



Bridge design

Part 1: Scope and general principles



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 AS 5100.1:2015.

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Standards may also be withdrawn.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 1: Scope and general principles

First published as HB 77.1—1996.
Revised and redesignated as AS 5100.1—2004.
Second edition 2017.

COPYRIGHT

© Standards Australia Limited

All rights are reserved. No part of this work may be reproduced or copied in any form or by any means, electronic or mechanical, including photocopying, without the written permission of the publisher, unless otherwise permitted under the Copyright Act 1968.

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

ISBN 978 1 76035 714 6

PREFACE

This Standard was prepared by the Standards Australia Committee BD-090, Bridge Design to supersede AS 5100.1—2004.

This Standard is also designated as AUSTROADS publication AP-G51.1-17.

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

- (a) the design of road, rail, light 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 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 5100.1—2004 are the following:

- (i) *Bridge barriers* The clauses for both the performance level definition and selection and design of road bridge barriers have been revised. With the increasing concerns about objects being thrown from bridge walkways and pedestrian bridges, clauses have been included for the design of appropriate restriction barriers.
- (ii) *Environmental impacts* Environmental issues that could have an impact on bridge concepts have been included to ensure their consideration in the design process.
- (iii) *Collision protection* The clauses for collision from rail traffic have been revised to bring the loading in line with international practice, and to clarify the requirements.

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 ‘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.

CONTENTS

	<i>Page</i>
1 SCOPE	4
2 APPLICATION.....	4
3 NORMATIVE REFERENCES	5
4 DEFINITIONS	5
5 NOTATION	6
6 MATTERS FOR RESOLUTION BEFORE DESIGN COMMENCES.....	7
7 ALTERNATIVE DESIGN METHODS AND MATERIALS.....	9
8 DESIGN PHILOSOPHY	9
9 SAFETY IN DESIGN	12
10 SUSTAINABILITY AND CLIMATE CHANGE	13
11 WATERWAYS AND FLOOD DESIGN	13
12 ENVIRONMENTAL IMPACT	15
13 GEOMETRIC REQUIREMENTS.....	16
14 ROAD TRAFFIC BARRIERS	21
15 COLLISION PROTECTION	27
16 PEDESTRIAN AND CYCLIST PATH BARRIERS.....	31
17 NOISE BARRIERS.....	33
18 DRAINAGE	33
19 ACCESS FOR INSPECTION, MAINTENANCE AND COMPONENT REPLACEMENT	34
20 UTILITIES.....	34
21 SKEW RAIL BRIDGES	35
22 FIRE REQUIREMENTS.....	35
23 ROAD SIGNS AND LIGHTING STRUCTURES	35
APPENDICES	
A ROAD BARRIER PERFORMANCE LEVEL SELECTION METHOD	37
B SPECIAL STUDIES	47
BIBLIOGRAPHY	48

STANDARDS AUSTRALIA

Australian Standard
Bridge design

Part 1: Scope and general principles

1 SCOPE

This Standard sets out requirements for the design of new bridges and other structures, and provides guidance on the assessment of existing bridges and modification to existing bridges. It covers the following:

- (a) *Bridges:*
 - (i) The design of road, rail, light rail, pedestrian and cyclist path bridges.
 - (ii) Assessment of the load capacity of existing bridges.
 - (iii) Strengthening and rehabilitation of existing bridges.
- (b) *Other structures:*
 - (i) Road sign and lighting structures, noise barriers and protection screens.
 - (ii) Retaining structures and deflection walls.
 - (iii) Culverts, and structural components related to tunnels, except those covered specifically by other Australian Standards.
 - (iv) Structures built over rail tracks.

2 APPLICATION

A number of clauses of the Standard nominate that some of the requirements of those clauses shall be confirmed as accepted by the relevant authority for a bridge or other structure before the design process is commenced. These clauses form part of the requirements of this Standard and are listed in Clause 6.

