Manual

Drafting and Design Presentation Standards

Volume 3 – Structural Drafting Standards

Queensland Government

Drafting and Design Presentation Standards
Volume 3: Structural Drafting Standards

Chapter 1: Introduction

November 2015

Queensland Government

Feedback: Please send your feedback regarding this document to: tmr.techdocs@tmr.qld.gov.au

Chapter 1 Amendments

Revision register

Issue/Rev No.	Reference section	Description of revision	Authorised by	Date
1	-	First issue	Manager (Structural Drafting)	Apr 2011
2	-	Document name change	Manager (Structural Drafting)	Nov 2011
	1.5	Add section Departures from Austroads Guide to Bridge Technology, Part 5: Structural Drafting		
3	1.2	Glossary of terms revised	Team Leader (Structural Drafting)	Sep 2015
	1.4	Combined with previous version 1.5 to eliminate repeated information	Team Leader (Structural Drafting)	Sep 2015
	All	Minor rewording	Team Leader (Structural Drafting)	Sep 2015
	Appendix A	Update image to current BDIR form	Team Leader (Structural Drafting)	Sep 2015

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1 Introduction

1.1 Figures and examples shown in this volume

The figures and examples shown in this volume are for presentation purposes only, and may contain some details that are now superseded. These details have been included for ease of reference, to illustrate typical solutions, and to show the required standard of drafting presentation. The details are not to be used without an engineering check and certification by a Structural RPEQ to confirm that the details are appropriate for the specific project.

1.2 Glossary of terms

Glossary of Terms	
Alignment	The geometric form of the centreline (or other reference line) of a carriageway in both the horizontal and vertical directions
Bridge Control	The line of reference used throughout bridge drawings. It may be the same line as the Road Control
Continuous Deck	Where a concrete bridge deck continues over a pier without an expansion or fixed joint
Crest Curve	A convex vertical curve in the longitudinal profile of a road
Crossfall	The slope of the running surface, measured at right angles to the alignment
Crown	The highest point on the cross section of a carriageway with two-way crossfall
Dead Load	Static Load created by the mass of the static components on a structure, like self weight
DWS	Deck Wearing Surface
Expansion Joint	Where the superstructure of a bridge is attached to a headstock with a joint that is designed to slide longitudinally as the bridge expands and contracts
Fixed Joint	Where the superstructure of a bridge is attached to a headstock with a connection that is not designed to move i.e. it is fixed
HC	A horizontal curve in the plan or horizontal alignment of a carriageway
Height (Ht)	TMR uses this term in place of Reduced Level (RL). Vertical or Z value of any point
HLP	Heavy Load Platform
Hog	Magnitude of upward deflection in prestressed deck units and girders due to the action of prestressing forces. Refer Chapter 15 - Prestressed Concrete Deck Units
Kerb	A kerb with a profile and height sufficient to prevent or deflect vehicles from moving off the carriageway
LHS	Left hand side
Live Load	Dynamic Load created by the mass of the moving components on a structure, like vehicular traffic
TMR	Department of Transport and Main Roads
No Off	Quantity of items to be fabricated / cast / manufactured. (in place of No Required or No)
Pavement	That portion of a road designed for the support of, and to form the running surface for, vehicular traffic
PSC	Prestressed Concrete

Glossary of Terms	
RC	Reinforced Concrete
RHS	Right hand side
RPEQ	Registered Professional Engineer of Queensland
Road Control	The line of reference used throughout road drawings
Sag Curve	A concave vertical curve in the longitudinal profile of a road
SM1600	Combination of S1600, stationary traffic load, and M1600, moving traffic load AS 5100.2 - Bridge Design
Superelevation	The slope of the running surface, measured at right angles to the alignment, usually on a horizontally curved pavement
VC	A vertical curve (generally parabolic) in the longitudinal profile of a carriageway to provide for a change of grade
Vertical Alignment	The longitudinal profile along the centreline of a road
WH&S	Workplace Health and Safety
WMS	Works Management System

1.3 References

This manual has been written to conform to (unless noted otherwise), and should be read in conjunction with, the following publications:

- *TMR Bridge Design Criteria for Bridges and other Structures*
- *TMR Departmental Standard Drawings*
- *TMR Departmental Specifications*
- *TMR Transport Infrastructure Contract*
- *TMR Road Planning and Design Manual*
- *TMR Drafting and Design Presentation Standards Manual*
- *Standard for Transport and Main Roads Engineering Surveys*
- *Australian Standard AS 5100 - Bridge Design*
- *Australian Standard AS/NZS 1100 - Technical Drawing Parts 101, 401 and 501*.

1.4 Departures from AS/NZS 1100 – Technical Drawing and Austroads Guide to Bridge Technology, Part 5: Structural Drafting

Drafters should be familiar with the contents of AS/NZS 1100 - Technical Drawing Parts 101, 401 and 501 and Austroads Guide to Bridge Technology, Part 5: Structural Drafting. Directions contained in this volume are intended to compliment these publications, but do depart from them in certain areas.

