Transport Roads & Maritime Services

NSW GOVERNMENT

QA SPECIFICATION PS361

BRIDGE AND STRUCTURE DETAIL DESIGN

IC-QA-PS361

VERSION FOR: ***Macquarie Park Bus Priority and Capacity Improvement Project - Stage 2***
DATE: ***November 2018 (RFT Issue)***

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CLAUSE PAGE

FOREWORD

RMS COPYRIGHT AND USE OF THIS DOCUMENT

When this document forms part of a contract

This document should be read with all the documents forming the Contract.

PROJECT SPECIFIC CHANGES

Any project specific changes have been indicated in the following manner:

(a) Text which is additional to the base document and which is included in the Specification is shown in bold italics e.g. ***Additional Text***.

(b) Text which has been deleted from the base document and which is not included in the Specification is shown struck out e.g. ~~Deleted Text~~.

RMS SPECIFICATION PS361

BRIDGE AND STRUCTURE DETAIL DESIGN

1 INTRODUCTION

1.1 PROFESSIONAL SERVICES SPECIFICATION

This Specification is one of a set of Professional Services Specifications for detailed design. Refer to PS301.

1.2 SCOPE & PROJECT DESCRIPTION

This Specification sets out the requirements for an aspect of detailed design. It requires C72 Panel Deed for Professional Services or equivalent Professional Services Conditions of Contract.

1.2.1 Project Specific Requirements

Refer to Annexure PS361/A for Project Specific Requirements for Bridge and Structure Design.

1.3 PROJECT INTRODUCTION

Refer to PS301 for Project Introduction details.

1.4 STRUCTURE OF THE SPECIFICATION

1.4.1 Schedules of HOLD POINTS, WITNESS POINTS, DELIVERABLES, MEETINGS AND WORKSHOPS.

The schedules in Annexure PS361/C list the **HOLD POINTS, WITNESS POINTS, DELIVERABLES, MEETINGS AND WORKSHOPS** that must be produced / observed. Refer to specification PS301 for definitions of **HOLD POINTS**.

1.4.2 Design Reference Documents and Support Information.

The schedules in Annexure PS361/M list the **DESIGN REFERENCE DOCUMENTS**, **REFERENCE DOCUMENTS** & **SUPPORTING INFORMTION** that apply to this Specification.

Unless otherwise specified the applicable issue of a referenced document, other than a RMS Specification, is the issue current at the date one week before the closing date for tenders, or where no issue is current at that date, the most recent issue.

2 BRIDGEWORKS AND OTHER STRUCTURES

The design of bridges is excluded from the scope of work.

2.1 INTRODUCTION

Specification PS361 provides guidance and sets technical requirements for the economic, engineering, environmental and aesthetic criteria which apply to the structures and are essential components in obtaining quality. This Specification:

(i) Defines the quality of the structure in terms of value for money consistent with adequate safety and durability, while taking into account the impact on the environment and costs including whole of life.

(ii) Provides a sound and rational basis on which competitive tenders can be sought

(iii) Develops and promulgates best practice whilst encouraging innovation.

(iv) Facilitates quality control of design, construction and maintenance.

(v) Defines methods for assessing maintenance requirements when evaluating options.

2.2 OBJECTIVES

(i) To review and evaluate the preferred structures concept design option at each site. This will involve reviewing and assessing the Design Proposal consisting of Bridge (other structures) Proposal sketches, completed Form 62 Bridge Design Proposal – Summary and Approvals and Design Report, all of which have been prepared during the concept design phase of the project.

(ii) To undertake the detailed design and documentation of all structural components of the project to meet the specified requirements based on the approved Bridge (structures) Design Proposal.

2.3 SCOPE

This Specification covers the requirements for the design of all structural aspects of the project works including:

(i) Road, pedestrian and shared path bridges and other associated structures with a span length greater than 6.0 m.

(ii) Underpasses.

(iii) Sign support structures.

(iv) Retaining walls (excluding Reinforced Soil Wall (RSW) which is covered under RMS Specification R57), with an effective height greater than 1.2 m.

(v) Modification of existing structures.

(vi) Box Culverts and other major drainage structures.

(vii) Other associated structures, including noise walls where applicable.

The document does not cover the requirements for tunnels.

2.4 TECHNICAL APPROVAL

The design, checking, independent proof engineering for complex structures, certification and review of drawings must be in accordance with the Technical Approval Procedure in Annexure PS361/D.

The verification procedures of the PSC's Quality System must not supersede the requirements of the Technical Approval Procedure.

2.5 STRUCTURES CONCEPT OPTION REPORTS

A structures concept option report(s) has been prepared during the concept design phase of the project. The Structures concept option report would have been prepared in accordance with PS261 and the Technical Approval Procedure in Annexure PS361/D.

The report(s) include a list of the site and design constraints that apply at each site, a list and summary of the investigations and findings to date, general arrangement sketches, discussions of the relative merits of each option and finally a recommended preferred concept design option for each site.

The concept design drawings show the plan layout, elevation, horizontal and vertical alignment, skew diagram, superstructure details including typical cross-sections and substructure details including proposed foundation type.

The report provides clear justification for the preferred concept design for each structure.

The PSC must review the concept options report and provide an assessment of its findings. The concept options report including any findings approved by the RMS Representative must be used as the basis for the detailed structures design.

2.6 GEOTECHNICAL INVESTIGATIONS AND DESIGN SUPPORT

The PSC must undertake a geotechnical and foundation study for each new bridge and structure listed in section 2.3, including any temporary structures and for each existing structure affected by the project works or the temporary works. Refer to PS331 for the scope of minimum geotechnical investigation and geotechnical design requirements for bridge foundation and structures.

In addition to the requirements stated in PS331, this study must provide and assess the following:

(i) Be sufficient to identify and provide all the information required to design, construct and maintain each new structure and to preserve and protect existing structures.

(ii) Encompass the structural adequacy, long term deformation and durability of the foundation, including the effects of the placement of fill in embankments near or adjacent to structures.

(iii) Provide preliminary assessment on any existing structures that would be impacted by the proposed works.

(iv) Predict the in-situ ground movement, structural movement and groundwater movement.

(v) Identify any aggressive ground or water conditions that may be potentially harmful for foundation and structural elements to achieve the required design life.

(vi) Include sufficient drainage on the soil-supporting structures.

(vii) In accordance with the Chief Bridge Engineer Circular, CBE 2000/09, the structure design report must include the relevant parts of geotechnical investigation report, geotechnical foundation design and assessment report as prescribed in PS331 as an appendix for each structure element required in the project.

(viii) The cover sheet for each set of drawings for the Design Documentation must cross reference to the relevant geotechnical investigation reports. (See Site Information Docuents PS392).

Furthermore, the PSC must provide ongoing design support during foundation construction for all bridges (other structures). This advice will be with respect to the analysis of dynamic testing results, penetration

details, the geotechnical study and the original design assumptions to assist in the determination of the appropriate contract level, pile capacity and overall pile lengths.

2.7 WATERWAY INVESTIGATIONS

The PSC must perform a hydrology study for each structure and prepare a report that includes:

(i) A clear description of the waterway and hydraulic regime within the study area.

(ii) A detailed investigation and analysis, using an appropriate model and methodology, of the impacts of each option on the hydrology and hydraulic regime.

(iii) Recommendations of the relevant design parameters to be taken into consideration and adopted for the road and bridge/culvert designs for each option and any variations, based on hydrological and hydraulic considerations.

(iv) Recommendations of appropriate mitigation and management measures, taking into account the requirements of relevant water authorities, to ensure that hydrological and hydraulic impacts are minimised.

(v) Liaison with stakeholders regarding the identification, significance and management of hydrology within the study area and sign off by statutory authorities (where required) as to the appropriateness of the hydrology/hydraulics design.

The report must include the comparison of the existing and proposed conditions of flood level stream velocity and the change in flood flow distribution for the 20, 100, 2000 and the Probable Maximum Flood (PMF). Estimation of scour depth for the 2000 year flood must be included in the report - refer to PS371.

2.8 EXISTING STRUCTURES

An existing structures report has been prepared during the concept design phase of the project.

Where possible the retention or modification of existing structures has been considered for incorporation into the proposed works. During the concept design phase for the project, a full assessment of these structures was carried out and an existing structures report prepared on the adequacy of these structures for their proposed purpose.

The load rating for the main structural elements of the bridge (other structures) must be in accordance with AS5100.7.

The PSC must review this report(s) and use it as the basis for the detailed design.

If a structure requires modification or requires addressing of a non-compliance, then the modification, strengthening or upgrading of the design must be in accordance with the current design standards.

A non-compliant structure may be addressed by undertaking works to eliminate the non-compliance or by providing justification and obtaining approval from RMS to retain the non-compliance (e.g. through the departure from standard procedure).

In addition to structural adequacy, the existing structures report must include all requirements for:

(i) Modifications to approach slabs, kerbs, railings, parapets, traffic barriers, barriers on approaches etc.

(ii) Drainage, including retro fit of drainage systems into the project drainage system.

(iii) Surfacing correction.

(iv) Necessary adjustments for possible strengthening, etc. to meet current loading requirements (including a critical visual inspection, materials assessment and an analytical investigation and assessment).

(v) Repair of defects required etc.

(vi) Likely effects of adjacent proposed construction, e.g. influence of soft soils, and superimposed loads on existing bridge abutments and piles (will require, as part of this issue, a geotechnical engineering assessment).

The existing structures report must make recommendations regarding each structure.

HOLD POINT	
Process held:	Further design associated with existing structures
Submission details:	Existing structures report
Release of hold point	The RMS Representative will release the hold point following consideration of the PSC's review and comments of the existing structures report and incorporation of RMS comments.

The drawings and documentation must specify all modifications and repairs.

2.9 ~~BRIDGE DEMOLITION~~

~~If a structure needs to be demolished, the PSC must prepare a bridge demolition report (or review and supplement the bridge demolition report prepared at concept stage if applicable) that includes:~~

~~(i) A complete method statement(s) for inclusion in the construction contract tender documents that addresses/considers as a minimum:~~

~~a. Methods for removing the bridge substructure, in particular the piling.~~

~~b. Methods for minimising disturbance in the river bed and associated negative effects of the demolition.~~

~~c. Methods for minimising disturbance to the road traffic and road closures in consultation with Transport Management Centre.~~

~~d. Methods for materials handling, storage and disposal.~~

~~e. Required environmental mitigation methods to protect flora and fauna and the watercourse itself, from falling debris.~~

~~f. Safety requirements for both the demolition works and the adjacent community.~~

~~g. The inclusion of a demolition works program and demolition diagrams.~~

~~h. Consideration of the services attached to the existing bridge in consultation with the relevant Authorities, and in accordance with PS321 - Detailed Survey and Utility Adjustment.~~

~~i. Consideration of WHS and environmental management issues for incorporation in the WHS development plan – refer to PS301 and the project environmental management plan – refer to PS311 or PS312 as applicable.~~

~~j. Consideration of the waste management requirements - refer to PS311or PS312 as applicable, including full consideration of non-destructive methods which are likely to allow reuse of bridge components by others.~~

2.10 BRIDGE DESIGN PROPOSAL

Following the release of the structures concept options report hold point, a design proposal for the structure consisting of a completed Form 62 and a design report were prepared during the concept design phase of the project.

The design proposal drawing includes all details listed in section 20 of RMS Structural Drafting and Detailing Manual (RTA Bridge Engineering).

HOLD POINT	
Process held:	~~20~~ 50% Detailed design
Submission details:	Design proposal ~~Form 62~~ and design report
Release of hold point	The RMS Representative will release the hold point following consideration of the PSC's review of the bridge (other structure) general arrangements which have been prepared during concept design, and incorporation of RMS comments.

2.11 STRUCTURAL DESIGN OBJECTIVES

The design and detail of the bridges and structures must ensure an economic life of structure as specified in Table PS301.2 – Asset Design Life of PS 301.

All structural design must incorporate the most up to date and appropriate technology available.

All structural design must consider the urban design objectives for the project. They must have an attractive appearance appropriate to their general surroundings and any adjacent structures - refer to PS381.

2.12 DESIGN REFERENCE DOCUMENTS

The design of structural works must be in accordance with the design documents listed below and in Annexure PS361/M Additional Design Reference Documents, Referenced Documents & Supporting Information. The PSC must comply with RMS Technical Directions, which contain additional RMS requirements for design and design detailing.

(i) AS 5100 Set -Bridge Design Set.

(ii) RMS Bridge and Geotechnical Technical Direction Manual.

(iii) RMS Bridge Waterway Manual, October 1994.

(iv) AUSTROADS Waterway Design (A Guide to the Hydraulic Design of Bridges, Culverts and Floodways) – 1994.

(v) RMS Structural Drafting and Detailing Manual.

(vi) RMS Aesthetics of Bridges – Design Guidelines to Improve the Appearance of Bridges in NSW, 2004.

(vii) The Design and Construction of Incrementally Launched Bridges, 1986.

(viii) Foundations on Sandstone and Shale in Sydney Region - Pells et al, 1998.

2.13 SUBMISSION OF DETAILED DESIGN

The PSC must submit detailed design packages at 20%, 80%, 100% and IFC completion for RMS review in multipage PDF format. The design report at all design stages must include the signed Form 62, and design reports which includes relevant investigation and other reports in the appendices.