Existing bridges and subsequent modifications were designed to the relevant Standard of the time. There is no requirement under this Standard to upgrade a bridge to the current Standard. However, change in use of a bridge may result in an assessment of the bridge in accordance with this Standard, subject to the requirements of the relevant authority who will consider risk, remaining life and the cost.

For bridges with spans greater than 100 m, rail bridges for train speeds greater than 160 km/h, or unusual or more complex bridges (including cable stayed and suspension bridges), the provisions of this Standard shall be supplemented by other appropriate Standards and specialist technical literature.

NOTE: Wave action on bridges is not covered in the Standard and specialist technical literature should be consulted.

3 NORMATIVE REFERENCES

The following are the normative documents referenced in this Standard:

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

AS

- 1428 Design for access and mobility (series)
- 1530 Methods for fire tests on building materials, components and structures
- 1530.4 Method 4: Fire-resistance tests for elements of construction
- 1742 Manual of uniform traffic control devices
- 1742.2 Part 2: Traffic control devices for general use
- 1798 Lighting poles and bracket arms—Recommended dimensions
- 5100 Bridge design
- 5100.2 Part 2: Design loads
- 5100.3 Part 3: Foundations and soil-supporting structures
- 5100.4 Part 4: Bearings and deck joints
- 5100.5 Part 5: Concrete
- 5100.7 Part 7: Bridge assessment
- 5100.8 Part 8: Rehabilitation and strengthening of existing bridges
- 5100.9 Part 9: Timber bridges
- TS 101 Design of post-installed and cast-in fastenings for use in concrete

AS/NZS

- 5100 Bridge design
- 5100.6 Part 6: Steel and composite construction
- 3661 Slip resistance of pedestrian surfaces
- 3661.2 Part 2: Guide to the reduction of slip hazards

EN

- 1992 Eurocode 2: Design Of Concrete Structures
- 1992-4 Part 4: Design of Fastenings For Use In Concrete

ABCB Australian Building Codes Board

NCC National Construction Code

Austroroads

Guide to Bridge Technology (set)

Guide to Road Design (set)

AASHTO Manual for Assessing Safety Hardware (MASH)

EOTA

ETAG 001 Guideline for European Technical Approval of Metal Anchors for Use in Concrete

4 DEFINITIONS

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

4.1 Design life

The period adopted in design for which a structure or structural element is required to perform its intended purpose with periodic maintenance and without replacement or major structural repairs.

4.2 Ductility

The ability of a structure to undergo large deflection prior to collapsing.

4.3 High frequency passenger rail line

A line with a peak intensity of more than 6 trains in an hour in each direction.

4.4 Major roadway

A road with a total traffic count at the bridge site of more than 40 000 vehicles per day (AADT) with 10% or more commercial vehicles.

4.5 Open deck (rail bridge)

A deck where the rail track form is comprised of rails seated on spaced transoms, which in turn are supported by stringer girders or deck girders.

4.6 Professional engineer

Any one or a combination of the following:

- (a) Where applicable, a member of a scheme established under Professional Standards Legislation in the relevant jurisdiction.
- (b) A person registered in a relevant area of practice on the National Engineering Register.
- (c) A Chartered Professional Engineer (CPEng) or equivalent qualifications recognized by Engineers Australia.
- (d) Where registration, legislation or chartered status is not applicable, a person eligible for the grade of Member of Engineers Australia with bridge experience that is considered acceptable to the relevant authority.

4.7 Reference surface

The road or rail level or, if a walkway is provided in front of the traffic barrier, the walkway level.

4.8 Relevant authority

An agency authorized by legislation or regulation to issue determinations, orders, or other instructions in respect of any subject covered by this Standard.

NOTE: Where compliance with this Standard is not a requirement of a relevant authority, but is a requirement of a body such as an insurance company or association, then that body, or its nominees, may perform the functions of the relevant authority for the purposes of this Standard.

4.9 Transom

A rail bearer on a rail bridge supporting and locating the track and guardrails, where required, fastened to it and supported by stringer girders or deck girders on open deck spans.

