AS 5100.2:2017
AP-G51.2-17
(Incorporating Amendment No. 1)

AS 5100.2:2017

Australian STANDARD

Bridge design

Part 2: Design loads

STANDARDS Australia

Austroads

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- 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

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Bridge design

Part 2: Design loads

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PREFACE

This Standard was prepared by the Standards Australia Committee BD-090, Bridge Design, to supersede AS 5100.2—2004.

This Standard incorporates Amendment No. 1 (August 2017). The changes required by the Amendment are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure or part thereof affected.

This Standard is also designated as Austroads publication AP-G51.2-17.

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, timber and composite construction, which embody principles that may be applied to other materials in association with relevant standards;

(c) the assessment of the load capacity of existing bridges; and

(d) the strengthening and rehabilitation of existing bridges.

The objective of this Part (AS 5100.2) is to specify minimum design loads and load effects for road, rail, pedestrian and cyclist path bridges, and other associated structures.

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.

Significant differences between this Standard and AS 5100.2—2004 are the following:

(i) Changes and clarifications to the provision for collision loads from rail traffic.

(ii) Changes to dynamic load allowance for rail traffic load effects.

(iii) Addition to provisions for bridge collision from waterway traffic.

(iv) Updated bridge traffic barrier loads to more closely reflect vehicles currently using the road network. Barrier test levels and minimum effect heights were adopted from the AASHTO *Manual for Assessing Safety Hardware* (MASH 2009) which replaced NCHRP Report 350 (1993).

(v) Earthquake design procedures for bridges rewritten to align with the current earthquake loading Standard AS 1170.4—2007, *Structural design actions*, Part 4: *Earthquake actions in Australia*. New displacement-based earthquake design procedures were included.

(vi) Improvement to serviceability and fatigue limit states for road signs and lighting structures.

(vii) Expansion of water flow forces to include impact from large moving objects during flood events.

(viii) Addition of light rail vehicles.

Other differences between this Standard and AS 5100.2—2004 are the following:

(A) Improved pedestrian and cyclist path barrier loads.

(B) Expanded dynamic loads for pedestrian and cyclist path bridges.

(C) New table for unfactored vertical pressure due to design rail traffic loads.

(D) Inclusion of super-t girders in the calculation of bridge thermal effects.

(E) Clarification of loads and load factors for construction loads.

(F) Addition of protective screen design for wind load and robustness.

(G) New fire effect load case.

A number of new or revised appendices have been added to this edition of the Standard, which provide additional information and guidance as follows:

(1) Update to special performance level bridge barrier loads.

(2) New alternative force-based earthquake design procedures.

(3) Bending moment and shear force for SM1600 and 300LA loads for simply supported spans.

(4) A summary of load factors and load combinations.

In line with Standards Australia editorial 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 ‘informative’ has been used in this Standard to define the application of the appendix to which it applies. An ‘informative’ appendix is only for information and guidance.

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1 SCOPE AND GENERAL

1.1 Scope

This Standard sets out minimum design loads, forces and load effects for road, rail, pedestrian and cyclist path bridges, and other associated structures.

1.2 General

Structures shall be proportioned for the design loads, forces and load effects in accordance with Clauses 6 to 26, as appropriate.

NOTE: If the relevant authority approves, the designer may vary any of the loads set out in this Standard, provided the provisions of AS 5100.1 are complied with.

The design loads and forces shall be considered as acting in combinations as set out in Clause 23.

NOTE: A summary of load factors is tabulated in Appendix D.

Each individual bridge shall be assessed to ascertain whether any other loads, forces or load effects are applicable for that particular design. The magnitude of these additional forces or load effects and their combination with other loads shall be consistent with the principles set out in AS 5100.1.

On the front sheet of the bridge drawings, the following details relating to design loads shall be shown, where relevant:

(a) The Standard used.

(b) Any significant variation to the minimum design loads as set out in this Standard.

(c) Traffic load, e.g. 300LA and SM1600, including lateral position, if critical, and the number of design lanes.

(d) Design traffic speed.

(e) Fatigue criteria, including number of cycles and route factor.

(f) Pedestrian loads, both horizontal and vertical.

(g) Collision load on the structure (e.g. substructure and superstructure where applicable) or alternative load paths provided.

(h) Design wind speeds.

(i) Flood data, e.g. design velocities, levels, debris, and the like.

(j) Earthquake criteria.

(k) Differential settlements and mining subsidence effects allowed for in the design.

(l) Foundation data where not shown elsewhere.

(m) Barrier performance level.

(n) The construction loads, methods and sequence, and any other specific limitations.

(o) Fire effects.

NOTE: Wave action is not included in this Standard. Where the bridge is subject to wave action, refer to specialist literature.

