Master Specification
Part ST-SD-D1

Design of Structures

September 2024

Government of South Australia
Department for Infrastructure and Transport

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Document Information

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Document Management

 This is a controlled document and it will be updated and reissued as approved changes are made.

Contents

ST-SD-D1 Design of Structures

1 General

a) This Master Specification Part sets out the requirements for the design of bridges and civil infrastructure structures, including culverts with a clear internal dimension greater than or equal to 1.5 m, including:

i) the documentation requirements, as set out in section 2;

ii) the Safety in Design requirements, as set out in section 3;

iii) the Sustainability in Design requirements, as set out in section 4;

iv) the interpretation of AS 5100 Bridge design requirements, as set out in section 5;

v) the corrections and additional requirements to AS 5100 Bridge design, as set out in section 6;

vi) the selection of bridge structure type requirements, as set out in section 7;

vii) the aesthetic requirements, as set out in section 8;

viii) the earthquake design provisions, as set out in section 9;

ix) the bridge abutment and substructure requirements, as set out in section 10;

x) the on-structure and approach barrier requirements, as set out in section 11;

xi) the bridge superstructure requirements, as set out in section 12;

xii) the bridge fixtures and fittings requirements, as set out in section 13;

xiii) the public safety barrier and anti-throw screen requirements, as set out in section 14;

xiv) the noise barrier requirements, as set out in section 15;

xv) the major sign structure requirements, as set out in section 16;

xvi) the precast concrete member requirements, as set out in section 17;

xvii) the maintenance requirements, as set out in section 18;

xviii) the materials and durability requirements, as set out in section 19; and

xix) the Hold Point requirements, as set out in section 20.

b) This Master Specification Part does not apply to the design of Tunnels or buildings unless elements have specifically been referred to in TUN-CIV-DC1 “Tunnel Civil Requirements”.

c) The design and prediction of soil movement must be undertaken and documented by a suitably qualified Chartered Professional Engineer with an area of practice of geotechnical engineering.

d) The design of bridges and civil infrastructure structures must comply with the Reference Documents, including:

i) AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals;

ii) AS 1627 Metal finishing;

iii) AS 1768 Lightning protection;

iv) AS 2312 Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings;

v) AS 2865 Confined spaces;

vi) AS 3610 Formwork for concrete;

vii) AS 4312 Atmospheric corrosivity zones in Australia;

viii) AS 4678 Earth-retaining structures;

ix) AS 5100 Bridge design;

x) AS/NZS 1214 Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series);

xi) AS/NZS 1554 Structural steel welding;

xii) AS 1597.2 Precast reinforced concrete box culverts, Part 2: Large culverts (exceeding 1200 mm span or 1200 mm height and up to and including 4200 mm span and 4200 mm height);

xiii) AS/NZS 3845 Road safety barrier systems and devices;

xiv) AS/NZS 4680 Hot-dip galvanized (zinc) coatings on fabricated ferrous articles;

xv) Austroads Guide to Road Design (available from: https://austroads.com.au);

xvi) Bridge Aesthetics Design guideline to improve the appearance of bridges in NSW (available from: https://roads-waterways.transport.nsw.gov.au/);

xvii) CIA Z7 series (available from: https://concreteinstitute.com.au/);

xviii) Department Structures Group Drafting Guidelines for Consultants (available from: https://dit.sa.gov.au/standards/standards_and_guidelines);

xix) Queensland Department of Transport and Main Roads Technical Note 62 Assembly and Tensioning of High Strength Bolts and Nuts (available from: https://www.tmr.qld.gov.au/):

A. TN62 Part 1 - Class 8.8;

B. TN62 Part 2 - Class 10.9; and

C. TN62 Part 3 - Class 4.6;

xx) TfNSW Specification TS 01764.2 Modular Bridge Expansion Joints - DC (IC-DC-B316) (available from: https://roads-waterways.transport.nsw.gov.au/);

xxi) VicRoads Bridge Technical Note 007 Noise Attenuation Walls (available from: https://www.vicroads.vic.gov.au/business-and-industry/technical-publications/bridges-and-structures);

xxii) VicRoads Bridge Technical Note 014 Road Sign and Lighting Structures (available from: https://www.vicroads.vic.gov.au/business-and-industry/technical-publications/bridges-and-structures);

xxiii) VicRoads Standard Section 685 Anti-Graffiti Protection and Graffiti Removal (available from: https://webapps.vicroads.vic.gov.au/VRNE/csdspeci.nsf/);

xxiv) Welding Australia TGN-BC-01 Tack Welding of Reinforcement Bar; and

xxv) Worksafe Victoria: “Construction and Erection of Bridge Beams” (available from https://www.worksafe.vic.gov.au).

e) For all new and existing or modified structures, the Contractor must adopt structure numbers as allocated by the Principal, which must be used for all drawings and records.

f) For culverts with a clear internal dimension less than 1.5 m, the Department will accept structural designs completed by culvert manufacturers provided that they are designed and manufactured in accordance with the Contract Documents, including AS 1597.1 Precast reinforced concrete box culverts, Part 1: Small culverts (not exceeding 1200 mm span and 1200 mm height) and AS1597.2 Precast reinforced concrete box culverts, Part 2: Large

culverts (exceeding 1200 mm span or 1200 mm height and up to and including 4200 mm span and 4200 mm height).

2 Documentation

2.1 Design Basis

In addition to the requirements of PC-EDM1 “Design Management”, the Design Basis must:

a) address the requirements relating to the selection of the structure type as required by section 7;

b) include a bridge aesthetic report as required by section 8d); and

c) include the results of the risk assessment conducted by the Contractor in accordance with section 14c) which identifies the location and extent of anti-throw and public safety barriers required on all structures delivered as part of the Works.

2.2 Design Documentation

In addition to the requirements of PC-EDM1 “Design Management”, the Design Documentation must include:

a) all electronic structure models and data files including Microsoft Excel spreadsheets (as applicable);

b) the Durability Report as required by section 2.5;

c) where square hollow section or rectangular hollow section are used, details of the finite element model in accordance with item 6 of Table ST-SD-D1 5-1;

d) details of the minimum required concrete strengths for both lifting and transport of precast concrete members in accordance with section 17.1a);

e) details of the lifting points and anchors, and a rigging diagram (if required) in accordance with section 17.1c);

f) for pretensioned precast concrete members, a minimum concrete strength for lifting and transport in accordance with section 17.1d);

g) details of the sealing of joints between precast crown units and joints between precast base slab units (if any) in accordance with section 17.2e);

h) details of all materials to be incorporated into the Works in accordance with section 19.1b);

i) for large concrete members, the Contractor’s methodology for ensuring that the requirements of section 19.2a)v) are met during the concrete placement and curing period;

j) the submission of concrete mix designs and testing of special design mixes where required by section 19.2c);

k) electrical continuity provisions, including a strategy to ensure that the reinforcement cage is electrically continuous prior to pouring of concrete, where required by section 19.3a)iv);

l) any instances where different grades of steel are to be used in the design in accordance with section 19.5l); and

m) the instructions in accordance with section 19.7b).

2.3 Design Drawings

In addition to the requirements of PC-EDM1 “Design Management”, for the design of structures, Design Drawings, and related records as part of the Design Documentation must:

a) reflect the strategy to minimise whole of life embodied carbon and optimise recycled content through the design of concrete structural elements, as required by section 4d);

b) as part of the general notes on the drawings, include a summary table showing the target levels of cement replacement for each element in accordance with section 4f);

c) identify all design loads and fatigue loads and cycles, including the design location for HLP400 design loads in accordance with item 1 of Table ST-SD-D1 6-1, and all other relevant design load details;

d) identify whether levelling nuts have been used in the design of anchor bolts and baseplates for road signs and lighting structures, including major sign structures, as required by sections 0 and 16g);

e) identify whether bonded or un-bonded stressing tendons have been used in the design of post-tensioned elements as required by section 12.4a);

f) include details of any modified bitumen product used for deck waterproofing in accordance with section 12.8;

g) where applicable, an isometric view of the connecting element between the bridge barrier and the approach barrier in accordance with the requirements of section 13.4h);

h) outline the proposed traffic safety protections for major sign structure gantries as required by section 16m);

i) indicate the jacking locations and estimated jacking loads for bearings as applicable as required by section 18.1d)iii); and

j) ensure that any reference to:

   i) any ancillary drawings, on any sheet, has the reference to its drawing and sheet number; and

   ii) a Reference Document, has a detailed reference to the applicable requirement (for example, section 14.5.2(a) of AS 5100.1).

