AS 5100.4:2017
AP-G51.4-17

AS 5100.4:2017

Australian STANDARD

# Bridge design

# Part 4: Bearings and deck joints

STANDARDS Australia

Austroads

This Australian Standard® was prepared by Committee BD-090, Bridge Design. It was approved on behalf of the Council of Standards Australia on 13 March 2017.
This Standard was published on 31 March 2017.

---

The following are represented on Committee BD-090:

- Australian Industry Group
- Australian Steel Institute
- Austroads
- Bureau of Steel Manufacturers of Australia
- Cement and Concrete Association of New Zealand
- Cement Concrete & Aggregates Australia—Cement
- Concrete Institute of Australia
- Consult Australia
- Engineers Australia
- New Zealand Heavy Engineering Research Association
- Rail Industry Safety and Standards Board
- Steel Construction New Zealand
- Steel Reinforcement Institute of Australia
- Sydney Trains

---

This Standard was issued in draft form for comment as DR 5100.4:2016.

Standards Australia wishes to acknowledge the participation of the expert individuals that contributed to the development of this Standard through their representation on the Committee and through the public comment period.

---

## Keeping Standards up-to-date

Australian Standards® are living documents that reflect progress in science, technology and systems. To maintain their currency, all Standards are periodically reviewed, and new editions are published. Between editions, amendments may be issued.

Standards may also be withdrawn. It is important that readers assure themselves they are using a current Standard, which should include any amendments that may have been published since the Standard was published.

Detailed information about Australian Standards, drafts, amendments and new projects can be found by visiting **www.standards.org.au**

Standards Australia welcomes suggestions for improvements, and encourages readers to notify us immediately of any apparent inaccuracies or ambiguities. Contact us via email at **mail@standards.org.au**, or write to Standards Australia, GPO Box 476, Sydney, NSW 2001.

---

# Australian Standard®

## Bridge design

## Part 4: Bearings and deck joints

Originated as HB 77.4—1996.
Revised and redesignated as AS 5100.4—2004.
Second edition 2017.



Published by SAI Global Limited under licence from Standards Australia Limited, GPO Box 476, Sydney, NSW 2001, Australia

ISBN 978 1 76035 717 7

# PREFACE

This Standard was prepared by the Standards Australia Committee BD-090, Bridge Design to supersede AS 5100.4—2004.

This Standard is also designated as Austroads publication AP-G51.4-17.

The objectives of the AS(AS/NZS) 5100 series are to provide nationally acceptable requirements for—

(a) the design of road, rail, pedestrian and cyclist-path bridges;

(b) the specific application of concrete, steel and composite steel/concrete construction, which embody principles that may be applied to other materials in association with relevant Standards; and

(c) the assessment of the load capacity of existing bridges.

The objective of this Part (AS 5100.4) is to specify requirements for the design and selection of bearings and deck joints for bridges in Australia.

The requirements of the AS(AS/NZS) 5100 series are based on the principles of structural mechanics and knowledge of material properties, for both the conceptual and detailed design, to achieve acceptable probabilities that the bridge or associated structure being designed will not become unfit for use during its design life.

Whereas earlier editions of the Bridge design series were essentially administered by the infrastructure owners and applied to their own inventory, an increasing number of bridges are being built under the design-construct-operate principle and being handed over to the relevant statutory authority after several years of operation. This Standard includes clauses intended to facilitate the specification to the designer of the functional requirements of the owner, to ensure the long-term performance and serviceability of the bridge and associated structure.

Significant differences between this Standard and AS 5100.4—2004 are the following:

(i) Tables of standard elastomeric bearing properties have all been updated to add additional numbers of elastomer layers in each plan size.

(ii) The requirements for the sealing rings of pot bearing have been modified.

(iii) Spherical advanced composite material bearings have been introduced.

(iv) The movement range deck joints need to be designed for have been modified.

(v) Load distribution from bearings to concrete surfaces has been introduced.

(vi) Project-specific requirements (Appendix E) have been added.

(vii) Provisions for modular bridge expansion joints (MBEJ) have been added.

In line with Standards Australia policy, the words 'shall' and 'may' are used consistently throughout this Standard to indicate, respectively, a mandatory provision and an acceptable or permissible alternative.

Statements expressed in mandatory terms in Notes to Tables are deemed to be requirements of this Standard.