1.3 Special studies

Where changes are made to a part or all of the design processes detailed in this Standard or new information or methods are introduced, they should be established by special studies.

NOTE: For information on special studies refer to AS 5100.1 Appendix B

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

1170	Minimum design loads on structures
1170.4—2007	Part 4: Earthquake actions
1530	Methods for fire tests on building materials, components and structures
1530.4	Part 4: Fire-resistance test of elements of construction
1657	Fixed platforms, walkways, stairways, and ladders—Design, construction and installation
5100	Bridge design
5100.1	Part 1: Scope and general principles
5100.3	Part 3: Foundations and soil-supporting structures
5100.4	Part 4: Bearings and deck joints
5100.5	Part 5: Concrete
5100.9	Part 9: Timber bridges

AS/NZS

1170	Structural design actions
1170.2	Part 2: Wind actions
5100	Bridge design
5100.6	Part 6: Steel and composite construction

Austroads
Guide to Road Design
Guide to Traffic Management Part 3: Traffic Studies and Analysis

AASHTO
LRFD Bridge Design Specifications
Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals
Manual for Assessing Safety Hardware (MASH)

3 DEFINITIONS

For the purposes of this Standard, the definitions given in AS 5100.1 and those below apply.

3.1 Air space developments

A structure built over a railway or road to support overhead offices, shops, public space or accommodation.

3.2 Cantilever sign structure

A sign structure supported at one end only.

3.3 External developments

A public or private structure adjacent to the road or rail corridor.

3.4 High-mast light poles

Light poles with an overall height exceeding 13 m.

3.5 Portal sign structure

A sign structure comprising one or more horizontal or sloped members supported by at least two vertical members.

NOTE: The members may be trusses.

3.6 Rail

Rail traffic includes rail freight trains, rail passenger trains, electrified trains, light rail traffic, trams and cane rail traffic.

3.7 Track category

3.7.1 *Heavy haul freight (HHF)*

Freight rail transport carrying axle loads over 25 t.

3.7.2 *Main line freight (MLF)*

Freight rail transport carrying axle loads up to 25 t.

3.7.3 *Branch line freight (BLF)*

Freight rail transport carrying axle loads below 25 t.

3.7.4 *Light rail (LR)*

Passenger only rail transport with axle loads not exceeding 15 t, including trams.

3.8 Underground rail

A rail track that is continuously enclosed above, below and both sides by structure and/or ground for a length of 80 m or greater, or as otherwise specified by the relevant rail authority.

4 NOTATION

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	axle load
ALF_{i}	accompanying lane factor for the i^{th} lane where 'i' equals 2 of more
A_{d}	wetted area of the pier normal to the water flow, equal to the thickness of the pier normal to the direction of the water flow multiplied by the height of the water flow
A_{deb}	projected area of debris

A_L	wetted area, equal to the width of the pier parallel to the direction of the water flow multiplied by the height of the water flow; *or*
	plan deck area of the superstructure
A_p	bridge area in plan
A_s	net wetted area of the superstructure, including any railings or barriers, projected on a plane normal to the water flow
A_t	area of the structure for calculation of wind load
a	maximum vertical acceleration
B	length of the bearing seat transverse to the bridge longitudinal axis
b	width between external barriers ignoring internal kerbs, median barriers and medians; *or*
	overall width of the bridge between outer faces of barriers
$C(T_f)$	design action coefficient for elastic horizontal earthquake response
C_d	drag coefficient
$C_d(T_f)$	design action coefficient
$C_h(\mathrm{T})$	acceleration spectral shape factor
$C_h(T_f)$	acceleration spectral shape factor at fundamental natural period of vibration of the bridge frame in the direction considered (longitudinal or transverse)
C_L	lift coefficient
C_m	moment coefficient
C_s	side force coefficient (which depends on the angle between the water flow direction and the plane containing the pier)
C_T	base number of load cycles
C_1	coefficient dependent on the end fixity conditions
D	total depth of superstructure
D_c	section depth in the direction considered
d	depth of the superstructure, including solid barrier, if applicable; *or*
	depth below underside of sleepers; *or*
	thickness of the slab over a box cell
d_{bl}	diameter of longitudinal reinforcement steel
d_{sp}	wetted depth of the superstructure (including any railings or barriers) projected on a plane normal to the water flow
d_{ss}	wetted depth of the solid superstructure (excluding any railings but including solid barriers) projected on a plane normal to the water flow
d_{wgs}	vertical distance from the girder soffit to the flood water surface upstream of the bridge
F_{BM}	braking force applied by multiple vehicles
F_{BS}	braking force applied by a single vehicle
F_c	centrifugal force
F_d	design drag force