2.4 Design Report

In addition to the requirements of PC-EDM1 “Design Management”, the Design Report must include a structural design report which details all aspects of the structural design, including:

a) a full set of design calculations, incorporating calculations and determinations for all structural elements, supported by appropriate drawings, sketches and details;

b) details of every aspect of the structural design, including:

   i) a summary of design methodology, design loadings and design assumptions, including any additional interpretations or clarifications to AS 5100 Bridge design, over and above those specified in sections 0 and 6;

   ii) a summary of design calculations;

   iii) the erection methodology and equipment;

   iv) the geotechnical design methodology, assumptions, and summary calculations;

   v) the durability, maintenance, and access; and

   vi) the comprehensive specifications of all materials to be incorporated into the structural design;

c) where special concrete mix testing has been carried out to inform the design, the results of all testing and verification that demonstrates the proposed concrete mix design will meet the requirements of the Contract Documents;

d) an index of all electronic structure models and data files including Microsoft Excel spreadsheets (as applicable);

e) the strategy implemented by the Contractor to minimise whole of life embodied carbon and optimising recycled content for the design of concrete structural elements forming part of the Works, in accordance with the requirements of section 4d);

f) in relation to the proposed concrete mix design, how the Contractor has met the requirements of section 4, including:

   i) the requirement to minimise whole of life embodied carbon and optimise recycled content for the design of concrete structural elements;

   ii) the performance of the proposed concrete mix design against the embodied carbon and recycled content business as usual assumptions set out in the Department Sustainability Manual;

   iii) how the Contractor has sought to minimise the use of Portland cement, including the results of the assessment conducted in accordance with the Department Sustainability Manual; and

   iv) how the design:

      A. meets the minimum Portland cement replacement levels set out in Table ST-SD-D1 4-1; or

      B. where alternative concrete mixes are used, achieves equivalent or greater reduction in whole-of-life embodied CO2-e emissions to those that would have been achieved by satisfying the requirements of Table ST-SD-D1 4-1;

g) justification for locating any piers in medians or the road reserve in accordance with section 10.4b)i);

h) details of any modified bitumen product used for deck waterproofing in accordance with section 12.8c);

i) the outcomes of any lightning strike protection risk assessments carried out in accordance with section 13.3;

j) in relation to noise barriers:

   i) justification for selection of the final approach in accordance with section 15f); and

   ii) information on resistance of the barrier as required by section 15g);

k) comprehensive details of the protective coating system (for steel members);

l) the results of the assessment of the steelwork corrosivity at the proposed location of the structures in accordance with the requirements of section 19.5c);

m) details of how the Contractor proposes to meet the steelwork protection requirements of ST-SS-S2 “Protective Treatment of Structural Steelwork”, including details of all protective treatments and coatings proposed to be used;

n) in relation to hot-dipped galvanised steel components, all information required by ST-SS-S3 “Galvanizing”, which includes the information listed in Appendix A of AS/NZS 4680 Hot-dip galvanized (zinc) coatings on fabricated ferrous articles;

o) design summary details in accordance with Appendix 1: Design summary; and

p) design summary sketch and structure live load capacity in accordance with Appendix 2: Structure capacity summary, sufficient to assess the structure’s ability to handle wide, high or heavy loads.

2.5 Durability Report

The Contractor must as part of the Design Documentation, include a Durability Report, which:

a) is prepared by a person with appropriate qualifications and extensive experience in the durability design of structures;

b) addresses how the durability design for structures will achieve the durability requirements of section 19;

c) identify the key durability risks and controls to ensure the Design Life requirements are met;

d) address how the durability design has considered assets which are not Readily Accessible;

e) detail all exposure and corrosivity classifications;

f) detail all proposed galvanising and protective coatings used for the Works;

g) provide details of all concrete mix designs to be used for the Works;

h) where required, detail the inputs, assumptions, methodology and results of the thermal modelling required by section 19.1c)iv);

i) where required, detail the inputs, assumptions, methodology and results of the durability modelling required by section 19.1c)v);

j) for concrete structure elements, addresses:

   i) use of appropriate concrete properties that are based on testing of the concrete mix designs in accordance with section 19.2;

   ii) how a probabilistic performance-based durability design approach has been adopted;

   iii) how the expected variation in concrete properties and in the concrete cover and surface chloride concentration has been accounted for in the durability design;

   iv) the Contractor's proposed methodology for ensuring that the requirements of section 19.2a)v) are met during the concrete placement and curing period, including where required, the inputs, assumptions, methodologies and results of the thermal modelling used to establish the methodology; and

   v) how the durability design complies with the requirements of section 19.2; and

k) include all other requirements of the Durability Report as set out in the Master Specification, including (as applicable):

   i) ST-RE-D2 "Design of Retaining Walls"; and

   ii) TUN-CIV-DC1 "Tunnel Civil Requirements".

2.6 Maintenance Plan

In addition to the requirements of PC-CN2 "Asset Handover", the Contractor must as part of the Maintenance Plan include a structures maintenance plan, which details the maintenance requirements for all structures, and includes:

a) procedures and time schedules for the repair or replacement of structural elements, assets and other asset components (as applicable) including bearings and expansion joints, in accordance with the Design Life requirements;

b) details of the frequency and extent of inspection required;

c) details of the frequency and extent of monitoring required;

d) deterioration levels at which rectification work or replacement is required;

e) intervention methods and design limitations / considerations;

f) details of how to safely access locations for regular maintenance, inspections or replacement of elements;

g) method of replacement of specific elements;

h) contact details of suppliers of replacement elements and spares;

i) warranties on proprietary products;

j) any manuals and drawings available from the manufacturer of all externally supplied components used in the Works, including mechanical and electrical elements;

k) a historical record of construction issues and their resolutions;

l) the methodology for the re-levelling of bridge approach slabs after settlement occurs as required by section 10.2e); and

m) procedures for the replacement of bearings, which sets out details of any traffic speed / lane restrictions required during replacement, as required by section 18.1d)ii).

3 Safety in Design

a) The design of structures must:

   i) meet the Safety in Design requirements set out in this section 3; and

   ii) meet the requirements of PC-EDM2 “Safety Management in Design”.

b) The Contractor must ensure that the structural design:

   i) takes safety into account such that all structures can be safely constructed, operated and maintained; and

   ii) eliminates or minimises safety risks so far as is reasonably practicable.

c) The design of girder bridges must comply with the requirements of Worksafe Victoria: “Construction and Erection of Bridge Beams”.

d) The Contractor must ensure that all structures:

   i) do not permit easy or unauthorised pedestrian access (for example by not including ledges and overhanging structures that can be easily accessed). Measures to prevent unauthorised access must be incorporated into the design of the structures; and

   ii) do not incorporate loose materials that could become a traffic hazard if used by a vandal to throw into the path of traffic.

e) The design of precast concrete elements must include any lifting attachments and assumed support arrangements that are cast into the concrete. These attachments must not be considered to form part of the Temporary Works.

f) A ‘partial barrier’ fence (such as a Monowills 2-rail barrier) must be provided where a structure presents a fall hazard of 1.0 m or more, and general access is not intended.

g) In relation to the ‘partial barrier’ fence required in section 3f):

   i) this is applicable if maintenance personnel and members of the public can gain access to the upper level; and

   ii) the fence must be positioned outside the working width of the traffic barrier, or a crashworthy fence must be provided.

4 Sustainability in Design

a) The design of structures must address and incorporate the sustainability requirements as set out in PC-ST1 “Sustainability in Design”.

b) Concrete elements (including pipes and culverts) must achieve:

   i) a reduction in whole of life embodied carbon; and

   ii) an increase in recycled content,

   compared with business as usual materials and technologies (described in the Department Sustainability Manual), which must be demonstrated in the Design Report.

c) The Contractor must develop and implement a strategy to minimise whole of life embodied carbon and optimise recycled content through the design of concrete structural elements. As a minimum, this must include:

i) selecting the most efficient concrete grade practical, to reduce overall cementitious content;

ii) optimising the structural design to reduce the volume of materials required; and

iii) replacing Portland cement with supplementary cementitious materials to the maximum extent practical.

d) Implementation of the strategy referred to in section 4c) must be evident in the Design Report and Design Drawings.

e) As a minimum, the Contractor must ensure:

i) the minimum Portland cement replacement levels in Table ST-SD-D1 4-1 are achieved; or

ii) alternative mixes that achieve equivalent or greater reduction in whole-of-life embodied CO2-e emissions are adopted.

f) Target levels of cement replacement for each element must be summarised and shown in a table format as part of the general notes on the Design Drawings.

Table ST-SD-D1 4-1 Minimum Portland cement replacement levels for concrete

Exposure classification	Concrete strength grade (MPa)	Minimum Portland cement replacement level
B1	32	30%(1)(2)
B1	40	30%(1)(2)
B2	40	30%(1)(2)
B2	50	30%(1)(2)
B2 / C1	10 or 20 (mass concrete)	50%(1)(2)
C1	50	40%(1)(2)
C2	55	70%(2)
B1 / B2 / C1 / C2	65	30%(1)(2)
U	Project specific mix design to be submitted for approval	

Table notes:
(1) Higher replacement levels (50% or higher) must be specified where 56-day concrete strengths are specified (refer to ST-SC-S7 “Supply of Concrete”).
(2) Replacement proportions must comply with Table 4.4.1 (B) of AS 5100.5 Bridge design, Part 5: Concrete.

5 Interpretation of AS 5100

The design of structures must be undertaken using the clarifications and interpretations of AS 5100 Bridge design contained within this section 5.

Table ST-SD-D1 5-1 Interpretation of AS 5100 Bridge design

ID	AS 5100 section reference	Interpretation / requirement	
1	Section 8.2 “Design Life” of AS 5100.1 Bridge design, Part 1: Scope and general principles	The design of structures must comply with the following Design Life requirements:	
		Element(1)	**Design Life (years)(3)**
		All structures and structural elements, unless otherwise specified in this Table ST-SD-D1 5-1	100
		Replaceable elements such as bearings and expansion joints excluding replaceable pedestrian balustrades	50
		Lighting structures	50
		Non-structural architectural elements including architectural cladding (2)	50
		Protection screen panels(2)	50
		Noise wall panels or barriers and other noise attenuation devices(2)	50
		Replaceable pedestrian balustrades	30
		Steelwork protective coating system design life to first maintenance	25
		Table notes: (1) Where a component of an asset is not Readily Accessible for maintenance or replacement, it must be designed to function for the full Design Life of the structure it forms part of without maintenance. (2) Excluding primary load carrying framework. (3) Without limiting the definition of Design Life in the Contract Documents, Design Life for structures is defined as the time required for de-passivation of concrete at the closest reinforcing layer, plus 20 years (for surface cracks to appear).	
2	Section 13.6 “Horizontal clearance to substructure components of bridges over roadways” of AS 5100.1 Bridge design, Part 1: Scope and general principles	The clear distance between the edge of the lane and the face of such barrier must be in accordance with AGRD Part 6: Roadside Design, Safety and Barriers.	