For the 80% completion stage, the submission must include the completion of a layout of each sheet, dimensions for all major structural elements and sufficient reinforcement and prestressing details for the determination of section capacities.

The 100% submission must include load rating form completed by the designer and checker and the Proof Engineer's Report including load rating form in for Complex bridges. It must also include a list of relevant RMS QA specifications and completed Annexure for the relevant construction specifications.

The IFC design package submission must include the completion of all sheets and certification by the designer and proof checker in accordance with the Technical Approval Procedure – refer Annexure PS361/D.

HOLD POINT	
Process held:	80% and 100% detailed design
Submission details:	Drawings, reports and certificates
Release of hold point	The RMS Representative will release the hold point following consideration of the drawings, reports and certificates and incorporation of RMS comments.

2.14 APPLICATION OF THE AS 5100

The design must conform to the requirements of AS 5100 Set – Bridge Design Set.

(i) AS 5100.1 Bridge design Part 1: Scope and general principals

(ii) AS 5100.2 Bridge design Part 2: Design loads

(iii) AS 5100.3 Bridge design Part 3: Foundations and soil supporting structures

(iv) AS 5100.4 Bridge design Part 4: Bearings and deck joints

(v) AS /RMS Interim 5100.5 Bridge design Part 5: Concrete

(vi) AS 5100.6 – Bridge design Part 6: Steel and composite construction

(vii) AS 5100.7 – Bridge design Part 7: Rating of existing bridges

In particular, the PSC's attention is drawn to the following clauses where their applications have been explained in the relevant paragraphs:

2.14.1 AS 5100.1 – Bridge design Part 1: Scope and general principles

(i) AS 5100.1, clause 6.2: Design life

Structures must be designed and detailed to comply with the design lives specified in Table PS301.2 – Asset Design Life of PS301.

(ii) AS 5100.1 clause 7.5: Piers and abutments

Scour depths at bridge piers, wall abutments and retaining walls including reinforced soil walls must be calculated ignoring the presence of any scour protection provided. Reinforced soil walls must not be founded on soils susceptible to scour.

Some scouring of abutment spill-through embankments due to floods up to the 100 year ARI flood event is permissible, provided the effective batter slope measured on a line from the scoured toe of the embankment to the front soffit of the abutment sill beam shall not be steeper than 1:1. Scour protection may be used on spill-through embankments to ensure this outcome is achieved.

For flood events higher than the 100 year ARI flood and up to the 2000 year ARI flood the design must ensure that under the permanent loads and water flow effects the bridge will not collapse. For these floods it shall be assumed that the embankment at the bridge abutments will be scoured away to an equal height in front of and behind the abutments.

(iii) AS 5100.1, clause 9.7: Vertical clearance over roadways

The minimum clearance for road bridges over classified roads and local roads for which alternative high level access is not available to 5.4 metres it must be in accordance with Annexure A17-Departures from Standards of PS301.

The minimum vertical clearance for pedestrian and shared path bridges is 5.5 metres.

(iv) AS 5100.1, clause 10: Road traffic barriers

a. clause 10.1 – Scope

Traffic barriers for bridges and traffic barriers located along the edges of vertical or near vertical earth retaining structures, including reinforced soil walls, must be designed in accordance with the requirements for traffic barriers on bridges in AS 5100.1 and AS 5100.2 and subsection (b) to (e) below. Internal traffic barriers on bridges must be designed to the same performance level or higher as for the external traffic barriers.

b. clause 10.2 – General

Cyclists must be considered and addressed in determining the height of the bridge traffic barriers. Where the height of bridge traffic barriers on one side of a bridge is raised to contain cyclists, the bridge traffic barriers on the other side of the bridge must be raised to the same height and designed to the same details except where a higher performance level is required to comply with subsection (c) to (d) below.

All concrete parapets of the bridge traffic barriers must be integrally connected to the bridge deck and provide continuity, except over link slabs where the traffic barriers must be debonded from the link slabs for a distance not less than 500 mm either side of the link slab centreline. The debonded layer must consist of a 3 mm thick cork layer. The bottom of the inside face of the traffic barrier must be provided with a 20 mm x 20 mm rebate and sealed with an appropriate sealant in accordance with RMS B312.

c. clause 10.5 – Performance levels

Traffic barriers on each bridge and retaining structures must be designed to the performance level, required by the risk assessment procedure in AS 5100.1 Appendix B;

d. clause 10.6.1 – Parapet type barriers

Traffic barriers must consist of concrete parapets mounted with two rail tubular metal barriers that comply with the Type traffic barrier requirements in RMS Standard Bridge Drawings B500 and B503. The barriers must be terminated in accordance with the details in RMS Standard Bridge Drawings B501to B506.

Concrete parapets must not be constructed using the slip-forming method.

Full height precast barriers must not be used.

Exposed joints between adjoining precast concrete parapets of traffic barriers must be sealed around the outside perimeter of the joints with an appropriate sealant 10 mm deep conforming to RMS B312.

e. clause 10.6.3 – Bridge approach barriers

A transition barrier must be provided on the approach to all bridges. They must be extended and transitioned smoothly in stiffness, strength and performance levels prior to connecting to the roadside barriers.

The performance levels of the approach barriers shall be assessed and designed to same procedures as the bridge barriers. Traffic barriers at the approaches shall contain and redirect errant vehicles leaving the travel lane at 15˚ departure angle, bypassing the end of the barriers on the bridge structure and encroaching beyond the clear zone. Considerations must be given to distance to:

1) right of way boundary,
2) rigid objects,
3) steep descent,
4) use of crossing below and
5) parallel walkways and service roads.

(v) AS 5100.1, clause 11.2: Collision from road traffic

The need for protection of bridge abutments and piers and structures for collision loads from road traffic must be determined in accordance with Bridge Technical Direction BTD 2008/07 and the following requirements where "x": is the minimum distance between nearest face of the bridge support and the edge of the nearest travel lane:

a. Where "x" is greater than 11 metres the bridge support does not need to be designed for collision from road traffic if adequate sight distance has been provided;
b. where 'x" is less than 5.5 metres and traffic barriers complying with subsection (vii) below have not been provided, the bridge supports must be designed for the full collision load specified in clause 10.2 in AS 5100.2;
c. where 'x" is between 5.5 metres and 11 metres and traffic barriers complying with subsection (vii) below have not been provided, the bridge supports must be designed for a collision load varying linearly from the full load specified in clause 10.2 in AS 5100.2 when "x" is 5.5 metres to zero load when "x" is 11 metres
d. traffic barriers provided to protect bridge supports must be at least Medium Performance Level and designed for the full collision load specified in clause 10.2 in AS 5100.2.

Bridge superstructures where collision from road traffic has the potential to cause significant damage, collapse or loss of service:

a. bridge superstructures and superstructure elements must designed, as a minimum, to absorb the collision loads for protection beams specified in AS 5100.2 without significant damage, collapse or loss of service; and

b. superstructure elements potentially subject to impact must be designed with sufficient redundancy to prevent collapse or loss of service if damaged by road traffic collision.

(vi) AS 5100.1, Section 11.3: Collision from railway traffic

Piers for the road bridges over railway must be designed to resist the collision load from rail traffic in accordance with the requirements of clause 10.4 of AS 5100.2 and must be protected by deflection walls. Deflection walls may be either independent walls in front of the columns or be an integral part of the piers and have a continuous face extending 2m past the end of the columns.

Guard rails or kerbs must be provided on the deck of the railway bridges over road in accordance with ESC 210.

(vii) AS 5100.1, clause 12: Pedestrian and bicycle-path barriers

Where an internal traffic barrier is located on a bridge which separates the road carriageway from a cycleway or a combined pedestrian cycleway, a smooth continuous running rail must be provided to avoid snagging of pedals or other parts of the bicycle or rider on the barrier. The running rail must be located 1.3 metres above the top of the cycleway or the combined pedestrian cycleway. The running rail, including its connection and joints, must be detailed such that it does not come loose in the event of a vehicle impact to prevent spearing into the vehicle or pedestrian/cyclists. Beyond the ends of the bridge where the running rail terminates it must be suitably flared downwards to prevent spearing into vehicles or pedestrians/cyclists.

(viii) AS 5100.1, clause 14: Drainage

The drainage system must be designed so that a minimum amount of water flows across deck joints. Scuppers in a piped drainage system must not be spaced more than 12m apart. Free draining scuppers through decks must not be used unless approved by the relevant Authorities. Free draining scuppers must be designed to prevent use by fauna, including bats and birds and must be maintenance free for a 100 year design life.

Where grated inlet drains are provided, they must not be located over the closed voids of bridge girders unless the girders are concrete box girders and the voids are large enough for the connecting pipework within the girder to be easily and safely accessible for future inspections and maintenance. Drainage pipework must not be located within the voids of steel box or steel trough girders. Inlet drains must be located clear of any integral connection between girders and the deck slab. Components of the grated drains that are not readily removable must be designed to be maintenance free and made from Grade 316 stainless steel.

Water leaking from tunnels or any associated approach structures and runoff from the approaches must be diverted and prevented from flowing onto the deck.

All pipework for drainage must be resistant to fire and corrosion and to all commonly occurring chemical spillage. Where pipework is located in a concrete box girder the parts of the pipework that are located outside the box must be designed such that ignited flammable liquids cannot discharge into the pipework located inside the box girder.

Hanging rods and associated anchorage fixtures that support the drainage system must be made from Grade 316 stainless steel.

All drainage structures must be readily accessible for cleaning and maintenance purposes.

(ix) AS 5100.1, clause 16: Utilities

The requirements of all relevant Authorities to accommodate and provide for existing and planned future Services within and on the bridges must be satisfied. Ducts or conduits provided in bridges for planned future services must be installed with stainless steel draw wires of sufficient length and strength to permit future installation of Services. Junction boxes must be provided for bridges longer than 200m.

In addition to any ducts that may be required for lighting and by Service Authorities, traffic barriers on all bridges must contain, as a minimum, an additional 100 mm inside diameter UPVC, SWV pipe duct and suitable fittings, to AS 1415, for future services in accordance with Bridge Technical Direction BTD 2008/08. In twin bridges, the Services ducts must be provided in the outside (nearside) traffic barrier of each of the bridges.

2.14.2 AS 5100.2 – Bridge design Part 2: Design loads

(i) AS 5100.2, clause 5.3: Superimposed dead loads

Deck wearing surfaces, additional concrete to compensate for prestress girder hogs or geometric requirements and earth fill on top of bridges or other similar structures must be taken as superimposed dead loads with an ultimate limit state (ULS) load factor of 2.0.

(ii) AS 5100.2, clause 6: Road traffic loads

a. clause 6: Road traffic loads

All bridges, culverts, underpasses and retaining walls supporting traffic must be designed for SM1600 loadings.

b. clause 6.3: Heavy load platform

All bridges, culverts, underpasses and retaining walls supporting traffic must be designed for HLP320/400 heavy load platforms depending on the route as determined by RMS.

The lateral position of the HLP320/400 must be shown on the cover sheet or on the general arrangement sheet of the bridgework set of drawings in the Design Documentation.

The lateral position of the centre of the HLP320/400 must be determined as follows:

1. one lane bridge: Within ± 1.0 m either side of the centreline of the carriageway; or
2. two lane bridge: Within ±1.0 m either side of the centreline of carriageway; or
3. three (or more) lane bridge: Within any two marked travel lanes the vehicle travelling on centreline of the two marked lanes, or on the centreline of carriageway, which ever produces the most critical effect.The bridge must also be designed for one half of the SM1600 loading on any adjacent unoccupied travel lane in conjunction with the HLP320/400 loading. The accompanying lane factor for both the HLP320 loading and the one half of the SM1600 loading must be taken as 1.0. The design must allow for the errors in positioning the heavy load platform loads by upto 1m laterally in either direction from the specified position.

(iii) AS 5100.2, clause 9: Minimum Lateral Restraint Capacity

A positive restraint system between the superstructure and the substructure shall be provided at piers and abutments. The restraint system shall be designed to resist an ULS force of 500kN or 5% of the superstructure dead load at that support, whichever is greater acting in any inclination between horizontal and vertical applied at any potential impact points on the superstructure concurrent with the minimum permanent vertical load that increases the safety acting on the support with a ULS load factor of 0.75. The impact force shall be taken to act at the level of the soffit of the superstructure.

Supports providing this restraint shall also be designed to resist this design force.

Where the total vertical reaction due to permanent effects at a support is less than 500 kN, the positive vertical restraint shall be provided for the difference.

(iv) AS 5100.2, clause 11.2.5: Continuity

Full moment, shear and tensile lateral strength shall be provided throughout the barrier length without impacting thermal, rotational and other structural movements of the structure. Continuity transfer devices can be detailed to achieve this.

Metal traffic barrier railings must be made continuous by providing bolted sleeve joints in accordance with RMS Standard Bridge Drawings B504. The bolts must be designed to have cupped ("mushroom") heads with the cupped heads located at the top of the rails. The threaded bottom of the bolt must not project beyond the nut by more than a bolt diameter.