The term 'normative' and 'informative' have been used in this Standard to define the application of the appendix to which it applies. A 'normative' appendix is an integral part of the Standard. An 'informative' appendix is only for information and guidance.

# CONTENTS

*Page*

1 SCOPE .... 4
2 NORMATIVE REFERENCES .... 4
3 DEFINITIONS .... 5
4 NOTATION AND ABBREVIATIONS .... 6
5 FUNCTIONS OF BEARINGS AND DECK JOINTS .... 11
6 LOADS, MOVEMENTS AND ROTATIONS .... 11
7 GENERAL DESIGN REQUIREMENTS .... 11
8 MOVEMENT RESTRAINTS .... 13
9 ALIGNMENT OF BEARINGS AND DECK JOINTS .... 14
10 ANCHORAGE OF BEARINGS .... 14
11 LOADS RESULTING FROM RESISTANCE TO MOVEMENT .... 15
12 ELASTOMERIC BEARINGS .... 17
13 POT BEARINGS .... 26
14 SPHERICAL APPROVED SLIDING MATERIAL (ASM) BEARINGS .... 27
15 PLANE SLIDING CONTACT SURFACES .... 31
16 MECHANICAL BEARINGS .... 32
17 LOAD DISTRIBUTION FROM BEARINGS TO CONCRETE ELEMENTS .... 34
18 BEARINGS SUBJECT TO UPLIFT .... 35
19 DECK JOINTS .... 36
20 MODULAR BRIDGE EXPANSION JOINTS (MBEJ) .... 39

APPENDICES
A TABLES OF STANDARD ELASTOMERIC BEARING PROPERTIES .... 52
B TESTING OF ELASTOMER—CATEGORY 1 TESTS .... 82
C MANUFACTURING TOLERANCES FOR LAMINATED ELASTOMERIC BEARINGS .... 86
D TESTING OF LAMINATED ELASTOMERIC BEARINGS .... 88
E DESIGN REQUIREMENTS FOR MODULAR DECK JOINTS .... 90
F TEST PROCEDURE FOR EXPERIMENTAL MODAL ANALYSIS .... 92

BIBLIOGRAPHY .... 96

STANDARDS AUSTRALIA

**Australian Standard**

**Bridge design**

Part 4: Bearings and deck joints

## 1 SCOPE

This Standard sets out minimum design and performance requirements for bearings and deck joints for the articulation and accommodation of movements of bridge structures. It applies to elastomeric, pot, spherical and mechanical bearings and deck joints, all of which are locations where rotation or translation, or both, can take place. It does not apply to concrete hinges.

## 2 NORMATIVE REFERENCES

The following are the normative documents referenced in this Standard.

NOTE: Documents referenced for informative purposes are listed in the Bibliography.

| | | |
|---|---|---|
| AS | | |
| 1683 | Methods of test for elastomers | |
| 1683.11 | Method 11: | Tension testing of vulcanized or thermoplastic rubber |
| 1683.12 | Method 12: | Rubber, vulcanized or thermoplastic—Determination of tear strength (trouser, angle and crescent test pieces) |
| 1683.14.1 | Method 14.1: | Adhesive strength of vulcanized or thermoplastic rubber—One-plate method |
| 1683.15.1 | Method 15.1: | International rubber hardness |
| 1683.15.2 | Method 15.2: | Durometer hardness |
| 1683.22 | Method 22: | Determination of vulcanization characteristics using the oscillating disc curemeter |
| 1683.24 | Method 24: | Determination of the resistance of vulcanized or thermoplastic rubbers to ozone cracking—Static strain test |
| 1683.26 | Method 26: | Rubber, vulcanized or thermoplastic—Accelerated ageing or heat-resistance tests |
| 5100 | Bridge design | |
| 5100.2 | Part 2: | Design loads |
| 5100.5 | Part 5: | Concrete |
| AZ/NZS | | |
| 1554 | Structural steel welding | |
| 1554.5 | Part 5: | Welding of steel structures subject to high levels of fatigue loading |
| 2312 | Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings | |
| 5100 | Bridge design | |
| 5100.6 | Part 6: | Steel and composite construction |
| ISO | | |
| 815 | Rubber, vulcanized or thermoplastic—Determination of compression set | |
| 815-1 | Part 1: | At ambient or elevated temperatures |
| 13000 | Plastics—Polytetrafluoroethylene (PTFE) semi-finished products | |
| 13000-1 | Part 1: | Requirements and designation |