ID	AS 5100 section reference	Interpretation / requirement
3	Section 18 “Drainage” of AS 5100.1 Bridge design, Part 1: Scope and general principles	a) Drainage water from the bridge must not discharge directly into any water course, railway line, traffic lane or footpath. Free draining scuppers through decks must not be used. b) All pipework for structure drainage must be corrosion resistant, fire proof (to mitigate against the risk of fuel raining down from the structure in the event of a fire) and must be concealed from public view except from directly underneath. c) All drainage on, or part of, structures must be Readily Accessible for cleaning and maintenance purposes and to enable replacement where required. d) Where the design rainfall is exceeded and the capacity of the pipe drainage system is exceeded, all water must be directed to the ends of the bridge for disposal.
4	Section 23.3 “Anchor bolts and baseplates” of AS 5100.1 Bridge design, Part 1: Scope and general principles	The method of design (whether levelling nuts are used or not) must be explicitly stated on the relevant Design Drawings.
5	Table 8.2(A) “Extremes in Shade Air Temperatures” of AS 5100.2 Bridge design, Part 2: Design loads	Maximum temperatures must be increased by 3°C.
6	Section 9 “Rail traffic” of AS 5100.2 Bridge design, Part 2: Design loads	The rail traffic design load must be based on the 300LA design loading. Where the Contract Documents specify a lower design load level, then the design actions must be obtained by proportioning the specified load by the 300LA load requirements under section 9 of AS 5100.2 Bridge design, Part 2: Design loads.
7	Section 24.4 “Fatigue limit state design” of AS 5100.2 Bridge design, Part 2: Design loads	a) Subject to c), the requirements of AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals and VicRoads Bridge Technical Note 014 Road Sign and Lighting Structures must be used. b) The natural wind gust formula from AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals must be used in place of AS1170.4 Structural design actions, Part 4: Earthquake actions in Australia. c) Where the Contractor proposes to use a square hollow section or rectangular hollow section, for the purposes of fatigue design of the weld the following requirements apply: i) the Contractor may adopt a suitable fatigue category detail as represented in the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals 5th Edition 2009 (AASHTO LTS 5th Ed 2009); ii) full scale testing is not required; iii) a finite element model in accordance with the latest version of AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals including Appendix D must be developed; and iv) details of the finite element model must be submitted with the Design Documentation.

ID	AS 5100 section reference	Interpretation / requirement
8	Section 9 “Buried structures” of AS 5100.3 Bridge design, Part 3: Foundations and soil-supporting structures	a) Culverts must be designed based on the methods of limit state design, using theoretical strength and serviceability calculations. b) Design based on prototype or proof-load testing is not permitted. c) In the design of culverts, the culvert units must be designed for sway. Sway must not be deemed to be restrained by bearing against the soil.
9	Section 5 “Functions of bearings and deck joints” AS 5100.4 Bridge design, Part 4: Bearings and deck joints	Clause 5 of AS 5100.4 Bridge design, Part 4: Bearings and deck joints must be read as if modified by the requirements of section 12.7.
10	Section 9.2.2 “Design shear strength of slabs” of AS 5100.5 Bridge design, Part 5: Concrete	The shear strength of culvert crown unit roof slabs must be calculated in accordance with AS 3600 Concrete structures or Appendix H of AS 1597.2 Precast reinforced concrete box culverts, Part 2: Large culverts (exceeding 1200 mm span or 1200 mm height and up to and including 4200 mm span and 4200 mm height).
11	Section 2.4.3 “Cracking” of AS 5100.5 Bridge design Part 5: Concrete	Minimum reinforcement of 500 mm^2/m must be provided with a maximum bar spacing of 300 mm. SL81 reinforcing mesh is deemed to meet this requirement.
12	Section 4.14.3.2 “Cover for corrosion protection” of AS 5100.5 Bridge design, Part 5: Concrete	Concrete bridge decks that are sealed with an approved modified bitumen product, and then surfaced with asphalt concrete, do not need to have cover increased if a curing compound is used for curing.
13	Section 7.3 “Ties” of AS 5100.5 Bridge design, Part 5: Concrete	Reinforcement in tension elements (including ties designed with strut-and-tie modelling) must not be lapped. Such reinforcement must be either continuous single length or have full strength welded or mechanical splices.

6 Corrections and additional requirements to AS 5100

The design of structures must be undertaken using the corrections and additional requirements to AS 5100 Bridge design, in accordance with Table ST-SD-D1 6-1.

Table ST-SD-D1 6-1 AS 5100 corrections and additional requirements

ID	AS 5100 section reference	Corrected / additional requirement
1	Section 7.3 “Heavy load platform loads” of AS 5100. 2 Bridge design, Part 2: Design loads	The design loads for bridges are W80, A160, SM1600 and, where specified in the Contract Documents, HLP400. Where HLP400 is required by the Contract Documents, the lateral placement of the HLP400 is as follows: a) for 2 marked lane bridges, +1.0 m either side of centreline of the bridge; b) for 3 or more marked lane bridges, in 2 marked lanes with the vehicle travelling +1.0 m either side of centre of any 2 adjacent marked lanes. Consideration must be given to the most likely path of the vehicle. The code co-existent half SM1600 on the adjacent lanes must be applied to create the worst effect. An accompanying lane factor of 1.0 must be applied to this co-existent load; and c) for one lane ramps, must be positioned on a one lane ramp as located by the Contractor. The tolerance on lateral position must be specified. The design location of the HLP400 must be shown on the general arrangement drawing as part of the Design Drawings.
2	AS 5100.5 Bridge design, Part 5: Concrete	a) For pre-stressed members, the maximum compressive stress at serviceability limit state when HLP400 is present is 0.6f’c. b) Design must be undertaken on the basis that the required concrete compressive strength at transfer of precast pretensioned members is specified as: i) for characteristic 28-day compressive strengths >55 MPa, fcp = 0.5 x f’c; and ii) for characteristic 28-day compressive strengths ≤55 MPa, fcp = 0.6 x f’c.
3	Table 4.14.3.2 “Required cover where standard formwork and compaction are used” of AS 5100.5 Bridge design, Part 5: Concrete	Concrete decks cast onto precast elements (such as deck units and super T-girders) must have a minimum cover at the bottom of the cast-in-place deck of: a) up to 30 mm less than the value in Table 4.14.3.2 of AS 5100.5 Bridge design Part 5: Concrete; and b) no less than 30 mm.

7 Selection of bridge structure type

a) The Contractor must assess and recommend the optimal bridge structure type (or types) to achieve the project objectives.

b) The selection of the structure type must assess and balance the requirements of:

i) whole of life cost including capital and operational expenditure;

ii) constructability including:

A. construction safety; and

B. impact to the adjacent local community including traffic, residents, and users;

iii) maintenance aspects including:

A. minimising future maintenance of the bridge structure, bearings, and joints; and

B. impact of maintenance activity on operational services;

iv) bridge aesthetic requirements and public realm; and

v) benefit to the local industry.

c) The proposed structure type must be documented in the Design Basis.

d) The Design Basis must include all required supporting information on the selection of the structure type.

8 Aesthetic requirements

a) The design of structures must comply with the urban design requirements set out in PR-LS-D1 “Landscape and Urban Design”.

b) The structural design must be integrated with all relevant aesthetic requirements of the Contract Documents, including those set out in “Bridge Aesthetics Design guideline to improve the appearance of bridges in NSW”.

c) The design of structures must meet the following aesthetic requirements:

i) soffits of bridges must be in plane with girder underside soffit levels at the same depth as adjacent girders after taking deck crossfall into account;

ii) for bridges, the minimum clear height from the finished ground level of a publicly accessible area to a bridge soffit must be 3.0 m;

iii) white cements must not be used in any part of any structure;

iv) use of materials that may result in rust staining (such as weathering steel) must not be used in any part of any structure;

v) where there is significant variability in the colour of concrete finishes in areas visible to the public, painting of concrete must be used to provide a consistent and uniform appearance;

vi) temporary lifting and erection recesses or formwork marks must not be visible on precast concrete elements;

vii) the bridge and approaches must incorporate a cohesive and aesthetically pleasing architectural form responding to the adjacent structures on the corridor;

viii) bridge structures and approaches must maximise the open space under the structure and minimise the visual barrier created by the structures;

ix) architectural components or cladding must not restrict visual inspection for maintenance of the girders, headstocks or bearings and where practical cladding must not be provided on any bridge component;

x) the design must minimise the risk of staining and streaking of concrete edges and vertical surfaces;

xi) the use of feature lighting on structures is generally discouraged;

xii) subject to section 8c)v), concrete finishes must not be painted, unless otherwise allowed by the Contract Documents;

xiii) retaining wall facia must be integrated with the bridge aesthetics and architectural form; and

xiv) the height of retaining walls is to be minimised to reduce the visual barrier created by the structure across the corridor. Nominally, the wall height to the bridge soffit should be a maximum of 5 m (depending on the bridge spans and form).

d) The Contractor must include in the Design Basis, a bridge aesthetic report detailing the collaboration between the architectural and structural design, addressing the elements in “Bridge Aesthetics Design guideline to improve the appearance of bridges in NSW”.