(v) AS 5100.2, clause 14: Earthquake forces

a. clause 14.3.2: Bridge classification

All bridges including pedestrian bridges on or over the main carriageways are essential for post-earthquake recovery and are classified as Type III bridges.

b. clause 14.3.4: Site factor

In determining the bridge earthquake design category (BEDC) of the structure the site factor must be obtained from Table 2.4(a) in AS 1170.4 -1993 to suit soil profile below pile cap or footing.

c. clause 14.7: Structural detailing requirements for earthquake effects

Bridges with a BEDC of BEDC-2, BEDC-3 or BEDC-4 must be designed with ductility reinforcement within the potential hinge zones in accordance with the requirements of clause 10.7.3.5 in AS 5100.5 irrespective of the value of the structural response factor used to analyse the bridges.

(vi) AS 5100.2, clause 15: Forces resulting from water flow

a. clause 15.1: General

Scour shall be calculated by one of the following methods:

1. In accordance with the Hydraulic Engineering Circular No 18 – Evaluating Scour at Bridges, Fifth Edition, April 2012 (Publication No FHWA HIF-12-003) assuming any soil is granular (i.e. non-cohesive);
2. For simple single column pier forms of narrow and transition pier proportions and for common pier forms of narrow and transition pier proportions where suitable technical references justify the estimate of effective pier width, scour may be calculated using the simplified Sheppard-Melville method described in NCHRP Web Only Document 175: Evaluation of Bridge Scour Research: Pier Scour Processes and Predictions; or
3. By physical hydraulic modelling acceptable to the RMS Representative.

Where the adjacent spans are longer than 20 m and the catchment upstream of the bridge is not heavily timbered, the effective or projected width of the pier need not be increased to account for debris.

b. clause 15.2.2: Serviceability limit state

The serviceability design flood must be the 1 in 100 year ARI flood event.

(vii) AS 5100.2, clause 16: Wind loads

Wind loads on noise barriers must be in accordance with clause 16 in AS 5100.2 and RMS R271. The total load on the structure must include the wind load on attachments including noise barriers, lighting, traffic signals and traffic sign structures.

(viii) AS 5100.2, clause 17.3 and 17.4: Differential temperature

In any load combination, that includes differential temperature effects, the load factor for shears, reactions and moments due to differential temperature effects in concrete bridges in Table PS361.1 must be adopted.

Table PS361.1 - Load Factors

Concrete Bridge Type	SLS load factor	ULS load factor
Reinforced concrete	0	0
Continuous prestressed concrete superstructure	0.7	0.5
Segmental prestressed concrete with no non-stressed reinforcement across joints	1.0 in load combinations excluding traffic loading 0.7 in load combinations including traffic loading	0.7

For segmental prestressed concrete without non-stressed reinforcement across joints, the residual stresses also need to be accounted for at the serviceability limit state.

(ix) AS 5100.2, clause 21: Construction forces and effects

For the design of incrementally launched prestressed concrete bridges the following parameters must apply during the construction stage:

a. dead load - as per AS 5100.2;

b. live load – a minimum of 0.5kPa on all deck surfaces with an ULS factor of 1.5;

c. differential temperature - 70% of AS 5100.2 for SLS and 50% of AS 5100.2 for ULS;

d. wind load - 70% of AS 5100.2 for both SLS and ULS, with no launching to be carried out during strong winds;

e. differential settlement and construction tolerance allowances between bearing levels- as specified in Design Documentation and RMS B152 (must be monitored and controlled) during construction; and

f. load factors, limit states – as per AS 5100.2

(x) AS 5100.2, clause 22.2: Ultimate limit state load combinations

In all ultimate limit state load combinations, except for load combination (f), account must be taken of the effects of scour due to all floods up to the 1 in 100 year ARI flood.

Bridges must be designed for ultimate traffic loads concurrent with water flow forces for floods up to the 100 year ARI flood event and the corresponding scour depths. For ultimate limit state load combination (f), account must be taken of the effects of scour up to and including the 1 in 2000 year ARI design flood event.

(a) For ultimate limit state load combination (b) and (e), the flow and debris forces due to the 1 in 100 year ARI flood event must be considered if they produce adverse effects.

(b) For ultimate limit state load combination (c), ship impact loads must be included in this load combination

2.14.3 AS 5100.3 –Bridge design Part 3: Foundations and soil supporting structures

(i) AS 5100.3, clause 6.2: Design investigations

Sufficient and adequate geotechnical investigations must be undertaken for the design of bridge foundations. A minimum of one borehole must be drilled within 2 m of the centre of each pier and abutment foundations. Where the length of the pier or abutment foundation transverse (or skew) centreline of the substructure is greater than 12 m measured along the pier or abutment transverse (or skew) centreline of the substructure, a minimum of two boreholes must be drilled within 2 m of the centreline of each pier and abutment. The two boreholes must be more than 5 m apart measured along the transverse (or skew) centreline of the substructure of the pier or abutment, must not be located on the same side of the transverse (or skew) centreline of the substructure of the pier or abutment and must be located within the footprint of the foundation. Twin bridges must be treated as two separate bridges to determine the extent of geotechnical investigation required. This minimum level of geotechnical investigation only applies to bridge sites with relatively uniform subsoil strata and easily defined foundation conditions. If the subsoil is not relatively uniform, additional geotechnical investigations must be carried out as required to accurately define the foundation conditions.

The depth of the boreholes must extend to a minimum distance of 3 m below the founding level for pad footings and culvert base slabs and 3 m or five times the pile diameter below the founding level, whichever is greater, for pile foundations. Sufficient core must be recovered from the boreholes at and below the pile founding level to demonstrate the design parameters for the pile have been achieved.

Culverts typically are located on topographic low areas where the ground conditions are often less satisfactory. Investigation of such areas is frequently delayed or hampered due to regulatory constraints or accessibility. Hence the investigation for culverts must be planned and undertaken in a timely manner, to provide sufficient information prior to the commencement of design.

(ii) AS 5100.3, clause 9.4: Durability of steel

Steel piles and steel anchors must not be used in acid sulphate soils or potential acid sulphate soils where the measured or potential pH of the soil is equal to or less than 4 and/or the sulphate levels are greater or equal to 400 mg/l. In soils where the measured or potential pH of the soil is greater than 4 and the sulphate levels are less than 400mg/l, the minimum corrosion allowances specified in Bridge Technical Direction BTD 2007/13 must be adopted.

2.14.4 AS 5100.4 – Bridge design Part 4: Bearings and deck joints

(i) AS 5100.4, clause 5: Functions of bearings and deck joints

The number of deck joints shall be minimised. For bridge decks less than 120 m long deck joints must be located only at the bridge abutments. For bridges longer than 120 m the maximum number of deck joints shall be equal to the bridge length divided by 60m rounded down to the nearest integer..

The deck joints at the abutments must only be connected to the bridge approach slab by small movement joints detailed to the requirements of RMS Standard Bridge Drawings B620 and B621 or medium movement strip seal joints.

(ii) AS 5100.4, clause 7.4: Provision for replacement

Except for bridges with unreinforced elastomeric bearing strips, the superstructure and substructure of bridges must be designed to allow for the jacking up of the bridge superstructure for future replacement of bridge bearings under traffic in accordance with the requirements specified in Bridge Technical Direction BTD 2007/12. Jacks must be located on top of abutment and pier headstocks and not on temporary support structures. The locking rings must be in contact with the soffit of the superstructure. The design of headstocks must also make allowance for the provision of temporary packers during jacking. The location of the jacking points, the associated maximum jacking loads and the required size of the steel plate must be shown in the Design Documentation and marked For Information Only.

(iii) AS 5100.4, Clause 7.7: Access

Provision for maintenance access must comply with BTD/2008/02, and with the following additional requirements:

a. The permanent safe access corridor adjacent to spill through abutment headstocks must be a minimum of 1000mm wide and 1500mm high; and

b. For girder bridges with minimum clear gap of 1000mm between the side faces of girders, the access corridor under the girder soffit may be reduced to a minimum of 1000mm wide and 1000mm high, provided an access corridor of minimum dimensions 1000mm wide and 1500mm high is available between girders

c. Bridges over motorways and highways must safely be accessed from the local road with minimum interruption to the road network performance. The access provisions shall be detailed in the bridge design documentation.

(iv) AS 5100.4, clause 12: Elastomeric bearings

a. clause 12.5.1: General

Plain or unlaminated elastomeric pads must not be used to support prestressed concrete (PSC) planks in spaced plank superstructures. The attachment detail must be as shown in RMS Bridge Standard Drawing B330.

b. clause 12.6.7: Fixing of bearings

Inequality 12.6.7(2) must be replaced with the following inequality:

$$N_{min.PE} \geq 2.2 f_o A_b$$

where parameters Nmin.PE, fo, and Ab are as defined in AS 5100.3.

c. clause 12.7.4: Inclined elastomeric bearings

Strip, plain pad and laminated elastomeric bearings must not be installed on an incline unless:

1. the shear deflection of the bearings caused by the application of the self weight of the superstructure is less than 6mm. Where the bearings are inclined about both axes, the shear deflection must be taken as the vector sum of the longitudinal and transverse deflection; and

2. laminated elastomeric bearings are mechanically restrained on both the top and bottom faces.

(v) AS 5100.4, clause 14.2: Materials

Polished stainless steel surface mating with PTFE must be in accordance with ASTM A240/A240M-03b and not AS 1449.

(vi) AS 5100.4, Section 17.2: Joint types

a. Small movement sealant type joints must be detailed in accordance with RMS Standard Bridge Drawings B620 and B621.

b. For small to medium movements, strip seal joints comprising prefabricated rubber extrusion type joints between heavy reinforcing angles and with a maximum opening width less than 85 mm under ULS conditions (refer to clause 17.3.5 in AS 5100.4), prefabricated rubber extrusion type joints between heavy reinforcing angles must be used.

c. Finger plate type joints, saw tooth joints or modular bridge expansion joints must be used for larger movements.

d. Where pedal cyclists travel on a bridge, the design of bridge joints must allow for the safe passage of cyclists. Suitably designed coverplates may be provided over the shoulders only for the safe passage of cyclists so that the maximum opening does not exceed 200mm during service.

e. Bonded steel/rubber type joints must not be used.

f. Steel cover plates must be provided over traffic barrier openings at deck expansion joint locations where the maximum opening in the expansion joint gap is equal to or greater than 50 mm under ULS conditions. The openings in the traffic barriers must be measured in the longitudinal direction of the bridge. For joint movements up to 85 mm under ULS conditions, steel cover plates must cover both the inside face and the top of the barriers. Where the joint movements are greater than 85 mm under ULS conditions, steel cover plates must also cover the outside face of the traffic barriers for its full depth. Steel cover plates must not be less than 10 mm thick. The faces of the traffic barriers must be recessed such that, after installation of the steel cover plates, the exposed faces of the steel cover plates and the traffic barriers are on the same respective planes.

g. For medium to large movement joints deck edge stiffening of minimum 500mm *500mm shall be provided for the full width of carriageway at the expansion joint locations on the bridge deck.

h. Bridge deck joint products must be chosen from the List of RMS Approved Bridge Components to suit performance requirements.

(vii) AS 5100.4, clause 17.3: Requirements.

a. AS 5100.4, clause 17.3.1: General.

1. Bridge deck joints must be designed in accordance with the requirements in Bridge Technical Direction BTD 2008/10.

2. Joints must be selected, detailed and constructed such that the noise generated by traffic crossing the joint is kept to a minimum.

3. Joints must not inhibit the proper placement of concrete and must have adequate provision for maintenance and inspection access. Stainless steel drainage troughs must be provided under open finger plate type joints without seals in accordance with the requirements of Bridge Technical Direction BTD 2008/10 to prevent water or other liquids from staining any pier or abutment, causing any damage to bearings or restraints or causing corrosion or deterioration to concrete or metal surfaces.

4. The surface of bridge deck joints and bridge approach joints must not deviate by more than 3mm when measured from a 3m straight edge, including surface seal and cover plate areas.

5. Edges of deck under the joints must be stiffened with an edge beam to ensure sound concrete around the anchors, reduce congestion of reinforcement and limit deflections to 3mm during service.

6. Surface structural joints must not present a hazard to any road users, including pedal cyclists, motorcyclists, pedestrians, wheelchair users and disabled persons.

b. AS 5100.4, clause 17.3.2: Design loads

Modular bridge expansion joints and their associated anchorages must be designed for the load cases contained in RMS B316.

For deck joints other than modular bridge expansion joints, the joints and their associated anchorages must be designed for the load cases contained in clause 17.3.2 of AS 5100.4.

c. AS 5100.4, clause 17.6: Specific provisions for modular deck joints

Modular deck joints must be designed, fabricated and installed in accordance with RMS B316.

Where modular bridge expansion joints are used, adequate space, a minimum 800mm wide and a minimum 1500mm high, must be provided in the voided zone under the expansion joints to permit future inspection, maintenance and replacement of the individual components of the modular bridge expansion joints.