EN

| | |
|---|---|
| 1337 | Structural Bearings |
| 1337-5 | Part 5: Pot bearings |

ASTM

| | |
|---|---|
| A240/A240M-03b | Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels and for General Applications |
| C719-14 | Standard Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movement (Hockman Cycle)1, 2 |
| 5973 | Standard Specification for Elastomeric Strip Seals with Steel Locking Edge Rails Used in Expansion Joint Sealing |

NCHRP

| | |
|---|---|
| Report 467 | Performance Testing for Modular Bridge Joint Systems |

## 3 DEFINITIONS

For the purpose of this Standard, the definitions below apply.

### 3.1 Bonded layer

A layer of elastomer bonded on both faces to metal plates, achieved by a vulcanization process.

### 3.2 Deck joint

A structural discontinuity between two elements, at least one of which is a deck element, which is designed to permit relative translation or rotation, or both, of abutting structural elements.

### 3.3 Laminated bearing

An elastomeric bearing with two or more metal plates bonded into the elastomer.

### 3.4 Modular deck joint

A joint that consists of a number of transverse beams and seals that are connected to a series of support mechanisms that provide a large movement capability.

### 3.5 Plain bearing

A bearing made up of a single unbonded layer of elastomer.

### 3.6 Pot bearing

A bearing that carries vertical load by compression of an elastomeric disc confined in a steel cylinder and which accommodates rotation by angular deformation of the disc.

### 3.7 Rated load

The calculated maximum permissible compressive load that is applied to a bearing when it is subjected at the same time to specified shear strain and rotation.

### 3.8 Semi-bonded layer

A layer of elastomer bonded on one face to a metal plate.

### 3.9 Spherical bearing

Bearing consisting of a plate with a convex spherical surface and a plate with a concave spherical surface between which a low friction sheet and a mating material form a curved sliding surface.

### 3.10 Strip bearing

A plain bearing pad in which the length is more than 10 times the width.

### 3.11 Unbonded layer

A single layer of elastomer that is not bonded to metal plates.

## 4 NOTATION AND ABBREVIATIONS

### 4.1 Notation

The symbols used in this Standard are as listed below.

Unless a contrary intention is given, the following applies:

(a) Where non-dimensional ratios are involved, both the numerator and denominator are expressed in identical units.

(b) The dimensional units for length and stress in all expressions or equations are to be taken as millimetres (mm), Newtons (N) and megapascals (MPa) respectively, unless specifically noted otherwise.

(c) An asterisk (*) placed after a symbol as a superscript denotes a design action effect due to the design load for the ultimate limit state (ULS).

| Symbol | Definition |
|---|---|
| $A_b$ | bonded surface area |
| $A_{cs}$ | reduced contact area of the curved sliding surface |
| $A_{eff}$ | effective loaded plan area, nominally equal to the projected area common to top and bottom when a bearing is distorted tangentially |
| $A_p$ | projected contact area (length of the seating times the diameter of the pin) |
| $A_r$ | total rubber plan area |
| $A_1$ | effective loaded area at the interface of the attachment plate and the mortar pad or concrete substrate |
| $A_2$ | maximum distribution area based on a dispersion angle from the effective loaded area through the mortar pad and concrete |
| $a$ | plan dimension of the edge of the bonded surface of rectangular bearings parallel to the span of the bridge |
| $B$ | bulk modulus of elastomer |
| $B_c$ | width of centre beam at top |
| $B_w$ | contact width of dual truck tyres |
| $b$ | plan dimension of the edge of the bonded surface of a rectangular bearing transverse to the span of the bridge |
| $b_e$ | lesser of $a$ and $b$ for rectangular bearings |
| $b_1$ | load distribution width at the interface of the attachment plate and motor pad |
| $b_2$ | load distribution width based on the dispersion angle through the motor pad and concrete |
| $C_1$, $C_2$ | constant dependent on bearing shape |
| $D_L$ | design life of the component, in years |
| $d$ | plan diameter of circular bearing at edge of bonded surface |