The following are important departures:

Reinforcing bar shapes

Reinforcing details shall be in accordance with TMR Standard Drawings 1043 *Standard Bar Shapes* and 1044 *Standard Hook Lap and Bend Details, and General Steel Reinforcement Information*.

Reinforcing bar marking and identification

Reinforcing bars shall be shown on drawings in accordance with Chapter 3 *Concrete and Reinforcement Detailing*.

Text height

4 mm high text shall be used for sub-titles, Ht's, section arrows, and when labelling the Bridge Control. Refer Chapter 2 *Standard of Presentation*, Table 2.6-1 Text Styles.

Use of characters

Upper/lower case lettering shall be used for labelling, dimensioning and notes. Refer to examples in this manual.

Scales

TMR accept a larger range of drawing scales. Refer Table 2.18-2 Scale Format.

Abbreviations

Additional abbreviations may be used. Not all abbreviation are in upper case. Refer Chapter 2 *Standard of Presentation*, 2.16 *Abbreviations*.

Detail cross referencing

Details shall be labelled with numbers rather than letters. The labels shall be shown in circles rather than hexagons. Refer Chapter 2 *Standard of Presentation*, 2.7 *Sections Views and Details*.

Section and view cross referencing

Sections and views shall be labelled with letters rather than numbers. Refer Chapter 2 *Standard of Presentation*, 2.7 *Section, Views and Details*.

1.5 Information to be supplied to the designer

A range of information is required to be confirmed and supplied to the Designer in order that the structural design and drafting can be completed. The type of information required will depend on the structure being designed. For a typical bridge design, this information may include, but is not limited to:

- survey information
- design alignment including road profile and horizontal and vertical geometry
- hydraulic reports including flood velocities and flood immunity Heights
- environmental reports
- Geotechnical reports. These may be supplied in various stages, for example bore logs are sufficient in the early stages to commence drafting. Preliminary reports may follow but a final Foundation Report is needed before release of a project
- relevant information required by the Designer to undertake the design. TMR, Bridge Design obtains this information using a Bridge Design Information Request, refer Appendix A - Example Bridge Design Information Request.

- Other Designers' may obtain the information a different way. The information needed to complete the design includes, but is not limited to:
  - name of structure
  - contract and Job Numbers
  - Bridge Information System (BIS) number
  - design speed
  - preferred scheme documentation/contract type
  - common elements of the bridge/roadworks and their relevant schedule (bridge or roadworks schedule)
  - principal supplied items and their point of supply
  - environmental management and any restrictions at the bridge site both on and in the immediate vicinity of the site
  - details of existing structures
  - bench mark/permanent survey marks
  - permanent reference points
  - type of connection to bridge barriers
  - details of existing utilities and services including overhead power lines
  - details of existing utilities and services to be relocated and their relocated position
  - restrictions to transportation of precast prestressed concrete elements
  - any restrictions to clearances or construction space
  - details of any vibration sensitive structures adjacent to the site
  - any requirements for sequencing of works i.e. maintaining traffic flows during construction
  - type of deck drainage
  - provision for conduits on the bridge (electrical, telecommunications or future)
  - embankment slopes of the road immediately adjacent to the bridge
  - type of media for final printing of drawings. A3 permanent paper is preferred for ease of copying and handling
  - is WMS to be used? Extent of documentation (full scheme documents or 'basic' documentation).

1.6 Information to be supplied by the designer

The Designer shall supply information to the Client in order to complete the detailed design and drafting of the project. Refer 1.8 *Bridge Scheme Deliverables*. In addition, the Designer may be required to prepare preliminary General Arrangement drawings to confirm details of the project, refer Chapter 11 *General Arrangement Drawings*.

1.7 Bridge scheme deliverables

The Designer shall provide drawings and documentation as specified in the Terms of Engagement Contract.

Shown below is a typical set of Transport Infrastructure Contract – Construction Only (TIC-CO) scheme documents to be delivered by the Designer. Other types of contract, i.e. Design and Construct, Alliance, Early Contractor Involvement, will have different deliverables.

- Covering letter detailing particular aspects of the project, for example:
  - the location of items that may be contained in different schedules, for example, free draining granular material behind abutments, relieving slabs, DWS and so on
  - details of any action in response to the site verification
  - preboring for precast piles (a supplementary specification is needed to limit the maximum size of material in the embankments to 50 mm so that pre-boring is possible)
  - the close proximity to the construction site of the overhead power lines
  - Queensland Rail contacts and train operation times nominated to TMR from Queensland Rail
  - estimate and schedule of all quantities for the project, including detailed calculations, using the agreed software, and itemised as defined in Standard Specifications Roads.
  - structural drawings.

One complete set of all original certified drawings on either A1 film or A3 permanent paper, signed in blue. A1 drawings shall be clearly legible when copied to A3 size.

- one A3 paper copy of all drawings
- scanned electronic copy of all signed drawings in portable document format (pdf).

Supporting documentation, for example:

- environmental design report
- supplementary specifications.

Reinforcing Steel Schedule consisting of a tabulated listing, using the TMR steel scheduling program, of all reinforcing steel in the project. Refer Chapter 3 *Concrete and Reinforcement Detailing*.