9 Earthquake design provisions

a) Structures must be designed for earthquake loads in accordance with the Reference Documents.

b) Without limiting the requirements of section 9c), and unless otherwise specified in the Contract Documents, all structures must be designed to BEDC-3 classification.

c) Where a bridge spans a road or rail of a higher category than BEDC-3 classification, the higher category must be adopted for the bridge design as per AS5100.2 Bridge design, Part 2: Design loads.

d) For all structures:

i) the detailing of reinforcement must comply with section 10.7.6 “Additional detailing requirements for earthquake resistance” of AS 5100.5 Bridge design, Part 5: Concrete;

ii) lapping of reinforcement (including legs of ligatures between the outside face of the main flexural reinforcement and the surface of the member) in potential plastic hinge zones is not permitted;

iii) identification of potential plastic hinge zones must recognise the possibility of a seismic event larger than that used in the design;

iv) in potential plastic hinge zones, pile helix terminations must be anchored. If it is not possible to extend helices into capping beams, pile caps or footings, they must:

A. be anchored at their ends by an extra 1½ turns and then welded onto themselves in accordance with AS/NZS 1554.3 Structural steel welding, Part 3: Welding of reinforcing steel, or cogged around a longitudinal bar and passed into the pile and through the core;

B. for the last ligature, or the helix termination, must be within 50 mm of the pile concrete end adjacent to the capping beam, pile cap or footing; and

C. include a series of ligatures which are then extended into the capping beam, pile cap or footing to restrain the longitudinal pile starter bars in accordance with the requirements of AS 5100 Bridge design; and

v) reinforcement lapping zones in adjacent piles in piled retaining walls must not be at the same depth (level) to avoid issues with potential plastic hinges.

10 Bridge abutments and substructures

10.1 Bridge abutments

a) Where a bridge abutment has a sloping embankment beneath the bridge superstructure, slope protection must be provided at least over the area directly underneath the bridge superstructure.

b) The slope protection required by section 10.1a) must:

i) blend in and harmonise with the environment in accordance with the requirements of PR-LS-D1 “Landscape and Urban Design”;

ii) require minimal maintenance;

iii) be structurally stable; and

iv) if comprised of paving bricks, rocks or similar landscaping elements, be adequately bonded in place to prevent removal.

c) Care must be taken in the design to avoid damage to the bridge abutment from movements of soft soil caused by loading from the approach embankment. Down drag (negative skin friction) effects due to settlement on piles must be allowed for in the design of such piles together with methods to reduce such effects.

d) Where the depth of soft soil over weathered bedrock exceeds 3 m, raking pile configurations must not be used in bridge abutments.

10.2 Bridge approach slabs

a) Bridges approach slabs must be:

i) designed in accordance with the Reference Documents; and

ii) suitably proportioned, with a minimum length of 3 m in cuts and 5 m in fills, and designed with consideration of skew abutments (where applicable).

b) At each bridge abutment, one end of the bridge approach slab must be tied to the bridge abutment to prevent sliding of the bridge approach slab relative to the bridge abutment and settlement of the road surface next to the bridge.

c) In fill areas, the design must enable the bridge approach slabs to be lifted after any settlement occurs.

d) Bridge approach slabs must:

i) be designed in one or more parts with expansion joints provided along the centreline of the bridge or bridge approach slab and not under the wheel paths; and

ii) include lift points at the bridge approach slab end (away from the bridge deck) to facilitate lifting of the bridge approach slab.

e) The Contractor must specify the methodology for the re-levelling of bridge approach slabs after settlement occurs in the relevant Maintenance Plan.

f) The bridge approach slab nosing adjacent to the bridge must be designed to allow a minimum pavement thickness of 325 mm to be placed over the remainder of the bridge approach slab. The bridge approach slab must then grade downwards away from the bridge deck at a 10% slope.

g) For bridges in cut, the Principal may consider an alternate treatment to manage the differential settlement between the bridge and the bridge abutment, where:

i) it can be demonstrated that:

A. the risk of differential settlement has been appropriately mitigated in the design; and

B. the proposed alternative provides a whole of life (capital and operational expenditure) benefit; and

ii) the alternative treatment is submitted as a Design Departure.

10.3 Substructures

Pile caps must either:

a) not be visible; or

b) be covered by an appropriate façade.

10.4 Bridge pier and abutment protection barriers

a) The Contractor must avoid placing piers within road medians or the road reservation to the greatest extent possible.

b) Where the Contractor proposes to place a pier within the road median or road reservation:

i) the Design Report must include justification for why piers are required to be placed in the road medians or road reserve;

ii) irrespective of protection provided, all piers and vertical abutments must be designed for a collision load that is the greater of:

A. that specified in AS 5100.2 Bridge design, Part 2: Design loads; and

B. where the sign-posted speed is 80 km/h or greater, the collision load must be increased to 4000 kN;

iii) protection barriers must extend past the limits of the pier or abutment for a minimum of:

A. where the sign-posted speed is 80 km/h or greater, 15 m on the approach side and a minimum of 8 m on the trailing side; and

B. where the sign-posted speed is less than 80 km/h, in accordance with AGRD Part 6: Roadside Design, Safety and Barriers, however a minimum of 4 m must be provided on the trailing side;

iv) for the purposes of determining barrier deflection requirements adjacent to layback abutments:

A. the clear zone for barrier deflection purposes must be taken from the carriageway edge line to the toe of the layback abutment; and

B. layback abutments must be treated as non-frangible elements; and

v) alternative barrier treatments must not be used unless otherwise approved by the Principal as a Design Departure.

c) Bridge piers and vertical bridge abutments must have a TL5 rigid concrete barrier protection in accordance with:

i) option 1 as set out in section 10.4d); or

ii) where option 1 cannot be complied with, the requirements of:

A. option 2 as set out in section 10.4e); or

B. option 3 as set out in section 10.4f),

subject to approval by the Principal. Approval of option 2 or 3 will constitute a **Hold Point**.

d) Option 1 - Barrier with >3.0 m clearance from the back of barrier to the face of the pier or abutment.

A 1,100 mm high TL5 barrier must be used where there is at least a 3 m clearance from the back of barrier to the face of the pier or abutment. The barrier must meet the following requirements:

i) roll allowance must be in accordance with to AGRD Part 6: Roadside Design, Safety and Barriers;

ii) the barrier must be designed in accordance with Department Standard Drawing S-4064, sheet 2;

iii) a minimum 1,500 mm wide 75 mm thick asphalt strip (adjacent to the back of the barrier) must be provided between the barrier and the pier; and

iv) the barrier must be set 75 mm into the asphalt.

e) Option 2 - Barrier with 0.3 m to 3.0 m clearance from the back of barrier to the face of the pier or abutment.

A 1,300 mm high TL5 barrier must be used where there is between 0.3 m to 3 m clearance from the back of the barrier to the face of the pier or abutment. The barrier must meet the following requirements:

i) roll allowance must be in accordance with AGRD Part 6: Roadside Design, Safety and Barriers;

ii) the barrier must be designed for a 600 kN transverse impact load in accordance with Table 12.2.2 of AS 5100.2 Bridge design, Part 2: Design loads;

iii) the barrier and integrated footing or piles and connection must either be:

A. structurally designed and have reinforced concrete footing or piles with full strength, moment, and shear connections to the barrier; or

B. be based on full scale crash testing (in accordance with note 3 on Department Standard Drawing S-4064, sheet 3);

iv) the barrier must span the length of the pier; and

v) backfill between the barrier and the pier is subject to the Principal's approval as part of the Hold Point required by section 10.4c).

f) Option 3 - Barrier separated 0.05 m to 0.3 m from the back of barrier to the face of the pier or abutment.

Where there is 0.05 m to 0.3 m clearance from the back of the barrier to the face of the pier, the barrier must meet the following requirements:

i) the barrier must be connected to the pier or abutment footing;

ii) design impact load for the pier or abutment footing must be the collision load calculated in accordance with section 10.4b)ii);

iii) roll allowances must be in accordance with AGRD Part 6: Roadside Design, Safety and Barriers;

iv) the barrier must be designed for a 600 kN transverse impact load in accordance with Table 12.2.2 of AS 5100.2 Bridge design, Part 2: Design loads. No component of barrier impact loading must be transferred to the pier behind; and

v) backfill between the barrier and the pier is subject to the Principal's approval as part of the Hold Point required by section 10.4c).

10.5 Bridges with supports on railway station platforms

a) Subject to section 10.5b), the collision loads on support elements specified in section 11.4.2 of AS 5100.2 Bridge design, Part 2: Design loads, do not apply to piers and columns located on rail platforms which meet the following characteristics:

i) rail platforms are earth-filled and are designed and constructed in accordance with AS 4678 Earth-retaining structures;

ii) the transverse location of the face of a pier or column is at least 4.3 m from the centreline of the closest rail track; and

iii) the longitudinal distance of a pier or column is:

A. more than 20 m from the end of a ramped platform (excluding the length of the ramp); or

B. more than 2.6 m from the end of a vertical (non-ramped) platform,

and the loads specified in section 11.4.3 of AS 5100.2 Bridge design, Part 2: Design loads, must apply to all elements.

b) Where a rail platform does not comply with the requirements of section 10.5a), all piers and columns, including those on platforms, must be designed for the minimum collision load specified in section 11.4.2 of AS 5100.2 Bridge design, Part 2: Design loads.

c) Railway station platforms must not be assumed to provide any protection to permit reduction of the collision loads.

11 On-structure and approach barriers

a) Bridge traffic barriers, approach barriers and traffic barriers over structures, must provide a barrier performance level as determined by a site-specific risk assessment in accordance with AS 5100 Bridge design, and must be at a minimum:

   i) MASH TL3 (or equivalent); or

   ii) if the traffic barrier is attached to the deck of the structure, regular performance level.

b) On-structure barriers must:

   i) where a shared path is within 2 m of a traffic running lane, provide a barrier between the path and the traffic running lane, where practicable; and

   ii) be a barrier and railing type with maximum through visibility.

c) Barriers and screens must be designed such that, subsequent to a vehicle impacting the safety barrier or screen, there are no detached fragments or deformations of the barrier or screen that would present an undue hazard to traffic or pedestrians on and beneath the structure.

d) Traffic barriers that comprise w-beam or thrie-beam flexible rails without stiffening beam elements must contain the crash vehicle within the extremities of the supporting structure. An inelastic analysis must be used for the design of post-and-rail barriers under failure conditions to validate the failure mode and the deflected shape of the rail.

e) Vehicle roll allowance clear widths must be provided behind all barriers from the toe of the barrier up to a height of 4.6 m and calculated in accordance with AGRD Part 6: Roadside Design, Safety and Barriers. Where non-rigid barriers are used, design barrier deflection widths must be added to the roll allowance clear width.