4.10 Underground rail

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

5 NOTATION

The symbols used in this Standard, including their definitions, are listed below.

Unless a contrary intention is given, the following applies:

- (a) The symbols used in this Standard shall have the meanings ascribed to them below, with respect to the structure, member or condition to which a clause is applied.
- (b) Where non-dimensional ratios are involved, both the numerator and denominator are expressed in identical units.

- (c) The dimensional units for length, force and stress, in all expressions or equations, are to be taken as millimetres (mm), newtons (N) and megapascals (MPa) respectively, unless noted otherwise.
- (d) An asterisk (*) placed after a symbol as a superscript (e.g. M_y^*) denotes a design action effect due to the design load.

Symbol	Definition
AADT	annual average daily traffic
CU	adjustment factor for curvature
GD	adjustment factor for road grade
H	height of the barrier
RT	adjustment factor for road type
R_u	nominal capacity
S^*	design action effect
US	adjustment factor for deck height and under-structure conditions
ϕ	capacity reduction factor
ΣA	total depth of longitudinal barrier components

6 MATTERS FOR RESOLUTION BEFORE DESIGN COMMENCES

The matters for resolution listed below shall, where relevant, be confirmed as accepted by the relevant authority before commencing the design process.

- 1 Requirements for assessment of a bridge due to change in use (see Clause 2).
- 2 Acceptance of the bridge experience of a Professional Engineer (see Clause 4.6).
- 3 Specification of a rail track as underground rail (see Clause 4.10).
- 4 Approval of the use of alternative design methods and materials (see Clause 7).
- 5 Specification of a shorter design life for ancillary elements (see Clause 8.2).
- 6 Approval of non-linear methods of analysis (see Clause 8.4).
- 7 Approval to use post-installed fasteners in new construction (see Clause 8.8).
- 8 Specification of special conditions and requirements for design (see Clause 8.9).
- 9 Approval of the process for risk ranking and risk reduction (see Clause 9).
- 10 Specification of bridge waterway requirements (see Clause 11.1).
- 11 Specification of span and vertical clearances for watercraft (see Clause 11.1).
- 12 Specification of alternative ARIs for flood immunity and SLSs (see Clause 11.1 and Table 11.1).
- 13 Specification of soffit level of the bridge relative to the flood immunity level (see Clause 11.1).
- 14 Specification of the afflux and corresponding ARI (see Clause 11.1).
- 15 Determination of the environmental requirements (see Clause 12).
- 16 Specification of geometric requirements (see Clause 13.1 and 13.2).
- 17 Specification of minimum dimensional clearances for bridges over navigable waterways (see Clause 13.3).