2.14.5 AS/RMS 5100.5 – Interim Bridge design Part 5: Concrete

(i) AS/RMS 5100.5, clause1.1: Scope and application:

a. clause 1.1.1 Scope : Concrete design- RMS Interim

The design of concrete bridge elements must be in accordance with the interim concrete bridge design code "*AS/RMS 5100.5 May 2015 – Interim (Interim RMS Edition)*" (**AS/RMS 5100.5**) and not AS 5100.5

b. clause 1.1.2 Application

Bridge elements must not be designed or constructed using Ductility Class L steel reinforcement (as defined in AS/NZS 4761). Ductility Class L steel reinforcement must not be used in structures, other than bridges, required to undergo plastic deformation.

(ii) AS/RMS5100.5, clause 2.8: Cracking

Where the smallest dimension of a concrete element exceeds 1000mm, the temperature differential across any face the concrete element must not exceed 20°C during the curing period. . A temperature differential up to 25°C during the curing period is permitted provided CIRIA C660 modelling is undertaken to demonstrate that predicted long term crack widths will be less than 0.2 mm, and measures assumed to minimise the head of hydration must be documented in the drawings. Thermocouples must be located within the concrete element to monitor the maximum temperature and differential temperature across the concrete.

(iii) AS/RMS 5100.5, clause 4.10.3: Cover for corrosion protection

References to concrete cover to steel reinforcement in "*RMS Standard Bridge Drawings*", "*RMS Bridge Technical Direction Manual*" and "*RMS Technical Directions*" are to "nominal" cover as defined in clause 4.10.3.1 of AS/RMS 5100.5 unless stated otherwise. Concrete covers in Design Documentation drawings of reinforced concrete structures must be nominal covers in accordance with clause 4.10.3 of AS/Roads and Maritime 5100.5.

Waterproof membranes or wearing surfaces placed on top of concrete bridge decks and/or mass concrete placed against reinforced concrete elements must not be considered as barriers to environmental exposure when determining the required concrete cover to the steel reinforcement in bridge decks.

(iv) AS/RMS 5100.5, Table 4.10.3(A):

The following amendments shall be made to the nominal cover requirement in Table 4.10.3 (A) where standard formwork and compaction are used:

a. For exposure classification A must be increased to 45mm for Grade 32MPa concrete and 35mm for Grade 40MPa concrete.

b. For exposure classification B1 must be increased to 55mm for Grade 32MPa concrete and 45mm for Grade 40MPa concrete.

(v) AS/RMS 5100.5, Table 4.10.3(B):

The following amendments shall be made to the nominal cover requirement in Table 4.10.3 (B) for precast elements with rigid formwork and intense compaction

a. For exposure classification A must be increased to 35mm for Grade 32MPa concrete and 30mm for Grade 40MPa concrete.

b. For exposure classification B1 must be increased to 45mm for Grade 32MPa concrete and 35mm for Grade 40MPa concrete.

(vi) AS 5100.5, Section 6.2: Properties of Reinforcement

Refer Clause 2.14.5(a) regarding the use of Ductility Class L steel reinforcement to AS/NZS 4671.

(vii) AS/RMS 5100.5, clause 8: Design of beams for strength and serviceability

a. AS/RMS 5100.5, clause 8.2.12: Detailing of shear reinforcement.

Shear reinforcement must not be lap spliced. Longitudinal bars must be placed in the corners of fitment bends and hooks for anchorage.

b. AS/RMS 5100.5, clause 8.3.4: Requirements for torsional reinforcement

In checking the requirement for torsional reinforcement in a concrete beam, the calculated torsion moment T* in clauses 8.3.4(a)(i) and 8.3.4(a)(ii) of AS/RMS 5100.5, must be calculated assuming the uncracked section properties in the analysis.

(viii) AS/RMS 5100.5, clause 8.6.1: Crack control for tension and flexure in reinforced beams

Crack control for tension and flexure in reinforced concrete beams must be in accordance with clause 8.6.1 of AS/RMS 5100.5.

(ix) AS/RMS 5100.5, clause 8.6.2(a): Crack control for flexure in prestressed beams

Crack control design for prestressed beams must be in accordance with clause 8.6.2(a)(ii) of AS/RMS 5100.5, except that the increment in steel stress must be limited to 160 MPa as the load increases from the decompression state to the maximum combined serviceability limit state load.

(x) AS/RMS 5100.5, clause 9.1.2: Distribution reinforcement for slabs

Where the main steel reinforcement in the deck slab is transverse to the direction of traffic, the longitudinal distribution steel reinforcement in the deck slab must conform to the following requirements:

a. for bridge skews less than 25 degrees, the minimum quantity of longitudinal reinforcement to be provided must not be less than 1300 mm2 per metre width in the top face of the slab and 880 mm2 per metre width in the bottom face of the slab.

b. for bridge skews equal to or greater than 25 degrees, the minimum quantity of longitudinal reinforcement to be provided must not be less than 1300 mm2 per metre width in both the top and bottom faces of the slab.

Where a bridge skew is greater than 25 degrees, a rigorous and accurate analysis must be undertaken to account for both the skew effects on the transverse and longitudinal bending of deck and link slabs and the differential shrinkage effects between the deck slab and the bridge girders particularly in the vicinity of the acute corners of the bridge deck. Special attention must be given to control cracking of the bridge decks to within specification limits.

(xi) AS/RMS 5100.5, clause 9.1.3: Edge Stiffening

The transverse edges of deck slabs must be stiffened with discrete edge beams or cross girders having a minimum depth of not less than half the clear span between longitudinal girders, designed for the full effects of wheel loads and to minimise differential deflections.

(xii) AS/RMS 5100.5, clause 10.7.3: Restraint of longitudinal reinforcement

The design and detailing of lateral restraints must comply with the access requirements specified in RMS Chief Bridge Engineer Circular, CBE 00/05.

(xiii) AS/RMS 5100.5, clause 10.7.3.4(c): Detailing of lateral ties and helices

A helix must be anchored at its ends and splice locations by 1.5 extra turns of the helix at zero pitch and either a hook around a main longitudinal reinforcing bar or welding.

2.14.6 AS 5100.6 – Bridge design Part 6: Steel and composite construction

(i) AS 5100.6, clause 7: Composite box girders

Steel box or trough girders must be designed with sealed manholes to provide safe access into the inside of the girders for future inspections and maintenance in accordance with BTD 2008/02. The manholes must be fitted with vandal-proof locks.

(ii) AS 5100.6, clause 8.2.6: Temporary cross bracing

Any temporary cross bracing left in as part of the permanent works must meet the same durability requirements and have the same surface coating system as the element it is connected to.

2.15 DURABILITY

2.15.1 General

(i) Durability standards and guidelines detailed PS301 , Australian Standard AS 5100 Set Bridge Design Set and amendments, AS/Roads and Maritime 5100.5, RMS Bridge Technical Direction Manual, RMS Technical Directions and the requirements of RMS specifications, and the additional requirements in section 2.15.2 must be applied for the various materials and components used in all permanent structures.

(ii) For each bridge, a separate durability assessment report must be provided as part of the bridge design report in the Design Documentation. Durability Plan must be developed for each structure in accordance with BTD 2014/ 03

2.15.2 Additional requirements

(i) Materials, components and processes for all structural parts of the Project Works must provide the required durability.

(ii) Durability design for concrete structures with a design life greater than or equal to 40 years must be in accordance with Australian Standard AS 5100 Set Bridge Design Set and amendments, AS/RMS 5100.5, RMS Bridge Technical Direction Manual, RMS Technical Directions and the requirements of RMS specifications and the following requirements:

a. Dense, durable high strength concrete must be used. The minimum strength concrete to be used must be 32 MPa, except for blinding or mass concrete. In areas of severe exposure (equal to or exceeding AS 5100.5 exposure classification B2), blended cements must be used;

b. Blinding or mass concrete placed against a structure must not be considered to provide a protective barrier against environmental conditions

c. Concrete mix design must include provisions for the prevention of the deleterious effects of erosion, delayed ettringite attack, acid attack and sulphate attack as applicable; and

d. Except where stainless steel reinforcement is used, allowance must be made for possible future cathodic protection in accordance with the requirements of Bridge Technical Direction BTD 2008/13 for all reinforced concrete elements, including reinforced concrete elements in tunnels and culverts, that have a concrete exposure classification B2 or more severe. Allowance must also be made for possible future cathodic protection of piled foundations where the diameter of the excavated pile holes varies with depth. Electrical continuity must be provided for all non-stressed and stressed reinforcement, fitments and anchor plates. Anchors for metal items with a

large exposed surface area must be electrically isolated from the remaining reinforcement. The electrical continuity must be demonstrated for each reinforced concrete element for which allowance for cathodic protection has been provided. The electrical continuity must be tested in accordance with Australian Standard AS 2832.5 Cathodic Protection of Metals, Part 5: Steel in Concrete Structures.

(iii) Measures must be taken to minimise the possible deleterious effects of heat of hydration in thick concrete sections, which may include the use of blended cements, cooling concrete during curing, insulated forms and the use of larger aggregates. Such measures must be documented in the drawings. Where the smallest dimension of a concrete element exceeds 1000mm, the temperature differential of core of the element and surface must not exceed 20°C during the curing period. A temperature differential up to 25°C during the curing period is permitted provided CIRIA C660 modelling is undertaken to limit long term crack widths to be less than 0.2 mm. Thermocouples must be located within the concrete element to monitor the maximum temperature and temperature difference between the core and the surface of the concrete.

(iv) The durability of reinforcement which is incorporated in or contributes to the action of soil reinforcement techniques must comply with the requirements of RMS R57. Cement stabilised sand must not be used in the construction of the reinforced soil wall.

(v) Exposed steelwork must be either:

a. of suitable grade to resist corrosion; or

b. protected by a high grade protective coating having a minimum maintenance free life of 15 years. At the end of the maintenance free life, the coating must remain soundly adhered to the steel substrate and must be suitable for overcoating without removal. Lead based coatings, chlorinated rubber based coatings and alkaloid based coatings must not be used.

(vi) Structures must be designed to enable items such as bearings (except elastomeric strip bearings conforming to RMS B280), expansion joint seals, railings and drains to be easily maintained and readily replaced. Structures must be designed to enable all steel coatings to be maintained.

(vii) Where an item is not readily accessible for maintenance or replacement, it must be designed so that it will function for the life of the structure without maintenance.

(viii) All bearing attachment plates and pot bearings located in an atmospheric exposure classification B2, must be manufactured from grade 316 stainless steel.

(ix) The 56-day drying shrinkage of the concrete of second stage pour, such as deck stitch pour, expansion joint block outs, parapet stitch pour, must not exceed 500 microstrains.

2.16 PROVISIONS FOR SPECIFIC STRUCTURE TYPES

2.16.1 ~~Precast concrete girder and plank bridges and steel girder bridges~~

~~(i) Bridge superstructures consisting of multiple (2 or more) precast concrete girders with a concrete deck slab, where the depth of the precast girder is greater than 740mm must have end cross girders. The minimum depth of the end cross girder, measured from the top of the concrete deck slab must be 800mm, or 0.6 times the precast girder depth, whichever is the lesser. Cross girders must not extend beyond the face of the outside web of the edge bridge girders.~~

~~(ii) The maximum clear spacing between planks, cross section and prestressing for spaced plank bridge decks must conform to the details shown on Roads and Maritime Bridge Standard Drawings B301 to B320 inclusive. Plain or non laminated elastomeric pads must not be used to support PSC planks in spaced plank superstructures. Spaced planks must be supported on laminated elastomeric bearings~~

anchored by steel dowel and bottom attachment plate grouted to the headstock as shown in RMS Standard Bridge Drawing B330. Side by side planks must not be used for bridge superstructure.

(iii) Where precast concrete or steel bridge girders are designed for continuity over piers or integral with the substructure:

a. they must be designed for full continuity and not partial continuity;

b. where continiuty includes an intergral connection between the ends of girders and the top of the pier, the bottom of the girders must not be supported off the top of the pier. All temporary supports must be removed;

c. the number and type of bridge girders must be the same on either side of the piers and align over the piers;

d. the bridge must not have a skew greater than 5° or an angular deviation between the centreline of opposing girders on either side of a pier must not be greater than 1°; and

e. untensioned strands, wire or high tensile bars must not be considered in the calculation of section capacity;

(iv) The effects of staged construction, creep, shrinkage, differential shrinkage and differential temperature and a minimum 10 mm differential settlement between adjacent piers must be rigorously assessed in the design.

(v) Schematic details of any temporary supports of the precast girders and the loads on them shall be provided in the bridge drawings.

(vi) Positive moment connection between precast girders over the piers due to residual hog, differential shrinkage, differential temperature and effects of any prestressing through the integral diaphragm must be designed for assuming gross section properties and reducing any pre-compression from pouring the deck slab after constructing the integral diaphragm by an appropriate creep factor.

(vii) Shear at the ends of the girders with corresponding positive and negative moments including checking anchorage of the longitudinal reinforcement at the face of the bearing must be rigorously assessed.

(viii) The minimum requirements for steel reinforcement in deck and link slabs for both girder and plank bridges must be as detailed in RMS Standard Bridge Drawings B217 and B320 respectively unless specified otherwise in the Scope of Works and Technical Criteria.

(ix) Simply supported Super-T girder bridges must be designed to comply with the maximum span lengths specified in Bridge Technical Direction BTD 2011/06.