12 Bridge superstructure

12.1 Girders

Stepped or half-joints must not be used in the design of concrete girders.

12.2 Box girder bridges

a) Large box girder bridges constructed of concrete must have circular internal fillets of sufficient radii to mitigate stress concentrations due to torsional shear flow.

b) Large box girder bridges must include additional post-tensioning ducts and anchorages for installation of future tendons.

12.3 Bridge beams

a) Where bridge beams (including super T-beams, U-troughs and I-beams, but excluding planks) are used and are designed to be placed with the top flange of the beam matching the deck crossfall:

   i) the bearings must be placed horizontally; and

   ii) consideration must be given to having the bearing centreline positioned vertically in line with the centre of gravity of the beams to ensure beam stability during erection.

b) Where beams are included in the design of a structure, the design must compensate for crossfall and longitudinal grade by providing a tapered plate between the beam and the bearing.

c) Bridges with beams with a skew angle of 35° or greater must have special consideration given to the detailing at the ends of the beams.

12.4 Post tensioned elements

a) Where structural components incorporate post-tensioned elements, the Design Drawings submitted as part of the Design Documentation must clearly state whether the basis of the design is bonded or un-bonded stressing tendons with appropriate annotations being made on the relevant Design Drawings.

b) Segmental precast post-tensioned structures must use oversize ducts to allow for additional strand capacity in the event of duct blockages.

12.5 Bearings

a) The number of bridge bearings is to be minimised to the greatest extent practicable.

b) Bridge bearings must be located or treated to minimise the risk of unauthorised access.

c) For all bearings, top and bottom attachment plates must be provided to facilitate easy replacement.

d) All elastomeric bearings must have keeper plates at the top and bottom. A tapered steel bearing plate between the bridge girder and upper (flat) bearing plate must be used.

12.6 Drainage and ventilation of voids in superstructures

a) Where bridge superstructures contain voids (including box girders, super T-beams, voided slab construction and voids under footway slabs):

   i) drainage must be provided to ensure no pooling of water within any void; and

   ii) appropriate vermin control measures must be provided to minimise the risk of vermin entering the void.

b) Drainage outlets in superstructures must:

   i) for voids in beams, have an opening of no less than 25 mm in diameter; and

   ii) for all other voids, have an opening of no less than 50 mm in diameter.

c) Drainage must be provided for voids under footway slabs in superstructures, which must be discharged to drainage pits off the structure and connected to an appropriate drainage system.

12.7 Deck joints

a) The use of joints must be minimised where practical.

b) Where abutment movement joints are not used, adequate provision must be made for end diaphragms to move against the fill.

c) Joints must have a geometry that is suitable for cyclists (where appropriate).

d) Adequate measures must be taken to prevent water or other liquids from staining any pier or abutment and causing damage, deterioration or erosion to any bearing, restraint, concrete or metal surface.

e) For bridges ≤ 100 m in length:

   i) bridge decks must be continuous over the full length of the bridge with movement joints allowed at the abutments; and

   ii) intermediate deck joints must not be used.

f) For bridges > 100 m in length:

   i) joints must be used;

   ii) joints must be free draining finger plate or sawtooth type joints; and

   iii) bonded steel or rubber type joints must not be used except on pedestrian bridges where they may be used.

g) Joints must:

   i) not inhibit the proper placement of concrete and must have adequate provision for maintenance and inspection access;

   ii) be detailed and constructed such that the noise generated by traffic crossing the joint is kept to a minimum;

   iii) where modular type joints are used, comply with the Reference Documents including TfNSW Specification TS 01764.2 Modular Bridge Expansion Joints - DC (IC-DC-B316);

   iv) have a maximum open gap of 70 mm at the serviceability limit state and 85 mm at the ultimate limit state;

   v) not use steel angles exposed at the deck level as part of the joint system; and

   vi) be anchored in accordance with section 19.4 of AS 5100.4 Bridge design, Part 4: Bearings and deck joints.

h) Sliding plate expansion joints must not be used on the bridge road carriageway, except along footpaths and shared paths.

12.8 Deck waterproofing

At a minimum, bridge deck waterproofing membranes must:

a) be applied over the whole deck area directly onto the deck surface;

b) over (vertical) negative moment regions of fully integral abutment bridges to the greatest extent practicable; and

c) consist of an approved modified bitumen product over negative moment regions. Other products may be used elsewhere on the deck. The products must be specified in the Design Report and Design Drawings.

12.9 Pedestrian or bicycle bridges

Bridges that are exclusively for pedestrians or bicycles must incorporate fully enclosed screens in accordance with section 16.4 of AS 5100.1 Bridge design, Part 1: Scope and general principles.

13 Bridge fixtures and fittings

13.1 Utility Services and lighting

a) Structures must be designed to accommodate all conduits and supporting infrastructure required by the Contract Documents, including those forming part of the road lighting, telecommunications, incident management, ITS and any other applicable systems.

b) Conduits on structures must:

   i) comply with the requirements of RD-EL-C3 “Supply and Installation of Conduits and Pits”;

   ii) unless specified otherwise in the Contract Documents, be provided on both sides of the structure;

   iii) be incorporated into the kerb or footpath where practicable;

iv) be concealed (not be visible); and

v) be provided with draw cords.

c) Where conduits are provided within barriers on structures, any covers and voids must not adversely affect the safe functioning of the barriers.

d) Where road lighting poles, incident management columns, gantries or similar structures are to be positioned on a bridge structure, provision must be made for conduit connections including cable junction boxes between the poles, columns or gantries and the street lighting or incident management system conduits.

e) Where road lighting poles, incident management columns, gantries or similar structures are provided on structures, they must:

i) be positioned outside the clear zone, or behind a barrier;

ii) where positioned behind a flexible barrier or semi-rigid barrier, be fixed independently of the barrier so as not to fall onto traffic in a vehicle collision incident. This may require an independent footing system passing through the barrier; and

iii) be positioned to satisfy the requirements for vehicle roll allowance in accordance with AGRD Part 6: Roadside Design, Safety and Barriers.

f) Where it is not possible to locate a road lighting pole, incident management column, gantry, or similar structures independent of a barrier on structure, the connection of the pole to the barrier must be designed to the full plastic capacity of the pole. The plastic capacity must be un-factored and increased by 20% to account for over-strength.

g) The design of Utility Services and lighting on structures must comply with the following requirements:

i) gas, water and sewer mains must not be located inside box girders. Other Utility Services may be located inside box girders provided they are carried by appropriate racks or brackets;

ii) in multi-beam bridges, Utility Services must be located between beams, above the soffit plane;

iii) the design must be in accordance with the Utility Service Authority's requirements; and

iv) visible sag under dead loads and Utility Services loads is not permitted.

13.2 Attachments and fixtures

a) Attachments to concrete sections of the structure (including holding down bolts) must be:

i) cast into the structure and not fitted after construction; and

ii) hot-dip galvanized steel or Grade 316 stainless steel.

b) Exposed fixtures on structures must be hot-dip galvanized or Grade 316 stainless steel.

c) Fixtures inside box girders must be hot-dip galvanized steel or stainless steel.

d) Fixtures on structures must not be attached by drilling into concrete.

e) Any ferrules cast into structures must be hot-dip galvanized steel or Grade 316 stainless steel.

f) All infrastructure (including supports, brackets, pits, etc) associated with Utility Services must be approved by the relevant Third Party (Utility Service Authority).

13.3 Lightning strike protection

a) Where the top of metallic lighting poles located on structures are more than 2 m higher than those located at-grade in the adjacent terrain:

i) a site-specific assessment of the risk of lightning strike must be carried out in accordance with AS 1768 Lightning protection to determine the level of protection required for the structure, which must be included in the Design Report; and

ii) at a minimum, the structure must incorporate at least one of the following forms of lightning strike protection that effectively provides an electrical connection between the metallic structures and earth:

A. electrical connectivity of all reinforcement and support structures;

B. installation of lightning conductors of cross-sectional area and frequency in accordance with AS 1768 Lightning protection; or

C. installation of flexible electrical conductors to bypass bearings (where applicable) in accordance with AS 1768 Lightning protection.

b) All ITS equipment mounted on the structures must incorporate lightning strike protection in accordance with AS 1768 Lightning protection and the Contract Documents.

13.4 Bridge deck and upper retaining wall traffic barriers

a) The requirements of this section 13.4 apply to barriers on structures, approach barriers, and barriers along the top of retaining walls, but not along the bottom of retaining walls.

b) Bridge barrier components, including precast concrete elements, must be placed within a tolerance of ±5 mm from the location specified on the Design Drawings.

c) Concrete finish and installation tolerances must be in accordance with AS 3610 Formwork for concrete (class 3) and AS/NZS 3845.1 Road safety barrier systems and devices, Part 1: Road safety barrier systems.

d) Concrete colour must be standard Portland grey.

e) Subject to section 13.1f), traffic barriers on structures must not have any other elements attached to them, including light poles, signs, cameras, anti-throw screens, noise walls and urban design elements, which must be set behind the working width and roll allowance of the barrier.

f) Barrier transitions must be designed for the appropriate design loading at each end of the transition element.

g) At its leading end, the barrier must be transitioned into the crash cushion or another type of barrier with a suitable crashworthy terminal.

h) Design Drawings must show an isometric view of the connecting element between the bridge barrier and the approach barrier, where applicable.