- 18 Specification of road bridge carriageway widths (see Clause 13.4).
- 19 Determination of horizontal clearances to substructure components (see Clause 13.6 and 13.8).
- 20 Specification of minimum vertical clearance (see Clause 13.7, 13.8 and Table 13.7).
- 21 Superelevation and widening of the deck surface of a bridge on a horizontal curve (see Clause 13.9).
- 22 Specification of the clear walkway width on road bridges (see Clause 13.10).
- 23 Additional requirements for stairways (see Clause 13.11 and Table 13.11).
- 24 Specification of ramp gradient for pedestrian only subways (see Clause 13.12).
- 25 Approval of cyclist path width and ramp gradients (see Clause 13.13).
- 26 Requirement for traffic barrier where the posted speed is 60 kph or less with a 300 mm min. height non-mountable kerb (see Clause 14.2).
- 27 Approval of a bridge traffic barrier based on performance evaluation of an existing barrier [see Clause 14.4(d)].
- 28 Criteria for special performance barriers (see Clause 14.4).
- 29 Alternative crash testing standards (see Clause 14.4).
- 30 Approval or nomination of traffic barrier performance levels [see Clause 14.5.1, Items (b) and (c)].
- 31 Necessity or appropriateness of upgrading of barriers for bridge rehabilitation (see Clause 14.5.1).
- 32 Specification of the provision of special performance barriers (see Clause 14.5.6).
- 33 Approval of alternative barrier profiles (see Clause 14.6.1).
- 34 Determination of the maximum height of the top of the sloping barrier face (see Clause 14.6.1).
- 35 Approval of alternative barrier post setback [see Clause 14.6.2(c)].
- 36 Approval of crashworthy traffic barrier or impact attenuation device (see Clause 14.6.4).
- 37 Assessment of risk and determination of the level and form of collision protection (see Clause 15.1).
- 38 Determination of the minimum clearance of a pier or column from the roadway beyond which road traffic barrier protection will not be required (see Clause 15.2).
- 39 Approval for other than clear span between abutments for structures over rail (see Clause 15.3.2).
- 40 Approval of a risk assessment and risk assessment methodology (see Clause 15.3.2).
- 41 Approval of the failure mode of frangible piers and the maximum deflection (see Clause 15.3.3).
- 42 Approval to not protect piers using deflection walls (see Clause 15.3.4).
- 43 Requirement to design abutments beyond 20 m from the centre-line of the nearest track for derailment collision protection (see Clause 15.3.5).
- 44 Approval of risk assessment for abutments located beyond 10 m and within 20 m from the centre-line of the nearest track (see Clause 15.3.5).

- 45 Approval of alternative thickness for abutments located within 10 m from the centre-line of the nearest track (see Clause 15.3.5).
- 46 Approval not to use deflection walls in the specified locations (see Clause 15.3.6).
- 47 Specification of the length of a deflection wall (see Clause 15.3.6).
- 48 Determination of the requirements for concrete wall support in rail tunnels (see Clause 15.3.7).
- 49 Required level of protection for structures on platforms (see Clause 15.3.7).
- 50 Determination of the watercraft to be used for the pier collision forces, pier protection, or pier-redundant superstructures (see Clause 15.4).
- 51 Alternative barrier arrangements for the outside edge of a pedestrian or cyclist path (see Clause 16.2.2).
- 52 Requirements for pedestrian protection barriers over electrified rail (see Clause 16.3).
- 53 Requirement for protection screens (see Clause 16.4).
- 54 Minimum height of a protection screen [see Clause 16.4(c)(i)].
- 55 Alternative vertical clearances for a protection screen [see Clause 16.4(c)(iv)].
- 56 Requirement for noise barriers (see Clause 17).
- 57 Requirements for drainage of road and rail bridges (see Clause 18.1).
- 58 Permission for water to run onto the bridge (see Clause 18.1).
- 59 Waterproofing of rail bridges (see Clause 18.3).
- 60 Permission to attach utility services (see Clause 20).
- 61 Approval and provisions for method of attachment of utility services [see Clause 20(a)].
- 62 Determination that a bridge shall be designed for the effects of fire (see Clause 22).
- 63 Determination of the fire time-temperature curve [see Clause 22(a)].
- 64 Approval of the design life for a sign or light structure (see Clause 23.2).

7 ALTERNATIVE DESIGN METHODS AND MATERIALS

This Standard does not preclude the use of techniques or materials other than those specified in the Standard.

Where this Standard does not cover a design requirement or where bridges are to be constructed from materials other than those covered specifically by this Standard, reference shall be made to other relevant Standards and current technical literature for material-specific performance, durability requirements and good practice. All other parts of the AS(AS/NZS) 5100 series shall apply.

The use of alternative design methods and materials shall be subject to approval of the relevant authority.

NOTE: For information on special studies to justify the use of alternatives, see Appendix B.

8 DESIGN PHILOSOPHY

8.1 General

The design shall consider intended function, aesthetics, constructability, maintainability, sustainability, climate change and safety in design.

The design shall be based on engineering principles, experimental data and experience.

All structures shall be designed and detailed to fail in a ductile manner after they reach the ultimate limit state, so far as is reasonably practicable, such that when any element reaches an ultimate limit state alternative load paths shall ensure the continued stability of the structure. Where it is not practicable to ensure overall stability of the structure, consideration shall be given to segmentation of the structure to limit the consequences of any structural failure.