Design Report as detailed in the Design Brief. The Design Report must include a section on future bridge inspection and maintenance.

3D EPM. Refer Chapter 20 *Electronic Project Model (EPM).*

A complete set of Contract Documentation, as defined in the Project Brief and defined in Transport Infrastructure Contracts. When only ‘basic’ contract documents are required, they shall be prepared in the following order:

- estimate(s)
- form C7825 - Standard Document List
- annexures
- form C6826 - Drawing List

- form C7827 - Principal Supplies Material List
- supplementary specifications
- drawings
- environmental reports (Not Environmental Design Reports)
- steel schedules(s).

1.8 15%, 50% and 85% TMR review requirements

During the design process, the Designer shall supply information to TMR-Structures for review. Typically these reviews are held at 15%, 50% and 85% completeness, though additional reviews may be required. The following is a guide to the amount of drafting detail required at each stage:

15%

- draft general arrangement drawings including a superstructure section view
- articulation (location of expansion joints)
- service requirements
- barrier requirements
- lighting requirements
- drainage requirements
- vertical clearances to road and rail traffic
- draft abutment and pier drawings including preliminary founding Heights. These drawings need not show reinforcement at this stage.

50%

- foundation types confirmed
- complete set of draft drawings. These drawings need not show reinforcement at this stage.

85%

- complete set of checked drawings
- draft version of estimate, annexures, supplementary specifications, steel schedules and contract documents. Note that these are only required when they form part of the agreed deliverables that TMR are to review.

For additional engineering requirements, refer to the *TMR Bridge Design Criteria for Bridges and other Structures.*

Appendix A - Example Bridge Design Information Request Letter – Sheet 1

Structures, B&ME, Bridge Design | B&ME-PM-16_BDIR

BRIDGE DESIGN INFORMATION REQUEST

Engineering & Technology | Version 2.0, Issue Date 17-10-2013

NOTE: Document is uncontrolled when printed

PROJECT DETAILS

Project Name:	Goosepondss Creek Bridge Widenings		
Job No:	242/10H/1	Contract No:	MACD-1552
BIS No (New bridge):	TBA	BIS No (Existing bridge):	7329 (S'bound), 16997 (N'bound)

CONTRACT DOCUMENTATION

Type of Contract:	Combined Bridge & Road	Type of Scheme Documentation:	Road Construction Contract
Extent of documentation:	Basic	Use Works Management System (WMS):	Yes

Basic documentation consists of estimate, schedule of quantities, annexure, steel schedule, supp specs & relevant contract documents

Do you require steel schedules?	Yes

3rd party steel suppliers do schedule independantly due to proprietary software requirements

ESTIMATES & SCHEDULE ITEMS

Note that items for sheet/strip filter drains, abutment protection (MRS 11.03), bridge site preparation, excavation for structures, blinding concrete (MRS 11.04), bridge substructure(MRS 11.62), piles MRS 11.63 - 68), units & girders (MRS 11.74 - 76), bridge deck (MRS 11.77), bridge barriers (MRS 11.80), bridge bearings (MRS 11.81), repainting steel bridges (MRS 11.85), preparation for bridge widening (MRS 11.86) will be in the bridge schedule unless otherwise advised.

Provision for traffic:	Approach Schedule	DWS on bridge:	Bridge Schedule
Free draining granular material behind abutments:	Bridge Schedule	Expansion joints:	Bridge Schedule
Reinforced soil structures:	n/a	Anti-graffiti protection:	n/a
Environmental management:	Approach Schedule	Other (Please describe):	
Relieving slabs:	Bridge Schedule	Other (Please describe):	

PRINCIPAL SUPPLIED ITEMS

PSC deck units / girders:	Yes	Where are they to be supplied?	MR Registered Supplier
PSC piles:	Yes	Where are they to be supplied?	MR Registered Supplier
Bridge barriers:	No		
Other:			

EXISTING STRUCTURES

Are any existing structures to be removed?:	No

DESIGN SPEED

Design speed:	90	kph

CONNECTION TO APPROACH BARRIERS

Connection to approach barriers:	Thrie Beam Guardrail	Thrie Beam guardrail may be tapered to W Beam off bridge

SERVICES TO BE RELOCATED

Telecommunications:	No	Other:	
Electrical:	No		
Water Mains:	No		
Sewerage:	No		

OVERHEAD LINES IN BRIDGE VICINITY

Are any overhead lines within 10m of the bridge?	No

Appendix A - Example Bridge Design Information Request Letter – Sheet 2

Structures, B&ME, Bridge Design | B&ME-PM-16_BDIR

BRIDGE DESIGN INFORMATION REQUEST

Engineering & Technology | Version 2.0, Issue Date 17-10-2013

NOTE: Document is uncontrolled when printed

RESTRICTIONS TO TRANSPORT OF PRECAST PSC COMPONENTS

Are there restrictions to transporting items to site?	No	Restrictions may include small radius HC & /or VC's, steep grade or obstrucions.

DECK DRAINAGE

Drain water direct to waterway through scuppers:	Yes	Drain water through scuppers and channelled off bridge:	
Drain water off bridge by road designer:		Are there any special drainage needs?	