(x) The minimum concrete compressive strength at 28 days for cast in place concrete deck slabs must be 40MPa. The concrete mix must be designed to achieve a maximum target strength not exceeding 48MPa notwithstanding the maximum target strength specified in RMS B80.

(xi) Precast concrete girders must be manufactured using a concrete mix having a maximum aggregate size of not less than14 mm.

(xii) Precast concrete or steel bridge girders must be supported on bridge bearings.

(xiii) Stepped or half joints must not be used in bridge girders either during the construction stage or in the completed bridge.

(xiv) Major steel members must be designed to enable all steel surface protective coatings to be maintained as follows:

a. Adequate space, a minimum 800mm wide and a minimum 1500mm high, must be provided around all painted girder surfaces to permit future inspection, maintenance and replacement of the surface coating.

b. Discrete ferrules or lugs must be designed and provided to the underside of the top flanges of the steel girders to support temporary scaffolding needed to carry out the maintenance and replacement of the surface coating.

2.16.2 Incrementally launched concrete bridges

(i) During launching the maximum tensile stress in the superstructure assuming uncracked section properties, for SLS load combination, taking account of all load effects including self weight, construction live load, differential deflection due to settlement, construction tolerances and differential temperature effects, the maximum tensile stress in the superstructure, assuming uncracked section properties, must not exceed $0.5\sqrt{f'_c}$ where f'_c is the minimum compressive 28 day strength of the concrete.

(ii) The loading and load factors during construction must be as per section 2.14.2 of PS 361 Launching pads must be placed at least 75 mm from the outside face of the web.

(iii) Concrete cover between the soffit of the webs and the post tensioning ducts must be no less than 150 mm.

(iv) The eccentricity of the reaction of the sliding pads from the intersection of the centrelines of the web and the bottom flange must be considered.

2.16.3 Balanced cantilever bridges

Construction stage loadings for balanced cantilever bridges must be assessed using "AASHTO LRFD Bridge Design Specifications" or "SETRA Design Guide: Prestresses Concrete Bridges Built by the Cantilever Method".

2.16.4 Cable stayed bridges

In addition to the requirements of AS 5100, cable stayed structures must satisfy the requirements of "*PTI Guide Specification: Recommendations for Stay Cable Design, Testing and Installation*".

2.16.5 Railway bridges

(i) Railway bridges including bridges over railways must be designed in consultation with the Railway Authority.

(ii) Where bridges over railways have wall abutments, permanent access must be provided from the road level above the bridge and down to the front of the wall abutments for future inspection, monitoring, repair or replacement of bridge components in accordance with clause 2.14.4(c).

2.16.6 Partially or fully submerged bridges

Bridges that are subject to submergence must be designed to comply with the requirements in AS 5100.2 and to the following additional requirements:

(i) Bridges that will be partially or fully submerged by flood events more frequent than or equivalent to the 1 in 50 year ARI flood event must not have superstructures consisting of hollow closed cell girders, such as Super-T girders, unless the voids within the closed cells are large enough to allow easy and safe access for inspection and maintenance.

Bridges subject to submergence must comply with the Appendix A of the "*RTA Bridge Waterway Manual - RTA*" for all levels of submergence.

~~2.16.7 Integral bridges~~

~~Integral bridges must be designed in accordance with Bridge Policy Circular BPC2007/05, except~~

~~(i) the length of bridge must be limited to 40m.~~

~~(ii) the membrane and sand layer under the slab, required by section 4 of Bridge Policy Circular BPC2007/05, must be replaced by 150mm thick lean-mix concrete to RMS R82.~~

~~2.16.8 Pedestrian bridges~~

~~(i) The design of minimum restraint capacity of the superstructure must be in accordance with BTD 2011/05.~~

~~(ii) The hand railing, safety screen and barrier railing mesh infills shall be of polished Grade 316 stainless steel.~~

~~(iii) The design of pedestrian bridges must also consider the Reference Document "Pedestrian Bridge Design Standards for Built-up Areas"~~

2.16.9 Soil and slope structures

In addition to the requirements of section 5.13 of the Scope of Works and Technical Criteria and other sections of this Appendix, the design of soil and slope structures, including soil nail walls and slopes, reinforced soil walls, gravity retaining walls, cantilever retaining walls, anchored walls, reinforced soil slopes, unreinforced soil slopes and embankments on poor ground (ground which consists of firm or weaker soil layers as defined in Table A4 of Australian Standard AS 1726 Geotechnical Site Investigations (**Poor Ground**)) must comply with the following requirements:

(i) Reinforced soil walls must be designed in accordance with RMS R57.

(ii) Embankments on Poor Ground (including piled embankments) must be designed in accordance with BS8006. In addition to the loads specified in BS8006, earthquake loading with an annual probability of exceedance of 1 in 500 must be included design and addressed in the Design Documentation. For earthquake load cases, the partial load factor for external live load may be reduced to 0.

(iii) For designs of foundations for piled embankments in accordance with BS8006, the enhancing effect of the sliding resistance of the foundation soils may be utilised in the design analysis for lateral sliding.

(iv) Unreinforced soil slopes must be designed with the following factors of safety (F.O.S.):

  a. long term F.O.S. 1.5 minimum; and

  b. short term F.O.S. 1.2 minimum.

(v) The design ground water level must be determined in accordance with section 2.15.9(f)(vii).

(vi) Soil and slope structures, except those referred to in sections 2.15.9(f)(i) to 2.15.9(f)(iv), must be designed and constructed in accordance with AS5100 except that:

  a. the geotechnical strength reduction factors for all load combinations for strength and stability design must comply with Table PS361.2 instead of Table 13.3.1(A) of AS5100.3.

  b. the strength reduction factors for ground anchors must not exceed the reciprocals of the minimum safety factors specified in Table 2 of BS8081, and S* may be taken as 1.0Se.

  c. the acceleration coefficient 'a' referred to in AS 5100.2 must be replaced by the Hazard Factor 'Z' as defined in AS 1170.4.

  d. wall frictional angles and adhesion must comply with section 5.11 of the "Guide to Retaining Wall Design, 1993, published by the Hong Kong Government".

  e. base shear resistance must comply with section 5.12 of the "Guide to Retaining Wall Design, 1993, published by the Hong Kong Government".

f. calculations of earth pressure must comply with section 6 of the "Guide to Retaining Wall Design, 1993, published by the Hong Kong Government".

g. the design ground water level must be one which has a return period of 1 in 10 years. The determination of the design ground water level must consider storm response as well as seasonal response. The design ground water level must be either of the following cases, whichever is more critical:

1. a 1 in 10 year return period storm rise added to a typical wet season ground water level; or
2. a typical storm rise added to a 1 in 10 year return period seasonal rise.

Table PS361.2 - Range of Values of Geotechnical Strength Reduction Factor (ϕ_g) for Soil and Slope Structures

Method of assessment of ultimate geotechnical strength	Range of values of ϕ_g			
	Bearing and passive capacity	Restoring moment contributed by gravity force and non-passive pressure	Shear strength in sliding and slip surface analyses.	Pullout strength of soil reinforcement (excluding ground anchors)
Analysis using geotechnical parameters based on appropriate advanced in-situ tests or laboratory tests	0.35-0.50	0.50	0.65	0.5
Analysis using CPT tests	0.30-0.45	0.45-0.50	0.55-0.60	Not applicable
Analysis using SPT tests	0.25-0.40	0.45-0.50	0.50-0.55	Not applicable

h. slip surface analyses must be carried out to identify the most critical slip surface for each design load combination specified in clause 22.3 of AS 5100.2 and:

1. the design geotechnical shear strength along the complete slip surface must be determined using the ultimate geotechnical shear strength multiplied by the relevant geotechnical strength reduction factor in Table PS361.2;
2. the design geotechnical pullout strength of soil reinforcements and ground anchors must be determined using the ultimate strength and the corresponding geotechnical strength reduction factor;
3. the design structural strength of geosynthetic reinforcements must be determined in accordance with BS8006 (2010): section 5.3.3, Annexure A and Annexure D ;
4. the design strength of soil reinforcements or ground anchors must be the lesser of the design geotechnical pullout strength and the design structural strength;

5. the combined design geotechnical shear strength along the slip surface and design strength of soil reinforcements/ground anchors must be capable of maintaining all the critical slip surfaces in a stable condition.

(vii) Simultaneous occurrence of more than 1 transient effect is not required to be considered in the slip surface analyses.

(viii) A minimum nominal vertical live load of 20 kPa for stability and 10 kPa for settlement must be allowed for in the design of soil and slope structures. Where soil and slope structures neither retain road embankments nor support structures and where there is no possibility of these being constructed in the future, the minimum nominal vertical live load allowed for in the stability design may be reduced to 10 kPa.

(ix) The design of soil and slope structures must address all drainage issues associated with the structures, including provisions for cleaning and maintenance of the drainage infrastructure. Drainage must be provided behind any facing panels provided on soil and slope structures.

(x) Soil and slope structures must be provided with suitable free draining backfill and / or drainage systems to ensure there is no build up of water pressure behind the structure. Full width geotextile must be provided behind facing panels provided on soil and slope structures where the base of the oil and slope structures is below the level of the design flood event.

(xi) Cement stabilised sand must not be used in reinforced soil walls.

(xii) RSW must not be used in sites subject to flooding and on locations having B2 or severe exposure classifications.

(xiii) Abutment piles must have minimum 500mm clearance from RSW panels to facilitate compaction.

(xiv) All earth retaining structures carrying water mains or similar utilities within their influence zones are to consider the effect of accidental rupture of such utilities

(xv) Where soil and slope structures abut hillsides or are located in areas where water may enter the structure from behind and where water pressure is neglected in the design:

a. a full height drainage layer must be provided at the back of the structure. Where the height of the structure is greater than 4 metres the drainage layer must comprise a suitable granular filter material with a synthetic filter and separation fabric complying with RMS R63. Where the height of the structure is 4 metres or less the drainage layer must comprise either:

1. a suitable granular filter material with a synthetic filter and separation fabric complying with RMS R63; or

2. a prefabricated cellular material wrapped with a synthetic filter and separation fabric complying with RMS R63.

3. granular filter material must be Grade F20 Type A aggregate filter material defined in RMS R3580; and

4. surface water must be collected and discharged by a separate surface water drainage system, which must discharge to the stormwater drainage system.

(xvi) Structures supported by soil and slope structures must be designed to accommodate all movements resulting from settlement and creep of the soil and slope structures.

(xvii) Assessment of foundation conditions must be detailed in design calculations and geotechnical models and must be presented in the Design Documentation.

(xviii) The design of soil and slope structures must consider and address, but not be limited to, the following geotechnical failure mechanisms, both internal and external to the structures:

a. Ultimate Limit States:
   1. bearing failure;
   2. sliding failure;
   3. rotational failure; and
   4. slip failure.

b. Serviceability Limit States:
   1. settlement and lateral movement;
   2. tilting and rotation;
   3. differential settlement.

(xix) The slope of batters in front of spill through bridge abutments must not be steeper than 1.0V:1.5H.

(xx) Type F concrete traffic barrier must not be used as a retaining structure.

(xxi) Where existing structures are affected, their stability and deformation must be assessed and documented, and where required strengthening measures are to be designed to be consistent with new works.

(xxii) All design assumptions are to be included in the drawings for appropriate verification during construction by suitably qualified personnel.

(xxiii) Unprotected gabion walls are not to be used within 4 m of the carriageway. The design must consider the need to restrict public access and prevent vandalism.

2.16.10 Precast arch structures

The design of precast arch structures must assess and address foundation stability, settlements, including scour, differential settlements, and foundation treatment requirements.

The design must also assess and address loads that will be induced during the construction of the precast arch structures, including varying staged backfill levels, and the effects of construction traffic. In addition account must be made of variation in the design density of fill material both minimum and maximum during construction and in the permanent state.

2.16.11 Sign structures

(i) Sign structures must comply with the requirements of test 3-60 of the US National Cooperative Highway Research Program – Report Number 350 (NCHRP350). If sign structures are not designed to collapse, protection must be provided in accordance with part 6 of "RMS Supplements".

(ii) Sign structures must comply with RMS R143.

(iii) Sign structures must be designed in accordance with Bridge Technical Direction BTD 2009/01.

2.16.12 Noise barrier design

Noise barriers and support systems must comply with RMS R271. Concrete work must be in accordance with the requirements of RMS B80. Steel components must comply with the requirements of RMS B241 and be hot dip galvanised in accordance with the requirements of RMS B220.

2.17 INVESTIGATIONS AND STUDIES

2.17.1 Hydrology and Hydraulics

Hydrologic and hydraulic studies must be conducted for each bridge site that includes:

(i) assessing the impact of afflux on adjacent land upstream and downstream of the bridge for the 100 year ARI flood event;

(ii) checking the stability of the adjacent road embankment for the 1 in 100 year ARI flood event;

(iii) assessing the impact of the ultimate limit state event (1 in 2000 year ARI flood event) on the bridges, major drainage structures and major retaining walls; and

(iv) assessing the effects of the road on regional flooding for the Probable Maximum Flood.

(v) Estimate the flood levels, water flow velocities, effects of scour at Abutments and depth of scour at Piers for a range of floods up to the 2000 year ARI event.