14 Public safety barriers and anti-throw screens

a) The Contractor must provide public safety barriers and anti-throw screens on structures in accordance with the requirements of this section 14.

b) The Contractor must provide public safety barriers (measures to prevent people from climbing on bridges or jumping from bridges) and anti-throw screens (measures to prevent pedestrians throwing objects onto the areas below) at the following locations:

i) bridges designed to accommodate pedestrian or cyclist access (or are otherwise accessible by pedestrians or cyclists) with road traffic or rail traffic underneath;

ii) any other locations nominated in the Contract Documents; and

iii) any other locations identified by the Contractor through the risk assessment carried out in accordance with section 14c).

c) The Contractor must carry out a risk assessment in accordance with:

i) the Queensland Department of Transport and Main Roads risk assessment process (Technical Guidelines for the Treatment of Overhead Structures - Objects Thrown or Dropped); and

ii) the TfNSW risk assessment process (Bridge Technical Direction BTD2012/01 Provision of Safety Screens on Bridges),

in order to identify:

iii) any other locations not covered in section 14b) that are determined to require anti-throw screens or public safety barriers;

iv) for all locations (including those referred to in section 14b), the probability, consequence of anti-social behaviour on the structure;

v) the recommended type of public safety barriers and anti-throw screens; and

vi) the extent and type of any public safety barriers and anti-throw screens.

d) In addition to the requirements specified in the Reference Documents (including AS 5100 Bridge design), anti-throw screens and public safety barriers must comply with the following requirements:

i) an additional robustness serviceability requirement that the maximum screen deflection relative to posts must be less than 30 mm for a transverse load of 0.6 kN applied over an area of 0.2 m by 0.2 m, acting anywhere on the screen;

ii) the maximum post deflection must be based on the formula h/300 (where h = height of the screen above the base connection) for a 5% AEP event wind load or a transverse load of 0.6 kN acting at the top of the post;

iii) fatigue design must be conducted using a wind speed of 20 m/s and 200,000 cycles;

iv) anti-throw screens and public safety barriers must be located outside the roll allowance clear width behind the traffic barriers in accordance with AGRD Part 6: Roadside Design, Safety and Barriers. This clear width must be measured from the toe (bottom) of the barrier (traffic side face) and extends upwards above the barrier over the full 4.6 m height above the deck. For non-rigid barrier systems, barrier deflection must also be taken into account;

v) all barrier or screen elements that could be dislodged by a vehicle collision must be tethered and constructed from an anti-shatter material;

vi) to prevent electrochemical reaction, isolation must be provided between incompatible materials of the screen or barrier system;

vii) weathering steel must not be used where it is possible for water runoff from the element to visibly stain other elements;

viii) the design and general structural form of the screen or barrier must prevent climbing by unauthorised persons;

ix) anti-climbing devices must be installed to prevent risk of accessing the screen or barrier or the area behind the screen or barrier;

x) where anti-throw screens or public safety barriers are required, they must be provided on both sides of the structure;

xi) where anti-throw screens and public safety barriers are determined to not be necessary, the design of the structure must make allowance for the future installation of anti-throw screens and public safety barriers;

xii) anti-throw screens and public safety barriers on the structure or approaches must be integrated with the structure aesthetics and architectural form; and

xiii) architectural features must be designed such that they do not impact future installation of any anti-throw screens and public safety barriers.

e) The risk assessment required under section 14c) must be included in the Design Basis.

15 Noise barriers

a) This section 15 applies where noise barriers are required.

b) Noise barriers must be designed in accordance with the requirements of PC-ENV4 “Noise Assessment, Treatment Design, and Implementation” and VicRoads Bridge Technical Note 007 Noise Attenuation Walls.

c) Where noise barriers are located in the vicinity of traffic barriers, the noise barriers must be located outside of the traffic barriers with sufficient clearance to avoid any damage in the event of vehicular impact upon the traffic barriers.

d) Noise barriers must:

  i) not rattle or vibrate;

  ii) be vandal resistant;

  iii) facilitate straightforward and efficient maintenance, repair and replacement. The construction and material of the screen must result in little or no maintenance over the period of its Design Life; and

  iv) be designed for fatigue using a wind speed of 20 m/s and 100,000 cycles. Where collapse of the noise barrier could fall onto marked traffic lanes, the design must consider fatigue using a wind speed of 20 m/s and 200,000 cycles.

e) Design of noise barriers must achieve a reduction in embodied carbon and increased recycled content compared to business as usual materials and technologies (as described in the Department Sustainability Manual).

f) The design of noise barriers must investigate the use of alternative materials to concrete as a means of reducing embodied carbon and increasing recycled content, with an assessment completed in accordance with the Department Sustainability Manual. Justification must be provided for selection of the final approach in the relevant Design Report.

g) The Design Report must include information on resistance of noise barriers to the following:

  i) impact resistance from 4 kg projectile dropped from height of 3.0 m;

  ii) defacement by sharp implements;

  iii) vermin;

  iv) graffiti; and

  v) fire.

16 Major sign structures

The following requirements apply to the design of major sign structures:

a) the design of major sign structures (including cantilever signs and gantries over traffic) must comply with the Reference Documents including section 24 of AS 5100.2 Bridge design, Part 2: Design loads;

b) where a major sign structure supports electrical or electronic devices or equipment, the structure must be designed to accommodate all necessary supporting infrastructure, including ducts, cables, cable trays and junction boxes;

c) the fatigue strength of members and welded connections must be determined using full stress reversal for the stress range. Fatigue design must be in accordance with VicRoads Bridge Technical Note 014 Road Sign and Lighting Structures;

d) where levelling nuts are used on anchor bolts under baseplates, full stress reversal must be considered in the design of the anchor bolts and the bolts must be designed to carry all loads including all compression and lateral loads and designed for double curvature. Where levelling nuts are not used, full stress reversal does not apply;

e) the Design Drawings must state explicitly whether levelling nuts can be used, or not;

f) bolt installation and grouting must be in accordance with VicRoads Section 760 Erection of Sign Gantries and High Mast Light Structures, unless approved otherwise as a Design Departure;

g) the Design Drawings must state explicitly whether levelling nuts can be used or not;

h) where the structure supports a variable message sign (VMS), an access platform and mesh infilled balustrade must be provided:

   i) for the length of the sign plus any length for access and maintenance; and

   ii) in accordance with RD-ITS-S4 “Supply of Electronic Signs”;

i) the platform required in section 16h) must be free of sharp corners and projections that may cause injury and must not obstruct the rear access doors to the sign;

j) the mesh infill balustrade required in section 16h) must be a minimum of 1.1 m tall measured from the walkway surface. All mesh and gaps along any access and maintenance walkway must be a maximum of 10 mm to prevent objects from falling below;

k) the vertical clearance between a gantry sign and the pavement must be at least 6.5 m;

l) gantries must be assessed in accordance with AGRD Part 6: Roadside Design, Safety and Barriers, to determine appropriate level of traffic protection. The level of protection for major sign structures must be in accordance with VicRoads Road Design Note 06-13 Guidelines for the protection of gantry and cantilever sign supports;

m) the Contractor must detail the proposed traffic safety protection determined in accordance with section 16l) on the Design Drawings for each gantry;

n) a lifting arm and self-closing gate must be provided on all walk on structures with a safe working load of 150 kg;

o) major sign structures including VMS structures must be hot dip galvanised and painted. For major sign structures located outside of the North South Corridor (including surface road of South Road) and immediate ramps, the paint colour must be Black N61. All other major sign structures must be painted Green G61; and

p) where cantilever arms of length exceeding 9 m are used, they must be subject to vibration monitoring for a period of 12 months. As a minimum, vibration monitoring must be achieved by measuring vibrations in strain at the base-plate weld in order to establish that the strain range is less than the relevant constant-amplitude fatigue limit defined in AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals.

17 Precast concrete members

17.1 Lifting and transport

a) Minimum required concrete strengths for both lifting and transport of precast concrete members must be shown on the Design Documentation (2 concrete strengths for 2 types of lifting, and one concrete strength for transport).

b) In the calculation of minimum required concrete strengths, the corresponding design actions must adopt the factors from Table 17-1, to be applied to the unfactored dead load action of the lifted element.

c) Lifting points and anchors must be shown in the Design Documentation. A rigging diagram must also be shown in the Design Documentation if even load sharing between lifting points

or anchors is required by the design. The minimum factor of safety for the design of lifting anchors and concrete anchor pull-out capacity must be 4.0.

d) For pretensioned precast concrete members, a minimum concrete strength for lifting and transport corresponding to no lower than the minimum required concrete strength at transfer of prestress must be specified in the Design Documentation.