CONDUIT IN KERBS/PARAPETS OR FOOTWAY

Is conduit needed in kerbs, parapets or footway?	Yes	Please describe:	

EMBANKMENT SLOPES

What are the embankment slopes adjacent to the bridge?	1 on 2

SURVEY INFORMATION

Type of survey:	GDA	Combined Scale Factor	1.000209

BENCH MARKS

	Bench Mark 1		Bench Mark 2
Description:	PM116673	Description:	PM45488
Type:	Brass Plaque	Type:	Brass Plaque
Easting:	724418.884	Easting:	724725.008
Northing:	7662246.479	Northing:	7662074.175
Ht:	9.172	Ht:	6.871
Ht Datum:	AHD	Ht Datum:	AHD
AHD Correction Factor:	~	AHD Correction Factor:	~

PRP INFORMATION

Preceding PRP:	3	Following PRP:	4
Distance from preceding PRP to centre of bridge:	0.37km	Distance from centre of bridge to following PRP:	0.7km

THROUGH CHAINAGE

Through Chainage:	2.440 km	from:	Showground Intersection

ENVIRONMENTAL MANAGEMENT

Review of Environmental Factors (REF) been prepared?	No	Environmental Management Plan (EMP) been prepared?	No
Traffic Noise Study been prepared?	No		

Items of importance in reports: Only an Environmental Scoping Report has been prepared at this stage (copy attached). Further works required to produce an REF and EAR. There have not been any issues identified that are likely to require non-standard bridge design treatments.

FINAL DRAWING MEDIA

What final drawing media is required?	A3 Permanent Paper

Drafting and Design Presentation Standards
Volume 3: Structural Drafting Standards

Chapter 2: Standard of Presentation

February 2014

Queensland Government

Feedback: Please send your feedback regarding this document to: tmr.techdocs@tmr.qld.gov.au

Chapter 2 Amendments

Revision Register

Issue/Rev No.	Reference section	Description of revision	Authorised by	Date
1	-	First Issue	Manager (Structural Drafting)	Apr 2011
2	-	Document name change	Manager (Structural Drafting)	Nov 2011
	2.7	Cross referencing is done to drawing series number in an element, rather than the series number for the full set of drawing		
	2.9	Dimension arrow size increased to 3.5 mm. Dimension text offset from line 1.5 mm		
	2.17	Drawing sub codes removed		
	2.18	Drawing titles shall not be split up into sub-elements. Revision symbol is not longer required		
3	2.7	General: wording “and the numbers 1 and 0” deleted from line 10.	Team Leader (Structural Drafting)	Dec 2012
	2.18	Figure 2.18-5 Title Block – Partial view figure numbers corrected. Figure 2.18-6 Title Block (View A) – extra labelling added.		
4	2.6	General: Additional detail for font styles	Principal Drafter (Structural Drafting)	Feb 2014
	2.18	Title Blocks: Cad Files and Revisions sections. “Issue for construction” replaces “original issue”		

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2 Standard of Presentation

2.1 Glossary of terms

For a complete glossary of terms refer Chapter 1 *Introduction*.

2.2 Figures and examples shown in this volume

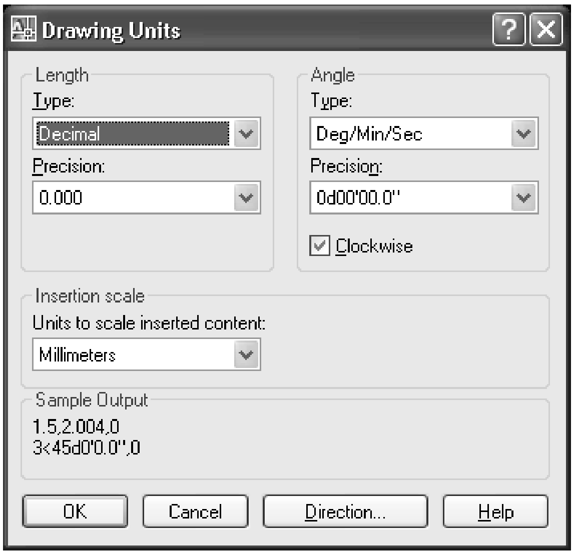
The figures and examples shown in this volume are for presentation purposes only, and may contain some details that are now superseded. These details have been included for ease of reference, to illustrate typical solutions, and to show the required standard of drafting presentation. The details are not to be used without an engineering check and certification by a Structural RPEQ to confirm that the details are appropriate for the specific project.

2.3 Drawing set up

This Section is provided as a guide only, and the drawing set up may be changed.

All drawings are to use colour dependant plot style tables (CTB), not style dependant tables (STB), General Arrangement drawings are to have the user coordinate system (UCS) set to world co-ordinates.

All drawings are to have the units set as follows:



The model is to be drawn at full scale in model space and view ports are to be created at the appropriate scales in paper space. All view specific text and dimensions are to be drawn in model space to match the scale of the view port for that view.

Drawing notes are to be in paper space in the bottom right-hand corner of the drawing.

2.4 Projection

Third angle projection is to be used on all drawings for plan, elevation and any external views such as end views.