(vi) The range of floods investigated shall include the 100 year and 2000 year ARI floods, and the over-topping flood if this is lower than the 2000 year ARI flood. Also the flood level shall be determined for the 50 year ARI flood.

2.17.2 Geotechnical studies for structures

A geotechnical and foundation study must be undertaken for each new structure in the Project Works and the Temporary Works and for each existing structure that is affected by the Project Works or the Temporary Works.

This study must:

(i) be sufficient to identify and provide all the information required to design, construct and maintain each new structure and to preserve and protect existing structures;

(ii) encompass the structural adequacy, long term deformation and durability of the foundation, including the effects of the placement of fill in embankments near or adjacent to structures; and

(iii) predict the in-situ ground movement, structural movement and groundwater movement.

For each structure site and tunnel, a separate geotechnical investigation report must be provided as part of the Design Documentation in accordance with Chief Bridge Engineer Circular, CBE 2000/09. The geotechnical investigation report must be prepared by a recognised geotechnical and foundation expert and must contain recommendations of design parameters for the design of the bridge foundations. Instead of providing a separate geotechnical investigation report for each bridge site, the geotechnical investigation report for each bridge site may be included as part of the bridge design report. The cover sheet of the bridgework set of drawings in the Design Documentation must cross reference the geotechnical investigation report.

2.18 PROVISIONS FOR SPECIFIC BRIDGE ELEMENTS

2.18.1 Bored cast-in-place piles

Testing of bored cast-in-place concrete piles for integrity and geotechnical strength must comply with the requirements of Bridge Technical Direction BTD 2011/08.

2.18.2 Concrete infilled steel tubular piles

Concrete infilled steel tubular piles must be designed to comply with the following requirements:

(i) Longitudinal steel reinforcement must be evenly distributed around the perimeter of the concrete infill and must be provided for the full length of the concrete infill. The cross sectional area of the longitudinal reinforcement must not be less than one percent of the gross cross sectional area of the concrete infill.

(ii) The top section of the steel tubes must be ignored in the structural design of the piles. For piles in watercourses the top section extends from the top of the pile down to the lower of a level 3 metres below the MLWSL for tidal watercourses or 3 metres below the normal water level for non-tidal watercourses. For piles on land the top section extends from the top of the pile down to the lower of a level 3 metres below the top of the pile or 1 metre below the ground water level. The top section of the piles must be designed as reinforced concrete columns to the requirements of AS/RMS 5100.5

(iii) Full composite action between the concrete infills and the steel tubes must be assumed to commence at a distance not less than three times the pile diameter below the bottom of the top section of the steel tube as defined in section 2.18.2(b) above and within a distance of not less than three times the pile diameter from the bottom of the concrete infill.

(iv) Weld beads must be provided circumferentially within the inside face of the steel tubular piles for the full depth of the concrete infill zone. The weld beads must be not less than 3 mm thick and must be spaced not greater than 300 mm apart. The weld beads must not be taken into account when determining the design length of the concrete infill.The length of weld beams must be based on the minimum penetration depth of the driven pile.

(v) Driving shoes at the toe of steel tubular piles must not be less than 50 mm thick and not less than 1000 mm long. The driving shoes must be fabricated from the same grade of steel as the tubular piles and must have the same outside diameter as the tubular piles.

2.18.3 Reinforced concrete piles with column extensions or piers without pile caps

Reinforced concrete piles that support single circular column extensions must have diameters at least 200 mm greater than the diameters of the column extensions to account for construction tolerances when installing the piles. The outside faces of column extensions (circular or otherwise) must be located within the outside faces/perimeters of the supporting piles.

Except for single circular column extensions, where pier walls or columns are supported directly on piles without pile caps, the minimum edge distance of the piles to the edge of the pier walls or columns must not be less than 200 mm

The construction joints between the tops of the supporting piles and the bottom of the column extensions or the tops of the supporting piles and the bottom of pier walls or columns must be located:

(i) at least 1000 mm below the existing or finished ground levels, whichever is the lowest, for columns on land;

(ii) at least 200 mm below the normal water levels for non-tidal watercourses; and

(iii) at least 500 mm below the MLWSL for tidal watercourses.

2.18.4 Pile caps

Pile caps that are constructed on land must be designed and constructed with the top of the pile caps located a minimum of 0.5 m below the existing ground level or finished ground surface level whichever is the lowest.

2.18.5 ~~Design of bridge abutments affected by embankments~~

~~(i) Where the depth of soft soil over weathered bedrock exceeds 3 metres, raking pile configurations must not be used in abutments.~~

~~(ii) Displacement restraint and rotational restraint at abutment pile heads must be minimised to reduce the internal pile forces (bending moments, shear forces) induced by lateral soil movement. Downdrag (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.~~

~~(iii) The maximum lateral soil movement after the construction of bridge abutment piles must be no greater than that designed in advance of construction.~~

~~(iv) If embankments constructed adjacent to existing bridges cause soil settlement or lateral soil movement at existing bridge foundations including at abutments or piers, the design must assess the impacts of the settlement or lateral soil movement on the existing bridge and the PSC must address and mitigate these impacts.~~

2.18.6 Lateral restraint blocks

Where restraint blocks are provided on top of bridge piers and abutments to transfer lateral loads, such as earthquake loads, from the bridge superstructure to the bridge substructure, a 20 mm minimum thickness, high density, low friction, pad abrasion resistant plastic sliding (e.g. HPDE, nylon) pad, shall be securely fixed with mechanical fasteners to the face of lateral restraint block to prevent direct concrete to concrete or concrete to steel contact. To ensure that a constant gap is maintained between the lateral restraint blocks and the sides of the bridge girders, the lateral restraint blocks must be constructed after the adjoining bridge girders have been erected.

2.18.7 Stainless steel dowel bars

Stainless steel dowel bars must be provided where bridge approach slabs are connected to bridge abutments and in other situations where the dowel bars are acting structurally, including horizontal restraints between the bridge substructure and superstructure, and in contraction joints of culvert base slabs and retaining walls. Stainless steel dowel bars must be Grade 304 conforming to ASTM A276.

2.18.8 ~~Bearings~~

~~(i) Installation of elastomeric bearings~~

~~The installation of elastomeric bearings supporting concrete bridge girders must comply with the requirements of Bridge Policy Circular BPC 2007/02. Recesses to the underside of the girders to fix the top of the elastomeric bearings must not be used except for plank bridges.~~

~~(ii) Stainless Steel Sliding Surface of Elastomeric Bearings~~

~~Elastomeric bearings with sliding contact surfaces must be designed to comply with the following requirements:~~

~~a. the bottom of the bearing must be mechanically anchored and must not rely on friction for anchorage.~~

~~b. the sliding contact surface must be located between the top of the bearing and the underside of the girder.~~

~~c. the attachment plate on the top of the bearing must be designed with keeper plates to prevent movement of the top of the bearing relative to the attachment plate.~~

~~d. the sliding contact surface must be designed to comply with the requirements of clause 14 in AS 5100.4 and to any additional requirements specified in RMS B282.~~

~~e. elastomeric bearings must be designed for serviceability limit state conditions. All other components including mechanical anchors and attachment plates must be designed for ultimate limit state conditions.~~

~~f. a dust seal must be provided to prevent contamination of the contact sliding surface.~~

2.18.9 ~~Composite deck slab systems~~

~~Concrete deck slabs incorporating precast concrete panels as permanent formwork with an in-situ concrete overlay must comply with the following requirements:~~

~~(i) Where the reinforcement in the precast panels is to function as the transverse reinforcement in the deck slab, the reinforcement must anchor past the front face of the stiff support of the panel in accordance with clause 8.1.8.3 of AS/RMS 5100.5.~~

~~(ii) Where the precast concrete panels have not been designed to act structurally in the longitudinal direction, a bottom mat of longitudinal reinforcement must be provided, at a minimum clear distance of 25mm above the top of the precast panels with a minimum reinforcement area of 500mm2 per m width.~~

~~(iii) Where the precast concrete panels have been designed to act structurally in the longitudinal direction, a cast in situ stitch between the ends of the precast panels having a width of at least the length of the splice length of the reinforcement must be provided.~~

2.18.10 ~~Bridge approach slabs~~

~~Bridges must be provided with adequately designed and suitably proportioned approach slabs. Approach slabs must not be integral with the bridge decks and/or approach pavements (i.e. must not be seamless pavements). Bridge approach slabs must be a minimum 6.0 metres long and detailed to comply with Roads and Maritime Standard Bridge Drawings B049E, B049F, B049G and B049H as applicable. Traffic barriers that are adjacent to bridge approach slabs must be designed as an integral part of the abutment wingwalls and not as part of the approach slabs. In fill areas provision must be made to enable jacking of the bridge approach slabs after any settlement occurs. The methodology for re-levelling of bridge approach slabs after settlement occurs must be included in the Design Report.~~

Drainage pits must be located adjacent to both the approach slabs but not within the bridge approach slabs.

2.18.11 ~~Safety screens~~

~~Safety screens must be provided on bridges over the Main Carriageways and the bridges over the North Coast Railway Line. Safety screens must be in accordance with Bridge Technical Direction BTD 2012/01 and section 31 of the "*RMS Structural Drafting and Detailing Manual*".~~

All vertical joints or overlaps in the safety screen mesh panels must be located at safety screen posts.

2.18.12 Anti-graffiti coatings

Except for structures and walls that are not visible to users driving on the road network, using pedestrian walkways or community facilities, the surfaces of structures, tunnel linings, noise walls, walls and barriers must be treated with non-sacrificial anti graffiti coatings which:

(i) must match the adjacent surfaces and the colours and the application of which does not alter the appearance of the structure;

(ii) must be to a minimum height of 3 metres above surrounding reinstated ground levels or any accessible footholds; and

(iii) where part of an element of a structure or wall requires treatment based on the height criteria in subsection 2.18.12(b) above, it must be applied to the whole of the element of the structure or wall.

(iv) To protect surfaces prior to applying the permanent anti graffiti coating, a sacrificial coating may be applied, provided that it in no way interferes with the adhesion of the permanent coating.

2.18.13 Design findings of main structural elements

For each bridge design, a table summarising the design findings of the main structural elements of a bridge must be included in the Design Documentation. The design findings for each of the main structural elements must identify the critical design effects (including shear, torsion, bending moment and axial load) and their locations together with the associated governing load case. The design findings must also include a

comparison of the critical design effects with the structural capacity for each of the main structural elements as well as any comments that may be relevant.

2.19 APPLICATION OF RMS CONSTRUCTION SPECIFICATIONS

The design and notes on the drawings should be compatible and consistent with the terminology and requirements of RMS construction specifications.

2.20 APPLICATION OF THE ROADS AND MARITIME STRUCTURAL DRAFTING AND DETAILING MANUAL

Structural drawings must comply with the "*RMS Structural Drafting and Detailing Manual*". Reference numbers prefixed with SDDM in this section 2.20 refer to section numbers in the "*RMS Structural Drafting and Detailing Manual*". For example: SDDM 4.2 refers to section 4.2 in the "*RMS Structural Drafting and Detailing Manual*".

(i) SDDM 1.0

All structural drawings for the Project Works must conform to the drafting practices described in the Structural Drafting and Detailing Manual.

(ii) SDDM 3.6

Each set of structural drawings must have a "Drawing Set Number".

Except for gravity or reinforced soil walls, each set of drawings for retaining walls with a structural height of 2.0 m or more at any location must be detailed in accordance with RMS Structural Drafting and Detailing manual.

The Drawing Set Numbers will be provided by the RMS Representative.

(iii) SDDM 12.0

Notes including general notes, concrete notes, steel reinforcement notes, structural steelwork notes and prestressing notes must be provided on each of the individual drawings to which they pertain. A single standard notes sheet must not be used to provide these notes.

(iv) SDDM 20.0

In accordance with clause 1.2 of AS 5100.2, the cover sheet of the set of drawings for each bridge must state all the loads for which the bridge has been designed. In addition to the design loads, the cover sheet must state the BEDC and the acceleration coefficient, the site factor and the bridge classification. In accordance with Chief Bridge Engineer Circular CBE 2000/09, the cover sheet must cross reference the geotechnical investigation reports and other relevant reports on which the bridge design is based.

(v) SDDM 23.0

Bar shapes labelling for reinforcement must be provided in the drawings.

2.21 MINOR STRUCTURES

Any minor structure not covered by this specification is to be designed in accordance with the appropriate Australian Standard (see Clause 2.2 PS301).

