Design loads*

AS 5100.4 *Bridge design - Bearings and deck joints*

AS 5100.5 *Bridge design – Concrete*

EN 1337-2 *Structural bearings. Sliding elements*

BTD 2008/02 *Access for Inspection, Monitoring and Repair or Replacement of Bridge Components*



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