All sections should be orientated in the third angle where possible but may be placed at the most convenient location on the sheet. The plan and direction of these sections will be depicted by section arrows. Refer 2.6 *Lettering for further requirements*.

2.5 Linework

All linework on drawings shall be in accordance with AS 1100 - *Technical Drawing, Part 101: General Principles*, and the table of line types shown in Table 2.5-1 Line Styles. The thickness of lines are to be used on the drawings without change. The layer names and colours are provided as a guide only and may be changed. Further details of linework relating to steel reinforcement can be found in Chapter 3 *Concrete and Reinforcement Detailing*.

Table 2.5-1 - Line Styles

LINE STYLE	TYPICAL APPLICATION
CONTINUOUS LINES – MR_CON	
MR_CON_018 (0.18 mm thick cyan in AutoCAD) MR_CON_025 (0.25 mm thick white in AutoCAD)	Dimensions, hatching, revision clouds, break lines and so on
MR_CON_035 (0.35 mm thick yellow in AutoCAD)	Outlines for reinforcement views, internal linework
MR_CON_050 (0.5 mm thick green in AutoCAD)	Outlines of views excluding reinforcement views
MR_CON_070 (0.7 mm thick blue in AutoCAD)	Reinforcement
MR_CONTOUR_MAJOR (0.25 mm thick colour 250 in AutoCAD)	Major contour lines (even metres)
DASHED LINES – MR_DSH	
MR_DSH_025 (0.25 mm thick white in AutoCAD) MR_DSH_035 (0.35 mm thick yellow in AutoCAD)	Hidden detail
MR_DSH_050 (0.5 mm thick green in AutoCAD) MR_DSH_070 (0.7 mm thick blue in AutoCAD)	Strip filters behind abutments, reinforcement in far face
MR_CONTOUR_MINOR (0.18 mm thick colour 250 in AutoCAD)	Minor contour lines (intervals)
DOUBLE CHAIN LINES – MR_DCH	
MR_DCH_025 (0.25 mm thick white in AutoCAD) MR_DCH_035 (0.35 mm thick yellow in AutoCAD)	Existing structures
CHAIN LINES – MR_CHN	
MR_CHN_025 (0.25 mm thick white in AutoCAD)	Centre lines
MR_CHN_070 (0.7 mm thick blue in AutoCAD)	Road and Bridge Controls
CONSTRUCTION JOINT LINES – MRB_CJ	
MRB_CJ_035 (0.35 mm thick yellow in AutoCAD)	Construction joints

LINE STYLE	TYPICAL APPLICATION
VIEW PORT LINES – MR_VPT	
MR_VPT – user defined (Non plotting layer)	View ports
CONSTRUCTION LINES – MR_CON	
MR_CON – user defined (Non plotting layer)	Construction lines

2.6 Lettering

The lettering on all drawings shall be in accordance with the font style details as outlined in Volume 1 *Drafting and Design Presentation Standards*, Chapter 2: *General Standards*.

Text styles and heights shall be as outlined in Table 2.6.1 - Text Styles. The layer names and colours are provided as a guide only and may be changed.

Table 2.6-1 - Text Styles

STYLE	LAYER	TEXT HEIGHT (Final height on A1 size drawing)	APPLICATION
Upper and Lower Case	MR_TXT_035 (yellow in AutoCAD)	3.5 mm	Drawing text / Notes / Dimensions
Upper and Lower Case	MR_TXT_050 (green in AutoCAD)	4.0 mm	Heights
UPPER CASE	MR_TXT_050 (green in AutoCAD)	4.0 mm	Sub-Titles / Bridge Control
UPPER CASE	MR_TXT_070 (blue in AutoCAD)	5.0 mm	Titles

2.7 Sections, views and details

General

Views and sections, where possible, shall be drawn adjacent to the plan or elevation to which they relate. Where details cannot be shown on the sheet of origin, they shall be cross referenced in accordance with AS 1100 - Technical Drawing, Part 501: Structural Engineering Drawing and Section 2.8 Orientation of Sections and Views.

If a series of cutting planes are used to define sections or views, any change in direction of the cutting plane shall be shown by 0.7 mm thick lines.

Use letters to nominate Sections and Views, and numbers to nominate Details. Do not reference views or sections with the same letter, or details with the same number, on the same drawing set for that element, for example Section A and View A on the abutment drawings.

Each element shall start labelling at the letter A and the number 1.

If the entire range of the alphabet is used, lettering shall continue with AA, BB etc. The letters I and O shall not be used to avoid confusion.

If the Section, View or Detail is shown on the same drawing it is taken from then '-' shall be shown in the title. If it is shown on another drawing, then the series number shall be shown, for example, 2, if referring to the second Abutment drawing.

Section arrows and titles shall be drawn in accordance with Figure 2.7-1 Sections, Views and Details and Figure 2.7-2 Examples of Sections and Details.

Sections

Sections are a view taken from a defined cutting plane. Other linework such as hidden detail lines or detail beyond the cutting plane may be included provided that it does not confuse the intent of the section. For example, a section taken through a headstock showing the wing wall that is beyond the cutting plane.