Table 17-1 Load multiplication factors for lifting and transport

Load case	Serviceability factor	Ultimate strength factor
Lifting using gantry crane or stationary crane on outriggers	1.8	2.4
Lifting as suspended load using mobile lifting equipment over even ground	3.0	4.0
Transport	7.5	10.0

17.2 Culverts

a) Design of culverts must incorporate a shiplap-type rebate shear key around the perimeter of the end face(s) of the crown unit legs and top slab where the units are to be placed adjacent to each other.

b) If precast base slabs are used, the base slabs must be designed to incorporate a shiplap-type rebate shear key along the end face(s) where the units are to be placed adjacent to each other. Joints in precast base slabs must be offset from crown unit joints.

c) Base slabs must have a cast-in recess of depth 30 mm to restrain each culvert leg from movement in both lateral directions. This recess must be filled with mortar and after the crown units are placed, with the surface trowelled off to direct water away from the culvert leg.

d) Reinforcement or formwork Shop Drawings (if any) must be submitted to the Designer for approval prior to fabrication in accordance with PC-EDM1 “Design Management”.

e) Joints between precast crown units must be sealed on the inside face with a suitable urethane caulk and taped with a butyl or petrolatum adhesive tape on the outside face. Joints between precast base slab units (if any) must be sealed on the inside face with a suitable urethane caulk. These details must be shown on the Design Documentation.

f) The design of culverts must use:

  i) at-rest lateral earth pressures;

  ii) soil with a gravity density of 21.0 kN/m^3;

  iii) the following load factor modifiers for lateral earth pressure and sway effects at the serviceability limit state:

    A. 1.0 on lateral earth pressure or sway effects that reduce safety;

    B. 0.85 on lateral earth pressure effects that increase safety; and

    C. 0.0 on sway effects that increase safety; and

  iv) the following ultimate load factors for lateral earth pressure effects at the ultimate limit state, to be applied to serviceability-factored effects:

    A. 1.4 on lateral earth pressure serviceability or sway effects that reduce safety;

    B. 0.7 on lateral earth pressure serviceability effects that increase safety; and

    C. 0.0 on sway effects that increase safety;

g) Culverts must be designed for frame actions from sway displacements for load case(s) with unequal horizontal loading. The following design steps must be carried out:

  i) determine what the sway displacement at the top of the culvert leg is under the serviceability load case;

ii) with no other load actions on the culvert frame, apply a horizontal load at the top of the leg that will give the same lateral displacement determined in section 17.2g)i); and

iii) the sway effects from the loading in section 17.2g)ii) must be added algebraically to the effects from the load case being considered in section 17.2g)i), using the load factor modifiers/factors from section 17.2f)iii) and section 17.2f)iv) as appropriate.

18 Maintenance requirements

18.1 Accessibility for inspection and maintenance

a) All structures must be designed and constructed to be Readily Accessible for inspection and maintenance in accordance with the Reference Documents and this section 17.

b) Deck joints must be Readily Accessible with provision to allow for inspection, maintenance and replacement in accordance with section 19.3 of AS 5100.4 Bridge design, Part 4: Bearings and deck joints.

c) Bearings must be Readily Accessible with provision to allow for inspection, maintenance and replacement (including jacking of components) in accordance with section 7 of AS 5100.4 Bridge design, Part 4: Bearing and deck joints.

d) For the design of bearings, the Contractor must:

i) ensure that bearing replacement can take place without the need to close the bridge;

ii) develop a procedure for replacement for inclusion in the Maintenance Plan, which sets out details of any traffic speed or lane restrictions required during replacement; and

iii) indicate the jacking locations and estimated jacking loads on the Design Drawings.

e) Access hatches must be:

i) positioned to allow for practical ease of access and to minimise the need for traffic control when in use; and

ii) designed in accordance with the requirements of AS 2865 Confined spaces.

f) Where bridge superstructures contain voids (including box girders, super T-beams, voided slab construction and voids under footway slabs):

i) passive ventilation and provisions for active ventilation must be provided where maintenance personnel require access to enable maintenance personnel to access within the void space; and

ii) structures should consider the need for internal signage to indicate distance to exits.

18.2 Box girder bridges

a) Safe access for inspection of medium box girders and large box girders must be provided in accordance with the requirements of Table ST-SD-D1 18-1.

b) All box girders must incorporate bird proofing.

c) Box girders with 3 or more spans must have internal signage showing direction and location of exit points.

Table ST-SD-D1 18-1 Box girder requirements

Item	Medium box girder(1)	Large box girder(2)
1. Internal lighting and power supply for inspection	Not required	Required
2. Access to each internal cell	Lockable hatch in bottom flange, located at least every second span	Lockable hatch through abutments or in bottom flange, located at least every second span
3. Access through internal diaphragms	Minimum opening of 0.6 m wide x 1.0 m high. For longer lengths (greater than 1.0 m), the opening size should be enlarged as determined by a risk assessment	Minimum opening of 0.9 m wide x 2.0 m high. For longer lengths (greater than 1.0 m), the opening size should be enlarged as determined by a risk assessment
4. Position of internal diaphragm access openings	The opening must be Readily Accessible with steps and handrails as appropriate	The opening invert must be as low as possible
5. Ventilation holes	One 75 mm diameter hole in the bottom flange of each box girder span covered with bird proof mesh	One 100 mm diameter hole in the bottom flange of each box girder span covered with bird proof mesh

Table notes:
(1) A medium box girder has an internal vertical clearance less than 2.0 m.
(2) A large box girder has an internal vertical clearance 2.0 m or greater.

18.3 Anti-graffiti coating

Where a concrete surface has not been painted, anti-graffiti treatments must be applied that:

a) are approved to APAS - 1441/1 where a permanent clear finish is required;

b) are approved to APAS - 1441/2 where a colour is required; and

c) comply with the technical requirements specified in VicRoads Standard Section 685 Anti-Graffiti Protection and Graffiti Removal.

18.4 Maintenance Plan

The Contractor must prepare a Maintenance Plan for structures in accordance with the requirements of section 2.6.

19 Materials and durability

19.1 General

a) All structural materials, components and processes for all Works must provide the required durability for each element of the Works. Where an item is not Readily Accessible for maintenance or replacement, it must be designed so that it will function for the Design Life of the structure without maintenance.

b) The Design Documentation must clearly display details of all materials to be incorporated into the Works.

c) For all assets (including all asset components) forming part of the Works, the Contractor must:

i) ensure that the durability design meets all applicable Design Life requirements, and includes consideration of the following elements (as applicable):

A. consider the changes in durability conditions as a result of climate change effects;

B. the effects of groundwater chemistry and variation of groundwater levels on the overall integrity of structures and the reliability and performance of the drainage system must be determined including the potential for the precipitation of insoluble salts;

C. the effect of acid sulphate soils, alkali aggregate reaction, alkali silica reaction and alkali carbonate reaction; and

D. the necessity of providing additional protection including coatings during the Design Life;

ii) prepare a Durability Report which sets out the basis for the Contractor's durability design, in accordance with the requirements of section 2.5;

iii) identify the key durability risks for the Works, and implement controls to ensure the Design Life requirements are met, which must be specified in the Durability Report;

iv) where required by the Contract Documents perform thermal modelling for concrete elements which demonstrates that temperatures and temperature differentials meet the requirements of section 19.2;

v) where required by the Contract Documents perform durability modelling, including for chloride ingress, sulphate attack and carbonation, taking into account their combined effects; and

vi) perform testing of the ground and groundwater to provide evidence for the selected durability design parameters (as applicable).

19.2 Concrete

a) Durability design for concrete structural elements must be in accordance with AS 5100 Bridge design, and the following additional requirements:

i) dense, durable concrete must be used;

ii) in areas of severe exposure (equal to or exceeding section 4.3 of AS 5100.5 Bridge design, Part 5: Concrete - exposure classification B2):

A. blended cements must be used; and

B. the concrete must be specified as high durability concrete (in accordance with ST-SC-S7 "Supply of Concrete");

iii) the concrete mix design must provide protection against erosion, delayed ettringite attack, acid attack, sulphate attack and alkaline aggregate reaction as applicable;

iv) measures must be taken to minimise the effects of heat of hydration in thick concrete sections, which may include the use of blended cements, cooling the concrete during curing, insulated forms, and larger aggregates;

v) for large and restrained concrete members (as defined in AS 5100.5 Bridge design, Part 5: Concrete), the Design Documentation must include details of the methodology to ensure that, during the concrete placement and curing period:

A. the maximum differential temperature between core and surface concrete does not exceed 20°C; and

B. the maximum concrete temperature anywhere within the concrete member does not exceed 75°C;

vi) epoxy coated reinforcement must not be used;

vii) cast-in-place stitch pour concrete (such as that used to connect precast concrete barriers to concrete bridge decks) must have a maximum shrinkage of 600 με.

viii) reinforcement elements crossing construction joints must be galvanized, where the construction joint:

A. is subject to constant exposure to weather;

B. is located in an area visible to the public; or

C. is in a critical location where it is possible that water is able to enter through a crack at the construction joint and cause corrosion of the reinforcement within the Design Life of the structure, including construction joints below the water table and in-situ infill concrete within precast traffic barriers;

ix) the durability planning and design of all structures must incorporate the recommendations of the CIA Z7 series of publications; and

x) durability of self-compacting concrete and uncompacted concrete must satisfy the same durability requirements as for compacted concrete.

b) In relation to special concrete mixes, the Contractor must either:

i) undertake testing in accordance with ST-SC-S7 “Supply of Concrete” (including the associated Hold Point) to verify that the proposed concrete mix design will achieve the specified properties, and integrate the test results into the design; or

ii) incorporate into the design, a range of concrete properties, as set out in AS 5100.5 Bridge design, Part 5: Concrete.

c) Where carried out in accordance with section 19.2b)i) for concrete design parameters, the submission of the concrete mix designs and testing of special design mixes must be included in the relevant Design Documentation.

19.3 Electrical continuity of reinforcement

a) Where provision for future cathodic protection is required by the Contract Documents, the Contractor must ensure that:

i) all reinforcements and metallic inclusions in the substructure (including in piles, pile caps, pad footings, piers and abutments) are made electrically continuous to allow for the future implementation of cathodic protection;

ii) a minimum of one future implementation point is included on each substructure, which is located with consideration of the future installation of a cathodic protection system;

iii) the implementation points required in section 19.3a)ii), at a minimum, consists of a cast-in stainless steel coupler Grade 316, flush with the surface of the concrete element, connected to the internally embedded electrical continuity system;

iv) electrical continuity provisions are shown on the Design Documentation, which include a strategy to ensure that the reinforcement cage is electrically continuous prior to pouring of concrete;

v) where precast elements are used in the construction of the substructure, each individual precast element has electrical continuity of reinforcement and fitments;

vi) in-situ construction and stitch pours have:

A. electrical continuity of reinforcement and fitments; and

B. electrical connectivity to the reinforcement in any attached precast elements; and

vii) non-structural tack welding of reinforcement is undertaken in accordance with Welding Australia TGN-BC-01 Tack Welding of Reinforcement Bar.