| | |
|---|---|
| $d_c$ | total compressive deflection |
| $d_1$ | diameter of the elastomeric pad within the pot bearing |
| $d_2$ | diameter of the projected plan area of the approved sliding material (ASM) sliding surface |
| $E_c$ | effective compression modulus of elastomer |
| $E_h$ | homogeneous compression modulus |
| $E_r$ | effective rotation modulus of elastomer |
| $E_s$ | Young’s modulus of elasticity |
| $e$ | eccentricity |
| $f'_c$ | lesser of the 28 days compressive cylinder strength of the mortar or concrete substrate |
| $f_d$ | design compressive strength of approved sliding material (ASM) |
| $f_n$ | normal stress |
| $f_o$ | stress used in calculation of anchorage of laminated bearing |
| $f_p$ | principal stress |
| $f_r$ | resultant stress |
| $f_{rn}$ | fatigue detail category defined in AS/NZS 5100.6, which is the corrected fatigue strength (in MPa) at $2 \times 10^6$ cycles |
| $f_u$ | tensile strength used in design |
| $f_y$ | nominal yield strength of metal plates; *or* |
| | nominal yield stress used in design |
| $f_5$ | detail category fatigue strength at cut-off limit |
| $G$ | chord shear modulus |
| $g_c$ | gap between centre beams at appropriate joint opening |
| $H$ | horizontal force; *or*<br>shear force, serviceability limit state (SLS) |
| $H^*$ | horizontal force; *or*<br>shear force, ultimate limit state (ULS); *or*<br>design longitudinal force |
| $h$ | minimum protrusion of sliding material above the recess in curved backing plate of a spherical bearing |
| $I$ | second moment of area of the plan area of the elastomer about its axis of rotation |
| $J_u$ | maximum ultimate opening between edge beams of a modular deck joint |
| $K_c$ | compressive stiffness of a bearing |
| $K_{cn}$ | compressive stiffness of an individual layer $n$ of elastomer in a laminated bearing |
| $K_h$ | lateral horizontal stiffness |
| $K_r$ | rotational stiffness of bearing |
| $K_{rn}$ | rotational stiffness of a layer $n$ |
| $K_s$ | shear stiffness of an elastomeric bearing |

| | |
|---|---|
| $K_v$ | effective compression stiffness |
| $L$ | diameter of the projected area of the sliding material; *or* |
| | length of the cylinder |
| $L_w$ | tyre contact length in direction parallel to traffic |
| $M$ | rotational moment |
| $m$ | ratio of the sides of a rectangular laminated bearing |
| $N$ | compressive load on a bearing, serviceability limit state (SLS); *or*<br>design bearing load |
| $N_c$ | number of centre beams supported on a support bar |
| $N_{min.}$ | minimum permanent compressive load normal to the bearing anchorage interface concurrent with $H$, serviceability limit state (SLS) |
| $N_{min.PE}$ | minimum compressive load, due to permanent load effects, normal to the bearing anchorage interface concurrent with $H$ |
| $N^*$ | design axial force at ultimate limit state (ULS) |
| $N^*_{min.}$ | minimum concurrent load acting in compression normal to the bearing anchorage interface, ultimate limit state (ULS) |
| $n_a$ | number of bearings contributing to adverse frictional load |
| $n_e$ | number of effective cycles of vibration following excitation |
| $n_r$ | number of bearings contributing to relieving frictional load |
| $n_{sc}$ | design number of stress cycles caused by the design load |
| $P^*$ | vertical load |
| $P$ | surface perimeter for laminated elastomeric bearings |
| $p$ | tyre inflation pressure |
| $Q^*$ | vertical design force |
| $Q^*_{up}$ | upward rebound force on the yoke of a modular deck expansion joint due to the passage of a wheel load across the joint |
| $q$ | ratio |
| $R$ | support reaction |
| $R^*$ | fatigue resistance for the appropriate detail category |
| $R_{lim}$ | ultimate section or member capacity of a component of a modular deck joint |
| $R_{ua}$ | characteristic ultimate shear capacity of mechanical anchors |
| $r$ | radius of cylindrical roller or rocker; *or*<br>radius of spherical rocker |
| $r_1$ | radius of the concave seating |
| $S$ | shape factor of a layer of elastomer; *or*<br>shape factor of the thickest inner layer |
| $S^*$ | design action effect (force, stress, stress range, etc) for the appropriate limit state; *or* |
| | design action in general |
| $s$ | shear stress |
| $T^*$ | transverse design force |