Sections should be hatched with the appropriate symbol. Refer Table 2.13-1 - Material Symbols. An exception to this is a section showing reinforcement detail. The hatching in this case shall be omitted as the intent of the section, showing the reinforcement, may be compromised.

Views

Views are auxiliary elevations looking from a position external to previously drawn elevations and plans.

Details

Details are drawn to show a magnified view of a specific area shown on an element. The target area is defined by a circle on the parent view, and a leader line runs out to the detail symbol, or to the detail itself. Refer Figure 2.7-1 Sections, Views and Details and Figure 2.7-2 Examples of Sections and Details.

Figure 2.7-1 - Sections, Views and Details

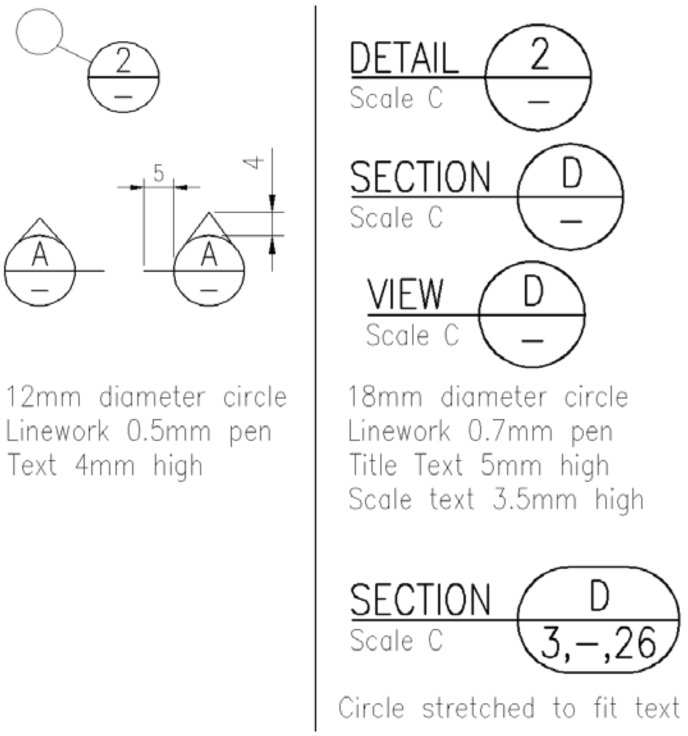
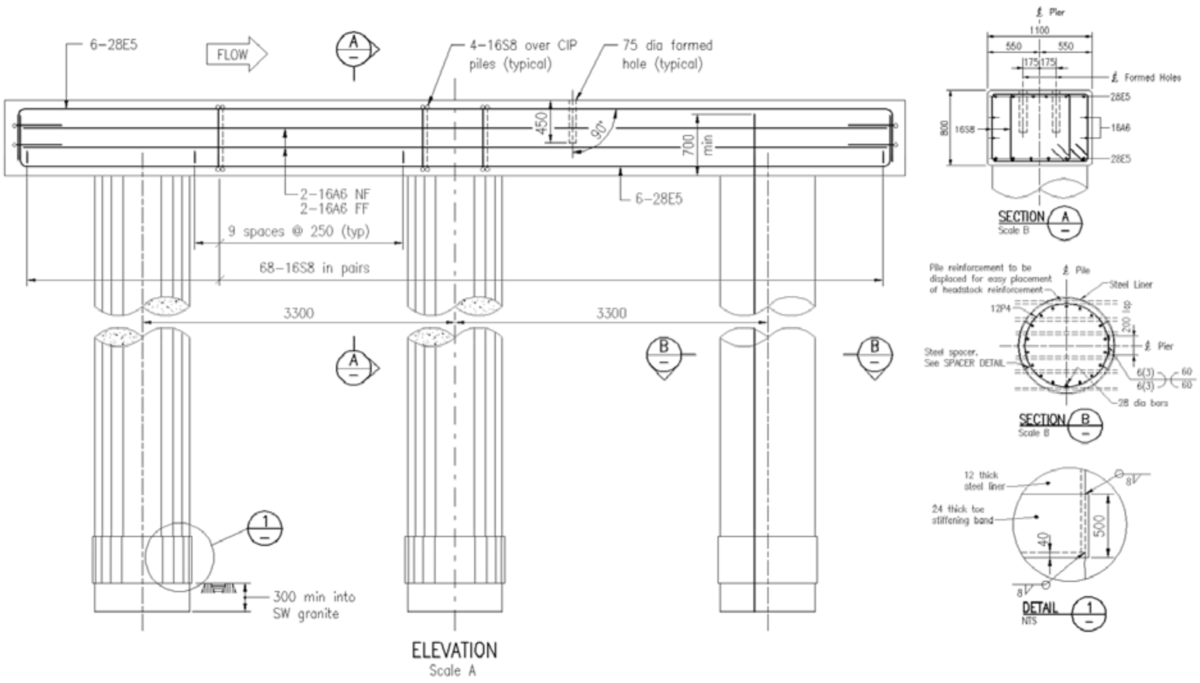