2.22 NON STANDARD FOUNDATIONS

The PSC must include in their tender submission price for the design of up to 5 different types of non-standard RMS sign post foundation designs, 5 different types of non-standard RMS traffic signal post/mast arm foundation designs and 5 different types of non-standard City of Ryde multi-function pole foundation designs. Examples of different types of non-standard foundations are:

- ***Single pile with cantilevered pile cap. Different pile size or length of cantilever is not considered a different foundation type***
- ***Two piles with pile cap. Different pile size or pile cap size is not considered a different foundation type***
- ***3 piles with pile cap. Different pile size or pile cap size is not considered a different foundation type***
- ***Piles with steel plate pile caps. Different pile size or steel plate pile cap size is not considered a different foundation type.***

ANNEXURE PS361/A – PROJECT SPECIFIC REQUIREMENTS

A1 PROJECT DETAILS

Table PS361.A1 – Project Details

Project Name	***Macquarie Park Bus Priority and Capacity Improvement Project - Stage 2***
Project Number	***P.0023019***
Location	***Epping Road, Herring Road, Waterloo Road and Lane Cove Road, Macquarie Park***
Local Council	***Ryde Council***
Length (size) of the project	***MR 373 Epping Road to MR 162 Lane Cove Road via Herring Road (7486) and Waterloo Road at Macquarie Park and MR 162 Lane Cove Road from Waterloo Road to Epping Road.*** ***Project length approximately 2.8km.***
Project features	• ***Upgrade of the state and local road network in the Macquarie Park precinct to improve travel times and reliability for buses and for other road users*** • ***3 new signalised intersections and upgrades to the existing signalised intersections*** • ***Installation of bus lanes and road widening with improved pedestrian and cyclist crossing facilities at signalised intersections*** • ***Partial (strip) property acquisitions along Herring Rd, Waterloo Road, Byfield St, Khartoum Rd and Lane Cove Rd to enable the road widening and intersection upgrade works*** • ***Service relocations to allow kerb relocation and lane widening***

A2 PROPOSED WORKS

Refer PS301: Professional Services for Detailed Design Scope and Requirements, Annexure PS301/A for project details, background and project specific requirements.

A3 DETAILED DESIGN DRAWING AND MODEL REQUIREMENTS

Table PS361.A3 – Detailed Design Requirements

Element	Depicted on the drawings Y/N	Included in the Model Y/N	Element	Depicted on the drawings Y/N	Included in the Model Y/N
Urban Design					
Retaining walls	**Y**	**Y**			
Signage, traffic signal post and mast arm foundations (both standard and non-standard)	**Y**	**Y**			
City of Ryde multi-function foundations (both standard and non-standard)	**Y**	**Y**			
Other structures required in the design of the work	**Y**	**Y**			

ANNEXURE PS361/B – PAYMENT

Payment will be made for all costs associated with completing the work detailed in this Specification in accordance with the Pay Item(s) in **PS301.**

Where no specific pay items are provided for a particular item of work, the costs associated with that item of work are deemed to be included in the rates and prices generally for the works.

ANNEXURE PS361/C – SCHEDULES OF HOLD POINTS, WITNESS POINTS, DELIVERABLES, MEETINGS AND WORKSHOPS

C1 SCHEDULE OF HOLD POINTS AND WITNESS POINTS

The PSC must give the RMS Representative at least five working days written notice prior to reaching any hold point for which a release by the RMS Representative is required. Only items with a **Y** are required for this project.

Table PS361.C1 – Hold Point Requirements

Clause	Type	Description	Required
2.8	Hold	Further design associated with existing structures	Y
2.10	Hold	~~20~~ 50% Detailed Design	Y
2.13	Hold	80% detailed design	Y
2.13	Hold	100% detailed design	Y

C2 SCHEDULE OF DELIVERABLES AND SUBMISSION DETAILS

The PSC must give the RMS Representative at least ten working days to review all deliverables identified in the table below. Only items with a **Y** are required for this project.

Table PS361.C2 – Deliverables and Submission Details

Section	Description of Deliverables	Delivery timeframe	Required Y/N
2.5	Review and assessment of Structures Concept Option Report, ***updated as required***, prepared by others during concept phase	Prior to commencing ~~20~~ ***50***% Detailed Design	***Y***
2.8	Review and assessment of the report on existing bridges/drainage/other structures (if applicable) ***updated as required***, prepared by others during the concept phase of the project	Prior to commencing ~~20~~ ***50***% Detailed Design	***Y***
~~2.9~~	~~Prepare a bridge demolition report (or review and assessment of the Bridge (other structure) demolition report including demolition method statement(s) (if applicable), prepared by others during the concept phase of the project)~~	~~Prior to commencing 20% Detailed Design~~	***N***
2.10	Review and assessment of ~~the Bridge and~~ Structures Design proposal	Prior to commencing ~~20~~ ***50***% Detailed Design	***Y***

	including proposal sketches ~~and completed form 62's~~, prepared by others during the concept phase of the project		
2.13	Detailed design drawings submitted for RMS review	At ~~20~~ ***50***%, 80%, 100% and IFC	***Y***
	~~Bridge construction staging drawings~~	~~At 80%, 100% and IFC~~	***N***
2.19	List of relevant RMS QA specifications and completed Annexure for the relevant construction specifications	At 100% submission and onwards	***Y***
~~Annex PS361/D~~	~~Work as executed drawings and construction compliance certificate.~~	~~On completion of construction~~	***N***

C3 SCHEDULE OF MEETINGS REQUIRED

Refer to PS301/A and PS301/C for meeting and workshop requirements and details.

Table PS361.C3 – Meeting Requirements

Clause	Description of Meetings	Required	Location	Expected Duration
	Refer PS301/A and PS301/C			

C4 SCHEDULE OF WORKSHOPS REQUIRED

Refer to PS301/A and PS301/C for meeting and workshop requirements and details.

Table PS361.C4 – Workshop Requirements

Clause	Description of Workshops	Required	Location	Expected Duration
	Refer PS301/A and PS301/C			

ANNEXURE PS361/D – TECHNICAL APPROVAL OF THE DESIGN OF BRIDGES AND STRUCTURES

Note: This annexure relates to clause 2.4.

The technical approval procedure entails a review of the detailed designs by RMS, checking by the proof checker and certification by the designer, and the proof checker for new work and the assessment and rehabilitation of existing structures.

The procedural requirements impose a discipline on the process that encourages good practice and should reduce the possibility of errors affecting structural fitness for purpose. Most importantly however, the procedures are in place to minimise the possible risks to road users and others who may be affected.

The technical approval procedures differ from the quality assurance process, which formalises and records good management practice. Quality assurance will supplement the technical approval, but it will in no way be a substitute for the comprehensive technical requirements in these technical approval procedures.

The technical approval procedures will help RMS to automatically identify those features that are not adequately covered by existing codes and standards. It provides valuable feedback and will initiate a course of action for improvement of existing codes and standards.

Scope

This procedure must without limitation apply to road, pedestrian and shared path bridges and other structures with a span length greater than 6.0 m and retaining walls with an effective retained height greater than 1.2 m.

The detailed design must be placed in one of two Classes: C or S. The following criteria must be considered when determining the class of structures.

Class C – are Complex structures, which require sophisticated analysis or structures which have any of the following features:

(i) Any span exceeding 37 m.

(ii) Retaining walls with an effective retained height greater than 6 m.

(iii) Cable stayed or suspension bridges.

(iv) Steel orthotropic decks.

(v) Bascule span bridges.

(vi) Post-tensioned concrete structures.

(vii) Skew exceeding 35°.

(viii) Bridges with a superstructure consisting of precast prestressed concrete girders and cast -insitu deck slab, where the girders are made continuous for live load or the superstructure is made fully integral with the substructure.

(ix) Other structures deemed by RMS to be complex.

Class S – are structures not within the parameters of Class C.

The assessment of load carrying capacity of existing structures and related construction work such as demolition, repair, renewal, rehabilitation and strengthening work must generally be categorised on the same basis as the original structure would have warranted.

Objectives

The fundamental objectives of this procedure are to ensure as far as reasonably practicable that structures are safe and serviceable in use, economic to build and maintain, sustainable and with minimal impact on the environment, and which satisfactorily perform their intended functions. The procedures also ensure as far as reasonably practicable that the user and any others who may be affected, are protected from any adverse effects resulting from any work carried out to any structures, and there is adequate provision for safety under all circumstances.

Definitions

The following definitions must apply throughout this document:

(i) Form 62: The document, which records the agreed basis and criteria for the detailed design or assessment of a highway/main carriageway structure. RMS staff can access the form in a PDF or DOC format from the Bridge Engineering Quality Management System (BEQMS) on the RMS Intranet. Direct links to both versions of the form are as follows:

a. http://home.rta.nsw.gov.au/policiesanddocuments/documentsites/ops/technical_services_bridge_procedures/docs/otb-tp-202-f62.doc

b. http://home.rta.nsw.gov.au/policiesanddocuments/documentsites/ops/technical_services_bridge_procedures/docs/otb-tp-202-f62.pdf

(ii) Proof checker: The organisation responsible for the independent check of the design or assessment of the existing structures.

(iii) Proof checking team: The group of engineers responsible for the proof check of the design or assessment. It may comprise an appropriate mix of specialists under the direction of a team leader.

(iv) Departure: Criterion, which departs from, or is an aspect not covered by, the standards contained in the brief.

(v) Designer: The organisation responsible for design of new structures or assessment of existing structures.

(vi) Design team: The group of engineers responsible for the design of new structures or assessment of existing structures. It may comprise an appropriate mix of specialists under the direction of a team leader.

(vii) Technical approval: The submission of proposals for agreement by RMS and the subsequent provision of certificates (refer to Annexure PS361/E) confirming that the design, assessment, specification or construction work complies with the agreed Form 62 and design/assessment and specification certificate as appropriate.

Contractual responsibilities and procedures

Technical Approval does not in any way modify the contractual and statutory responsibilities of any party for the work carried out by them or their agents/representatives.

This procedure has been written such that it is applicable in principle to all current and likely future forms of procurement. The procedures, format and terms used in this document, including the certificates (refer to Annexure PS361/E) and Form 62 are intended to be contract-neutral and should be taken as models. These must be amended and agreed with RMS, to suit specific contract requirements.

RMS requirements

Technical requirements for the design, construction, maintenance and operation of bridges and structures must be contained in a bridge design proposal (including Form 62). RMS should be consulted at the earliest

appropriate opportunity in order to avoid the risk of abortive work and to allow timely consideration to be given to the concept and detailed design.

Proposals

Provide sufficient information and evidence to demonstrate compliance with RMS requirements as specified in the brief and to justify their viability. Potential risks and hazards during whole life of structures such as construction, maintenance and demolition, must be identified, assessed and considered. Where available, references, special investigation and studies that have been carried out must be included.

Provide evidence that appropriate consultation has taken place with all relevant authorities having a direct interest in the design of the structure, and that full and proper consideration has been given to their respective interests. Risks and hazards which may affect the structure as a result of other parties' requirements (e.g. leakage of gas or water main) must be identified, assessed and considered. Documentation and the special requirements of those consulted must be included in the Form 62.

Describe the information that is available concerning existing records and assumptions made regarding the interpretation of available data that will be relevant to the design/ assessment.

All relevant documents that are being proposed for use in the design must be included in the design/assessment report.

Where specified, consider and make provisions for future widening and describe how the structure may be upgraded. In the case of road tunnels, it may be necessary to make provision for future development above or adjacent to the tunnel.

State any assumptions that are significant factors in the design that have been made with regard to construction processes or temporary works aspects. If construction processes or temporary works during the course of construction have structural implications different from those assumed by the designer, a further technical approval must be completed before the commencement of construction of that part of the works.

The proposal for design must consider aspects relating to:

(i) Sustainability (sustainable development that meets the need of the present without compromising the ability of future generations to meet their own needs e.g. prudent use of natural resources).

(ii) Environment (to minimise the impact of the structure on both the natural and built environments).

(iii) Aesthetics.

(iv) Buildability (the extent to which the design facilitates ease of construction, allowing the most efficient and economic use of resources, subject to the overall requirements for the completed project).

(v) Structure robustness (the ability of a structure not to be damaged disproportionately in the event of accident, misuse or deterioration).

(vi) Durability.

(vii) Maintenance and operational commitments in terms of whole of life costs in the choice of design option materials.

(viii) Provision of access for periodic inspections.

Departure from specified standards

Designers/assessors may seek to introduce cost savings, innovative techniques, research findings or developments in the state of the art by the adoption of 'departures'.

In cases where mixing standards with different design principles such as limit states and working stress are used, they may need to be considered as 'departures' unless it can be demonstrated that there is consistency and compatibility between the different design principles.

All applications for 'departures' must be subject to the approval procedures of RMS and details of the proposed 'departures' together with reasons and justification, including benefits to RMS, must be submitted to RMS prior to inclusion in the Form 62 or an addendum to the Form 62.

In some cases, the proof checker's comments on the proposed departures may be required to assist RMS's deliberation.

Submission of design/assessment proposal (including Form 62)

Generally, the submission must comprise a completed Form 62, location plan, general arrangement drawings, a report detailing the design criteria, relevant parts of the geotechnical report, documents relating to consultation, design reference documents and any other relevant information. Calculations and detailed drawings are not required as part of the submissions.

The report detailing the design criteria must include without limitation the following:

(i) Method of analysis proposed for superstructure, substructure and foundations.

(ii) Description and diagram of idealised structure to be used for analysis.

(iii) Assumptions intended for calculation of structural element stiffness.

(iv) Proposed earth pressure coefficients to be used in the design/assessment of earth retaining elements.

(v) Proposed 'departures' from standards.

(vi) Proposed method of dealing with aspects not covered by standards.

(vii) Acceptance of recommendations of the geotechnical report to be used in the design and reasons for any proposed changes.

(viii) If the geotechnical report is not yet available, state when the results are expected and list the sources of information to justify the preliminary choice of foundations.

(ix) Proposed arrangements for maintenance and inspection (traffic management, access, etc.).