The material parts of this Standard provide a range of capacity reduction factors that are based on the material properties and the degree of ductility for the mode of failure. Design using any material or mode of failure not explicitly covered by this Standard shall use a capacity reduction factor not greater than a capacity reduction factor given in this Standard for a similar level of ductility.

To ensure the safety and performance of the structure, attention shall be given to the following:

- (a) The quality control exercised in fabrication.
- (b) Supervision on site.
- (c) The control of unavoidable imperfections.
- (d) Competencies, qualifications, experience and skill of all personnel involved.
- (e) Documentation of design assumptions to ensure control over the conditions of use of the structure during its life.
- (f) Application of statistical methods and documentation of construction processes and material properties.

In addition, management control and supervision by professional engineers shall be undertaken at all stages of the design, construction and maintenance to prevent the occurrence of gross errors.

8.2 Design life

The design life of structures covered by this Standard shall be not less than 100 years unless otherwise specified. For the design of ancillary elements such as light poles, sign structures, drainage systems and noise barriers, a shorter design life may be specified by Clause 23.2 or by the relevant authority.

Elements such as bearings and expansion joints typically have a design life of less than 100 years. Provision shall be made to facilitate inspection, maintenance, removal and replacement of such elements and any fixings shall be detailed to be reusable.

8.3 Limit states

8.3.1 General

A structure or structural element shall be considered unfit for use if it reaches any one of a number of states at which it no longer satisfies the criteria governing its performance or use. All appropriate limit states shall be considered in design. Limit states are classified as—

- (a) ultimate limit states (ULSs); or
- (b) serviceability limit states (SLSs).

Unless specified otherwise—

- (i) an ultimate design action is an action that has a 5% probability of being exceeded during the design life, which (for a design life of 100 years) represents an average return interval of 2000 years; and
- (ii) a serviceability design action is an action that has a 5% probability of being exceeded per year, which represents an average return interval of 20 years.

8.3.2 Ultimate limit states (ULSs)

The ULSs include the following:

- (a) *Stability limit state*, which is the loss of static equilibrium by sliding, overturning or uplift of a part, or the whole of the structure.
- (b) *Strength limit state*, which is an elastic, inelastic or buckling state in which the collapse condition is reached at one or more sections of the structure. Plastic or buckling redistribution of actions and resistance shall only be considered if data on the associated deformation characteristics of the structure from theory and tests is available.
- (c) *Failure or deformation* of any foundation material causing excessive movement in the structure or failure of significant parts of the structure.
- (d) *Deterioration of strength* occurring as a result of, but not limited to, corrosion or fatigue such that the collapse strength of the damaged section is reached.
- (e) *Brittle fracture failure* of one or more sections of the structure of sufficient magnitude such that the structure is unfit for use.

8.3.3 Serviceability limit states (SLSs)

SLSs include the following:

- (a) *Deformation of foundation* material or a major load-carrying element of sufficient magnitude that the structure has limitation on its use.
- (b) *Permanent damage due to corrosion, cracking or fatigue*, which significantly reduces the structural strength or useful service life of the structure.
- (c) *Vibration* leading to structural damage or affecting its function.
- (d) *Flood damage* to the road or rail network and surrounding land resulting in effects such as scour damage to the channel bed, banks or embankments (see Table 11.1).

8.4 Analysis methods

Analysis for all limit states shall be based on linear elastic assumptions except where non-linear methods are specifically implied elsewhere in this Standard or approved by the relevant authority.

8.5 Design actions or loads

An action shall be a system of—

- (a) external concentrated or distributed forces (direct actions); or
- (b) imposed or constrained deformations (indirect actions), applied to a structure by a single cause.

The design action effects (S^*) for ULSs and SLSs shall be as specified in AS 5100.2.