Figure 2.7-2 - Examples of Sections and Details



2.8 Orientation of sections and views

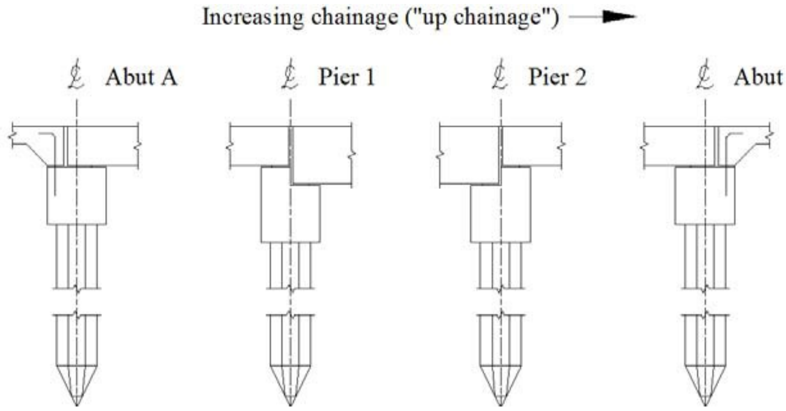
Orientation

Plan views of the bridge are to be drawn with increasing chainage starting left of the page to right.

Section and views

All section and view arrows are be orientated so that they show the "up chainage" side of the bridge component at the right hand side of the section or view. Refer Figure 2.8-1 - Section Orientation.

Figure 2.8-1 - Section orientation



Abutment and pier elevations

On Abutment B and Pier drawings the elevations are drawn looking "up chainage", however at Abutment A, the elevation is drawn looking "down chainage".

2.9 Dimensions

Each dimension necessary for the complete definition of a particular element shall be clearly shown on the drawing and shall be shown once only. Dimension and leader line arrows are to be 3.5 mm (A1 drawing) filled in type.

The dimensioning of any element shall be such that:

1. no dimension relating to that element need be deduced from other dimensions
2. all dimensions necessary to construct the element shall be shown so that there is no need to scale off a drawing to determine a dimension
3. dimensions shown on drawings shall be in millimetres and shall be placed parallel and above its dimension line and be able to be read either from the bottom or the right hand side of the drawing
4. a chain of dimensions shall be covered by an overall dimension except where dimensional tolerances are of critical importance
5. where practical, dimensions shall be placed centrally between the arrows denoting the limit for the dimension.

Order of accuracy for dimensions

6. dimensions for all components shall be calculated to an accuracy of 1 mm. Dimensions to be shown on the drawings may then be rounded off as shown:
    - concrete - 1 mm
    - reinforcing bar spacing - 5 mm
    - steel plate - 1 mm.

Order of accuracy for heights and chainages

7. heights shall be calculated to an accuracy of 1 mm. This is done to avoid any cumulative error that may occur. Heights shown on the final drawings may then be rounded off where necessary
8. heights and Chainages shall be shown in metres to three decimal places as shown below:
    - designed surface heights - 0.001 metres
    - chainages - 0.001 metres
    - contours - 0.250 metres generally, - 0.100 metres acceptable where ground is extremely flat
    - existing surface, flood and existing water heights, as reported.

Dimension, projection and leader lines

9. dimension lines shall not be shown as centrelines or as part of an elements outline. Projection lines for dimensions shall extend from a point not less than 2 mm (A1 drawing) from the surface of the object to a point not less than 2 mm (A1 drawing) beyond the dimension line
10. leader lines, projection lines, centre lines and the like are to be kept clear of dimension text, if possible, otherwise the clashing line is to be broken to provide an uninterrupted view of the dimension text
11. leader lines shall commence from either the beginning or end of a note with a short horizontal line (length 4 mm - A1 drawing) before being angled to the point of reference

12. the termination of the leader line shall be with an arrow to the outline of the element, or with a fully shaded dot (1.5 mm diameter - A1 drawing) within the area being noted.

Text

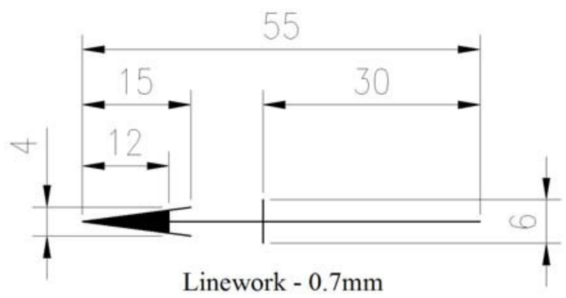
13. dimension text height shall be 3.5 mm and offset 1.5 mm (A1 drawing) from the dimension line.

2.10 Arrows

The dimensions shown in the following diagrams are for A1 drawings. The dimensions shall be halved for A3 drawings.