19.4 Creep and shrinkage testing of concrete

The Contractor may choose to undertake creep and shrinkage testing of concrete to refine their design, which complies with the following requirements:

a) prior to the receipt of long-term testing results on creep, shrinkage and modulus of elasticity of the concrete mix design, the Contractor must use a range of parameters equal to ±30% to the creep factor and design shrinkage strain and ±20% to the modulus of elasticity of concrete determined from AS 5100.5 Bridge design, Part 5: Concrete;

b) following receipt of long-term testing results on creep, shrinkage and modulus of elasticity of the concrete mix design, the Contractor must adopt a statistically derived range of values from the testing results to inform all structural design development;

c) the concrete mix components tested, including aggregate, additives, and cement, must be obtained from a single material source with sufficient dedicated resources to ensure that the concrete in all components constructed from that mix has constant concrete properties, including heat generation, shrinkage, and creep; and

d) the results of concrete mix testing, plus any available past testing of similar concrete mixes using the proposed constituent materials may be used to modify the range of creep and shrinkage parameters adopted in the design, subject to the approval of the Principal.

19.5 Steelwork

a) All steelwork must be either:

   i) hot dipped galvanized in accordance with AS/NZS 4680 Hot-dip galvanized (zinc) coatings on fabricated ferrous articles; or

   ii) protected by a high-grade protective coating system or hermetically sealed.

b) Coating systems must include a primer and finish coat.

c) The Contractor must perform an assessment of the corrosivity at the proposed location of the structure in accordance with AS 4312 Atmospheric corrosivity zones in Australia, which takes into account local microclimates and other related location-specific factors, and provide the results of this assessment in the Design Report.

d) Weathering steel must not be used in locations where there is potential for weathering steel runoff to stain the structure or other assets.

e) Steelwork (excluding weathering steel) must be protected in accordance with the requirements of ST-SS-S2 “Protective Treatment of Structural Steelwork”.

f) Where hot dipped galvanizing is to be used, it must be conducted in accordance with the requirements of ST-SS-S3 “Galvanizing”, including the information listed in Appendix A of AS/NZS 4680 Hot-dip galvanized (zinc) coatings on fabricated ferrous articles.

g) Site welding of the steelwork must only be used where it can be demonstrated, to the satisfaction of the Principal, that alternative approaches are unsuitable, in order to minimise damage to steelwork protective treatments. Use of site welding of steelwork will constitute a **Hold Point**. Site welding of steelwork must not be utilised until this Hold Point is released.

h) Selection of the coating system must be based on Table 6.3 of AS 2312.1 Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings, Part 1: Paint coatings for the appropriate corrosivity category, from the following system designations:

   i) EHB6 (primer must be PRN C01a, C01b or C01c);

   ii) PSL1 (system must include an additional intermediate coat of PRN C13 epoxy MIO to 125 µm);

   iii) PUR5 (primer must be PRN C01a, C01b or C01c); or

   iv) where a decorative or aesthetic finish is desired, only systems PSL1 and PUR5 are to be used.

i) The total minimum dry film thickness for each coat must be as specified for the designated system detailed in Table 6.3 of AS 2312.1 Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings, Part 1: Paint coatings, measured in accordance with test procedure MAT-TP913.

j) Regardless of the coating system used elsewhere on the structure, the faying surfaces of friction-grip (TF) bolted joints and of other joints with tensioned bolts (TB) (such as bolted end plate connections) must be treated as follows:

i) dry abrasive blast clean to AS 1627.4 “Preparation and pretreatment of surfaces, Part 4: Abrasive blast cleaning of steel”, Class 3, with surface profile in the range 35 to 65 microns; and

ii) application of one 80 micron coat of solvent-borne inorganic zinc silicate primer, complying with AS 3750.15 “Paints for steel structures, Part 15: Inorganic zinc silicate paint”, Type 4.

k) Fasteners must be hot dip galvanized in accordance with:

i) for bolts and nuts: AS/NZS 1214 Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series); and

ii) for washers: AS/NZS 4680 Hot-dip galvanized (zinc) coatings on fabricated ferrous articles.

l) Any instances where different grades of steel are used in the design must be clearly stated in the Design Documentation.

19.6 Major sign structures

In addition to the requirements of section 16, major sign structures must comply with the following requirements:

a) all components of major sign structures must be hot dip galvanized after fabrication in accordance with AS/NZS 4680 Hot-dip galvanized (zinc) coatings on fabricated ferrous articles. Prior to galvanizing, steel work must be blast cleaned to Class 3 in accordance with AS 1627.4 Metal finishing — Preparation and pretreatment of surfaces, Part 4: Abrasive blast cleaning of steel, to preparation Grade SA-3 in accordance with ISO 8501-1;

b) all galvanized steel must be painted, and all galvanized surfaces must be abrasive sweep (brush) blast cleaned in accordance with AS/NZS 4680 Hot-dip galvanized (zinc) coatings on fabricated ferrous articles, Appendix 1 and painted with primer suitable for the selected brand of the top coat; and

c) the top coat must be one coat of a 2 pack polyurethane gloss finish as approved under APAS-2911 to a minimum dry film thickness of 50 µm.

19.7 Pre-tensioned concrete girders

a) The inside top (void) face of the bottom flange of super T-girders does not require reinforcement normal to the longitudinal axis of the girder.

b) The Design Documentation must include the following instructions:

i) strand cutting and coating of the end of the strand must be delayed for as long as practical, and no sooner than 3 days after de-moulding of beams;

ii) the strand end face coating must be reinspected for cracking just prior to girder installation and the epoxy reapplied to any cracks; and

iii) strands that are debonded along their entire length must be fully removed as soon as practical after de-moulding of the beams. The void left from the removed strand at the girder ends must be plugged with a high build, non-sagging epoxy paste.

20 Hold Points

Table ST-SD-D1 20-1 details the review period or notification period, and type (documentation or construction quality) for each Hold Point referred to in this Master Specification Part.

Table ST-SD-D1 20-1 Hold Points

Section reference	Hold Point	Documentation or construction quality	Review period or notification period
10.4c)ii)	Approval of barrier options 2 or 3	Documentation	10 Business Days review
19.5g)	Use of site welding of steelwork	Documentation	10 Business Days review

21 Appendix 1: Design summary

Form STR-DP1-2 DESIGN SUMMARY

Plan No. _____ Project Leader: _____ Date: _____

Project: _____

_____

Structure Description: _____

Design Standard: _____

_____

Roadway Width: _____

No. Design Lanes: _____

Vehicle Loads:

Load Type	DLA (%)	Transverse positions of loads considered

Load Distribution:

Other relevant design decisions:
Include the following where applicable:
variations from Reference Documents,
information critical to the design or future structure performance

22 Appendix 2: Structure capacity summary

Form STR-DP1-3 STRUCTURE CAPACITY SUMMARY

Designer: _____ Date: _____ PLAN NO. _____

Checked: _____ Date: _____

Structure / Road names: _____
Structure Description: _____

Design Year: _____ Design Standard: _____
Line Diagram of Structure (show spans used in analysis):

Diagram of cross section:

LIVE LOAD CAPACITIES[1]

ULTIMATE STRENGTH:	Edge Beam[2]	Internal Beam
Ultimate LL Moment Capacity		
SERVICEABILITY: (PSC only)[3] Required: Yes ☐ No ☐ LL Moment Capacity - Case 1		
(steel stress increment) - Case 2		

Shear or Reaction check required[5] ? Yes ☐ No ☐ If yes, complete capacity information on reverse side

Live Load Distribution Factor[4] _____
Comments:

DLA used in design _____

If Shear or Reaction is likely to be critical[5], complete the following capacities:
(only complete if required. Insert dash in cell if not critical)

LIVE LOAD CAPACITIES[1]

ULTIMATE STRENGTH:	Edge Beam[2]	Internal Beam
Ultimate LL Shear Capacity		
Ultimate Reaction on Substructure		

NOTES

(1) These forms are suitable only for simply-supported structures. For continuous structures, capacities are required at tenth points along each span. Attach capacities as appropriate. For continuous structures, the dead load effects, superimposed dead load effects, and any other load effects considered, must also be included, together with the limit state load factors applied. If negative moment redistribution has been applied in the design, the redistribution percentage must be given.

(2) For structures without beam components (e.g. box girders, slabs etc), only complete one column. For slabs, indicate the width of slab to which the capacity applies. For culvert structures, provide corner and mid-span live load moment capacities.

(3) Serviceability capacities are only required for prestressed concrete structures. The crack control provision of AS 5100.5 Bride design, Part 5: Concrete - clause 8.6.2.1 (b) and 8.6.2.2 must be used for the 2 cases as follows:

	Steel Stress Increment Past Decompression	Min. Concrete Compression at Unreinforced Segment Joints(2)
Case 1	0.75 x Table 8.6.2.1 value, or 0.55fy(1)	1.0 MPa
Case 2	Table 8.6.2.1 value, or 0.75fy(1)	0 MPa

Table notes:

(1) Whichever is lesser; fy refers to reinforcement only (this may govern for low strength steel e.g. grade 230).

(2) Segmental structures only.

(4) The Live Load Distribution Factor is that proportion of load from a standard design lane that is distributed to the critical structural element, i.e. it is the actual load effect in the critical structural element divided by the load effect from one full design lane of load on the same structural element.

(5) Designer to assess if shear or reaction capacity is critical in assessing future vehicle loads on the structure. If likely to be critical, shear or reaction capacities are required.