8.6 Design capacity or strength

The design capacity or strength shall be as specified in this Standard. It shall be derived from the nominal capacity (R_u) of the element and the relevant capacity reduction factor (ϕ) of the material.

8.7 Verification of limit states

For ULSs, the following relationship shall be satisfied:

$$\phi R_u \geq S^* \quad \dots 8.7$$

For SLSs, the stress, deflection, cracking or vibration level shall satisfy the limits set out in the appropriate parts of the AS(AS/NZS) 5100 series.

Verification of the limit states relationships shall be by—

- (a) calculation;
- (b) testing; or
- (c) a combination of calculation and testing.

8.8 Post-installed fasteners

Post-installed chemical and mechanical fasteners (anchors) shall not be used in new construction unless approved otherwise by the relevant authority. Where post-installed fasteners are approved for use, they shall meet the following requirements:

- (a) The fastening design shall be in accordance with SA TS 101.
- (b) The fastener shall meet the prequalification requirements of SA TS 101 Appendix B. A fastener with a current European Technical Approval/Assessment (ETA) awarded in accordance with ETAG 001 satisfies the requirements of SA TS 101 Appendix B. For applications involving specific conditions such as cracked concrete, repeated loading, sustained tensile loading or seismic loading, products satisfying these conditions through relevant SA TS 101 Appendix B or ETA options shall be specified.
- (c) The installation of the fastener shall be carried out by a person certified by the Australian Engineered Fasteners and Anchors Council or evidence shall be provided of competency acceptable to the relevant authority.

8.9 Other considerations

Other effects, including accidents that can reasonably be foreseen shall be considered in the design. Consideration shall be given to the implications of damage or any other local failure in relation to the available load paths.

NOTE: In general, bridge structures are not designed for all possible loads and conditions, such as those arising in war or from sabotage, where the probability of occurrence is significantly less than that defined for the limit states specified in Clause 8.3.

For bridges generally and in particular pedestrian and cyclist path bridges over trafficable land and water, where piers are likely to be subjected to accidental forces greater than those specified in AS 5100.2, consideration shall be given to the provision of a clear span over the zone of potential impact. Where the provision of a clear span over the zone of potential impact is not practicable, appropriate redundancy, protection or robustness shall be designed into the structure to avoid collapse.

NOTE: In particular situations, the relevant authority may specify special conditions and requirements.

9 SAFETY IN DESIGN

Safety in design is mandated by statutory requirements and shall be incorporated into the design.

The safety in design process shall identify potential hazards and the potential risks to persons during construction, future operation, maintenance and eventual decommissioning of an asset. During the design phase, risks shall be eliminated or minimized.

The risks shall be ranked before and after a suitable control has been selected for implementation, which shall highlight where sufficient risk reduction controls have been achieved through design to reduce the risk to an acceptable level, using a process approved by the relevant authority. Residual risks shall be managed within the assets life cycle.

NOTE: As low as reasonably practicable (ALARP) or so far as is reasonably practicable (SFAIRP) are examples of risk processes.

The designer shall document, as a minimum, the following:

- (a) Hazards identified associated with a design (e.g. hazardous structural features, hazardous construction materials and hazardous procedures or practices) that might be realized in the construction, operation, maintenance and decommissioning phases of the project life cycle.
- (b) The hazard in terms of the potential risks of injury or harm.
- (c) The mitigation controls the designer has developed or utilized to reduce any risk.
- (d) Aspects of the design where the hazard has been identified but cannot be resolved during the design phase and needs to be managed during the construction, operation, maintenance and/or decommissioning phases.

10 SUSTAINABILITY AND CLIMATE CHANGE

10.1 General

Sustainability and climate change considerations shall reference relevant Standards and guidelines as well as policies and risk management approaches of the relevant authority.

10.2 Sustainability

Where documented guidance from the relevant authority is not available, reference may be made to industry guidance.