(x) Proposed arrangements for construction (traffic management, utilities and service diversions, interface with existing structures, etc.).

(xi) Authorities consulted and any special conditions required.

(xii) Name of proposed independent proof checker.

The Form 62 must record all the agreed criteria on which the design or assessment is to be based. Changes to an agreed Form 62 to account for subsequent variations during design, assessment or construction must render the Form 62 subject to re-approval and agreement by RMS. This must be confirmed either in the form of an amended version of the agreed Form 62 or as a separate addendum to the agreed Form 62. Submissions clearly indicating deletions or additions that have been made to the agreed Form 62 must be signed by the designer, concurred by the proof checker and forwarded with supporting information to RMS. Addenda must refer to the original Form 62 by the date of agreement by RMS.

Technical approval

When satisfied with the concept and detailed designs, RMS must confirm its agreement by signing off the Form 62.

The agreement of the Form 62 or acceptance of the certificates by RMS does not relieve the designer or the proof checker of the responsibility for the validity and arithmetical correctness of the calculations nor their translations into design details and drawings or specification clauses.

Design and assessment procedure

The design/assessment must comply with the Form 62. The Designer/Assessor must be responsible for the applicability and accuracy of all computer programs used and must ensure the validity of the program for each application.

Proof checking procedure (verifier)

Assessment, designs and drawings of Class C structures must be checked by a proof checking team (verifier) from a separate organisation proposed by the designer/assessor and agreed by RMS.

Assessment, design and drawings of Class S structures must be checked by a proof checking team (verifier) that may be from the same organisation but must be independent of the design/assessment team proposed by the designer/assessor and agreed by RMS.

The proof checker must carry out a comprehensive examination of all aspects of the concept and detailed design and any proposed departure where required by RMS, including specification clauses that affect structural integrity (e.g. new materials), and must ensure that it complies with RMS requirements. The checker (verifier) must ensure that the calculations are translated accurately into the design details and drawings, specification clauses or assessed capacities.

The proof checker must be responsible for checking, with due professional skill and care, in accordance with the agreed Form 62. In the course of checking the proof checker must draw the attention of the designer or assessor and RMS to any aspect of the agreed Form 62 where changes are considered necessary.

The proof checker's analytical works must be independent of that of the designer or assessor and carried out without exchange of calculation sheets or similar information between the designer and the proof checker

The proof checker must be responsible for the applicability and accuracy of all computer programs used in the check and must ensure the validity of the program for each application.

The method of analysis employed by the respective teams need not be the same but the designer or assessor and the proof checker should consult with each other during the course of their work to ensure that the results they are obtaining are comparable.

The start of the check need not await the completion of the design. Both activities may proceed in parallel as far as is practicable.

Certification - Refer to Annexure PS361/E

The certificates must be signed to declare the satisfactory completion of the work involved and that the organisations concerned have exercised due professional skill and care.

The design, assessment and proof check (verification) certificates must refer to the relevant Form 62 and any addenda by their respective dates of agreement by RMS, and any 'departures'.

Where additional and substitute specification clauses have been prepared, they should be submitted for acceptance by RMS. They may be submitted either individually or collectively on a specification certificate. Where clauses affect structural integrity (e.g. new materials), they must be checked in accordance with the Form 62.

The construction compliance certificate must refer to the relevant Form 62. Design, proof check certificates (verification), specification and work as executed drawings must be submitted to RMS for acceptance.

If the completed certificate consists of more than one page, each page should be identifiable by the name of the project and by the name and reference number of the structure and the date of preparation.

Suggested format of reports

This procedure proposes that various documents are prepared during the various stages. These various documents should ultimately be compiled to form the final report.

Standardisation of the format of the documents is desirable to improve efficiency and to ensure good quality data for the next stage. Annexures A and B are standard content lists for the reports. The final contents should be agreed with the RMS Representative for each project.

D1 SUGGESTED CONTENTS FOR STRUCTURES CONCEPT OPTION REPORT

The Structures Concept Option Reports are documents prepared prior to detailed design commencing. They are particularly useful for all parties in helping to understand the constraints identified in the preparation of the preliminary design. A suggested format for the Structures Concept Options report follows. The particular project requirements must be agreed with the RMS Representative.

Introduction

Briefly describe the project and structure.

Constraints and requirements

In this section all considerations that influence the options should be discussed under the following suggested headings:

Span arrangement and cross section

Identify proposed span arrangements and cross sections. Designers should consider whether departures from the standard relating to cross section are appropriate for the type and level of use of the proposed structure. This need should be balanced against safety, accessibility and maintenance issues.

Describe the superstructure, substructure and foundation. Provide details of the method of analysis proposed for the superstructure, substructure and foundations. Provide a description and diagram of the idealised structure used in the analysis. Provide details of the assumptions intended for structural element stiffness.

Description of existing structure

Briefly describe the existing structural form and its current condition. The description should identify whether the structure is to be modified, strengthened, upgraded or demolished.

Geotechnical

The relevant geotechnical investigation, and where relevant the foundation design information for each structure site should be summarised in the body of the report and the details included as an appendix to the structure design report for information.

Refer to section 2.6 of this specification – Geotechnical Investigation and Design Support

Hydrology and hydraulics

Describe the hydraulic conditions which may occur and quantify their associated effects upon the structure which need to be adequately resisted. (Refer to PS371)

Durability

Describe the durability requirements. Identify aspects of structural form and detail which require special attention. Identify aspects of inspection, maintenance, specification the of materials to be used in construction and the quality of construction practices relating to durability.

Construction issues

Describe any buildability constraints, including interfaces with the existing highway/main carriageway or other transport infrastructure, utility diversions etc. Consider undertakings with regard to traffic management and congestion. Identify effects for infrastructure users and the likely mitigation measures.

Maintenance

Describe the methods and facilities for maintenance and inspection of the structure.

Utilities and drainage

Describe the current and proposed utilities and drainage requirements.

(Refer also to PS321)

Work Health and Safety

Describe any WHS issues relating to the structure.

(Refer also to PS301)

'Departures' from standard

Record any known 'departures' from the standard that apply to the structure or those which may be required for the proposed use. Comment on the status of 'departures'.

Provide the proposed method for dealing with aspects not covered by standards.

Others

Authorities consulted. Record any constraints related to third parties (railway authorities etc.). RMS should be consulted to agree if there are any other project specific constraints e.g. environmental (fisheries, flora, fauna, noise, water quality etc.), traffic, public consultations, heritage, archaeological etc.

(Refer also to PS311 or PS312 as applicable)

Urban design

Describe the urban design form of the structure and the setting. (Refer to PS381)

Options comparisons

In a tabular form, compare options using the headings under "constraints and requirements" above (i.e. span arrangement and cross-section, description of existing structure etc.). The additional headings below should also be included to assist in evaluating the options.

Capital and whole life costing of options

Costing should take full account of the overall scheme considerations.

Adaptability for future developments

Describe the opportunities or limitations on future upgrades that each option presents.

Upgrading or strengthening to be made to the existing elements

Identify any problems in the existing structure which are to be rectified. These may in themselves form separate options.

Drawings

General Arrangement and drawings showing options.

Cross reference to an appendix where A3 drawings of the options are contained.

Preferred Option

A brief conclusion identifying the preferred option.

D2 SUGGESTED CONTENTS FOR THE DESIGN REPORT

The Design Report is a compilation of the Structures Concept Option report and the following:

Design findings

In a tabular form, include a summary of design findings i.e. the design effects, capacity, governing load case and any comments for all elements. Also include the proof checker's findings separately to ensure that the results are comparable.

Element	Design Action S*		Capacity ϕRu	Live load Effects	PE+ Transient Effects	Governing Load Case	Load Rating RF (AS 5100.7)
Abutment Footing	Axial Force (kN)/BM (kNm)						
	BM (kNm)/ Min Axial Load (kN)						
	Shear (kN)						

Proof checker's findings

In a tabular form, include the proof checkers findings to ensure that the results are comparable

Element	Design Action S*		Capacity ϕRu	Live load Effects	PE+ Transient Effects	Governing Load Case	Load Rating RF (AS 5100.7)
Abutment Footing	Axial Force (kN)/BM (kNm)						
	BM (kNm)/ Min Axial Load (kN)						
	Shear (kN)						

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ANNEXURE PS361/E – CERTIFICATES

Note: relates to Annexure PS361/C2.

Annexure PS361/E contains the following certificates:

(i) Design Certificate.

(ii) Additional and Substitute Specification Clause Certificate.

(iii) Construction Compliance Certificate.

E1 DESIGN CERTIFICATE

Name of Project	
Name of Structure	
Bridge Number	
Registration No of Plans	
Date:	

(1) We certify that reasonable professional skill and care has been used in the preparations of the design/assessment /proof check of (Name of Structure) with a view to securing that:

(a) It has been designed/assessed/proof checked (See Note 1) in accordance with:

(i) The Form 62 dated (date).

(b) It has been checked for compliance with the relevant standards in I.

(c) It has been accurately translated into construction drawings. The unique numbers of these drawings are:

Sheet No	Issue	Title

Signed: _____

Name: _____

Design/Assessment/Proof Checking Team Leader (see note 2)

Signed: _____

Name: _____

Position Held (see note 3) _____

Name of Organisation _____

Date: _____

(2) The departures from standards and additional criteria given in paragraph I are agreed.

(3) The certificate is recommended for acceptance.

Signed: _____

Name: _____

Senior Bridge Engineer _____

Date: _____

(4) The certificate is accepted by RMS

Signed: _____

Name: _____

Principal Bridge Engineer _____

Date: _____

Notes

(1) Delete if not required

(2) Practising Bridge Engineer

(3) A principal of the organisation responsible for the design/proof checking

(4) Describe the point at issue and the directed course of action

E2 ADDITIONAL AND SUBSTITUTE SPECIFICATION CLAUSE CERTIFICATE

Name of Project	
Name of Structure	
Bridge Number	
Registration No of Plans	
Date:	

(1) We certify that reasonable professional skill and care has been used in the preparation/proof check (see note 1) of the following additional and substitute specification clauses:

List clause numbers (see note 2) for the bridgework series of RMS Specifications.

The text of these clauses is appended to this certificate.

Signed: _____

Name: _____

Position Held **Design/Proof Check Team Leader (see note 3)**

Signed: _____

Name: _____

Position Held (see note 4) _____

Name of Organisation _____

Date: _____

(2) The additional and substitute specification clauses listed in the paragraph above and appended to this certificate are agreed.

(3) The certificate is recommended for acceptance.

Signed: _____

Name: _____

Position Held **Senior Bridge Engineer/ Bridge Engineer**

Date: _____

(4) The certificate is accepted by RMS.

Signed: _____

Name:	
Position Held	Principal Bridge Engineer
Date:	

Notes

(1) Delete as appropriate

(2) Only clauses that affect the structural integrity e.g. new materials are required to be checked. The category of check should be the same as in the Form62

(3) Practising Bridge Engineer

(4) A principal of the organisation responsible for the design/proof checking

E3 CONSTRUCTION COMPLIANCE CERTIFICATE

Name of Project	
Name of Structure	
Bridge Number	
Registration No of Plans	
Date:	

(1) We certify that (Name of Structure)

a) Has been constructed, commissioned, and tested (See Note 1) in accordance with:

- The Form 62 dated (date)
- The Design/Proof Check Certificates dated (date)
- The RMS specification (edition, date)

b) The construction of the works has been accurately translated into Work as Executed drawings. The unique numbers of these drawings are:

Sheet No	Issue	Title

Signed: _____

Name: _____

Position Held **Contractor's Representative (see note 2)**

Signed: _____

Name: _____

Position Held (see note 3) _____

Name of Organisation _____

Date: _____

(2) The certificate is recommended for acceptance

Signed: _____

Name: _____

Position Held **Senior Bridge Engineer/** Bridge Engineer

Date:	

(3) The certificate is accepted by RMS

Signed:	
Name:	
Position Held	**Principal Bridge Engineer**
Date:	

Notes

(1) Delete if not required
(2) Practising Bridge Engineer
(3) A principal of the organisation responsible for the design/proof checking
(4) Describe the point at issue and the directed course of action

ANNEXURE PS361/F TO PS361/L – NOT USED

ANNEXURE PS361/M – REFERENCE DOCUMENTS & SUPPORTING INFORMATION

M1 DESIGN REFERENCE DOCUMENTS

Refer to clause 1.4.2

RMS Technical Directions and Quality Alerts

RMS Design Guides

RMS Standard Drawings

RMS Specifications

Austroads Guides

Australian Standards

Urban Design

Software Programs

All City of Ryde Specifications and Standards including:

- ***City of Ryde Stormwater and Floodplain Management, City of Ryde***
- ***Council Stormwater and Floodplain Management Technical Manual***
- ***City of Ryde Standard drawings and specifications***
- ***City of Ryde, Macquarie Park Corridor, Public Domain Technical Manual***
- ***City of Ryde Development Control Plan 2014 Part 8.3 Driveways***
- ***City of Ryde Development Control Plan 2014 Part 8.5 Civil Works***

M2 REFERENCE DOCUMENTS

Refer to clause 1.4.2

M3 SUPPORTING INFORMATION

Refer to clause 1.4.2