NOTE: Consideration should be given to the following aspects:

- (a) Whole of life impacts, which includes issues such as whole of life costing, durability and life cycle impacts. Guidance on life cycle impacts can be found in the AS ISO 14040, AS ISO 14041, AS ISO 14042 and AS ISO 14043.
- (b) Site-based considerations, which include aspects such as water, roadsides, rail corridors, heritage, air quality, noise and biodiversity.
- (c) New technologies, which include manufacturing techniques, materials and/or installation methodologies.
- (d) Community benefits, which include issues such as amenity, heritage and character, functionality and accessibility of different modes of transportation.

10.3 Climate change adaptation

The resilience and adaptability of assets is an important consideration in respect of forecast climate change and the relatively long design life of bridge assets.

NOTE: Guidance on climate change and adaptation can be found in AS 5334.

11 WATERWAYS AND FLOOD DESIGN

11.1 General

The bridge waterway requirements shall be specified by the relevant authorities.

The span and vertical clearances required for watercraft during normal stream flow or at specific flood levels shall be specified by the waterway authority.

For road structures, the average recurrence interval (ARI) for flood immunity and SLSs shall be as defined in Table 11.1, unless specified otherwise by the relevant authority.

For rail bridges, the flood immunity and SLS ARI shall be 100 years unless specified otherwise by the relevant authority.

For pedestrian and cyclist path bridges, the flood immunity and SLS ARI shall be 10 to 50 years unless specified otherwise by the relevant authority.

The soffit level of the bridge shall be not less than the flood immunity level or as specified by the relevant authority.

The road, rail and bridge system shall sustain the SLS flood event without damage to the bridge, channel bed, banks, and road or rail embankments (including the local effects of piers and abutments).

The bridge shall not collapse under any flood up to and including the ultimate limit state (2000 year ARI) flood, including the effects of debris and scour. As critical design conditions may occur at the overtopping flood, this shall be considered in the strength design of the bridge.

The afflux limit (and corresponding ARI) shall be as specified by the relevant authority.

The hydraulic capacity of the system shall allow the passage of the 2000 year ARI flood without catastrophic effects or failures.

The design shall allow for the impact of any stream excavation, improvement works or any altered flood patterns caused by the bridge and the approach embankment of the road or rail system.

Consideration shall be taken of the corresponding scour at the relevant floods. Any scour protection, if provided for the SLS, shall not be relied upon at the ULS.

Abutments shall be adequately protected to prevent scour for floods up to the SLS.

TABLE 11.1
FLOOD IMMUNITY AND SLS ARI FOR ROAD STRUCTURES

Elements	Austroroads road classification	Flood immunity ^(Note 1)	SLS
Cross-drainage (culverts and bridges)	Controlled access highways Includes: Motorways and freeways (National/State/Territory)	100 years	100 years
	Arterial roads classes 1 and 2 ^(Note 2) Includes: Highways and urban arterial roads (National/State/Territory)	50–100 years	50–100 years
	Arterial road class 3 ^(Note 2) Includes: Main roads (State/Territory)	50 years	50 years
	Local roads classes 4 and 5 ^(Note 2)	10–20 years	20 years
	Urban collector/distributor roads	10–50 years	20–50 years
	Urban local roads	10 years	10 years

NOTES:

1 Subject to approval by relevant authority.

2 For description of road classes, refer to *Austroroads Guide to Road Design Part 2: Design Considerations*.

11.2 Estimation of design floods

The return interval of the ULS design flood shall be in accordance with Clause 8.3. The return intervals of the SLS design floods shall be in accordance with Table 11.1. Estimation of flood discharges, levels and velocities shall be based on methods appropriate to the locality.

Theoretical estimates shall be compared with local flood records and the performance of any existing structures. Where the catchment area is intersected by a length of road or rail track containing bridges, culverts, embankments and floodways, the behaviour of this system shall be considered as a whole in deriving design flood levels and velocities.

As critical design conditions may occur at flood levels that just cause overtopping of the superstructure, an estimate of the return interval of such a flood shall be made and, if appropriate, this condition shall be considered in the design.