North point arrow

The north point is to be shown on the plan view of the General Arrangement drawing clear of all contours and notation. The north point is to be detailed as follows:

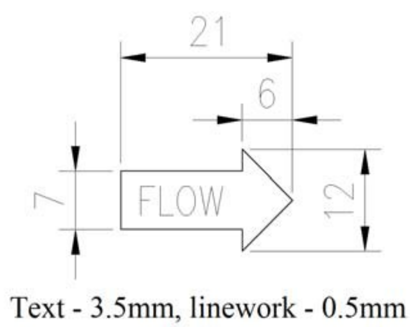


Flow arrows

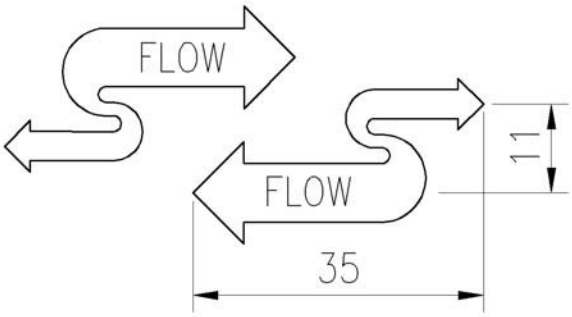
A flow arrow is to be shown on the Plan view of the General Arrangement drawing view to clearly show the direction of stream flow, where applicable, whether there is water present in the waterway or not.

Flow arrows should be shown on specific views throughout the bridge drawings to confirm correct orientation. Flow arrows are to be detailed as follows:

One way flow



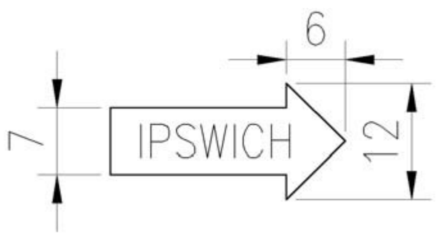
Tidal flow



Text - 3.5mm, linework - 0.5mm

Road direction arrows

Direction arrows are to be shown on the Plan view of the General Arrangement drawing to indicate the nearest town in each direction from the bridge. Generally the towns are those nominated in the road name of the title block. Direction arrows are to be detailed as follows:



Text - 3.5mm, linework - 0.5mm

2.11 Sloping features

Grades

Grades of roads and bridges shall be represented as a percentage. A slope of 5% indicates a displacement of five units vertically to 100 units horizontally. Grades rising in the direction of increasing chainage are shown as positive figures and grades falling in the direction of increasing chainage are shown as negative figures.

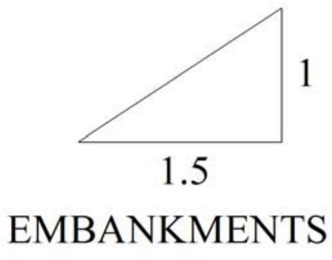
Crossfalls and superelevations

Crossfall is the resultant slope of the road surface in cross section, designed primarily to drain water from the road surface. Superelevation is the resultant slope of the road surface in cross section, designed primarily to counter the effects of a horizontal curve.

Crossfalls and superelevations of roads and bridges shall be represented as a percentage. A slope of 3% indicates a displacement of three units vertically to 100 units horizontally. Where a surface slope is shown an arrow shall indicate the downhill direction.

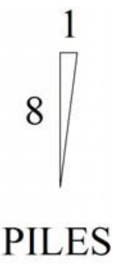
Slopes and batters

These shall be expressed as the vertical distance, given as unity, relative to the horizontal distance, for example the slope of an embankment should be expressed as 1 on 1.5 (1 unit vertical to 1.5 units horizontal). A small right angled triangle showing the horizontal and vertical relationship may be drawn adjacent to the slope or pile to indicate the angle of the feature being shown as follows:



Piles

When a pile is not set vertically, but at a slight angle to the vertical, it is said to be raked. The rake of a pile is expressed as the horizontal distance (given as unity) relative to the vertical height, for example the slope of a pile is expressed as one in eight (one unit horizontal to eight units vertical).



2.12 Contours

Contours are lines on a drawing joining points on the ground which are all at the same height above a known datum.

Contour lines are generally shown in intervals of 0.25 metres. Major contours at even metres, 123, 124 and so on, are labelled and shown as a full line. 0.25 m interval minor contours are not labelled and are shown as short dashed lines. Refer Table 2.5-1 - Line Styles.

The height of a contour is to be shown at a convenient point on an even metre contour line such that each contour can be easily and clearly defined.

The frequency of numbering should be such that the height of any contour line can be determined readily.

2.13 Symbols

General

Some symbols are reserved; refer *TMR Drafting and Design Presentation Standards Manual* – Volume 1, Chapter 2-*General Standards*, Appendix 2A.

Reference symbols

The following points are to be considered when using reference symbols:

- notes referenced by a symbol are to be used only when necessary, for example to reduce the number of similar notes of reference on the same drawing or to add extra notation for an item in a confined space on the drawing
- the reference note should be placed as close as possible to the point of interest on the drawing
- use different symbols for each subsequent reference on any drawing
- the size of the symbol is to be such that it is easily identified in all instances on an A3 size print of the drawing.

Welding symbols

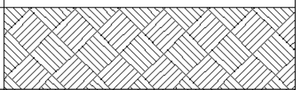
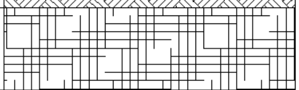
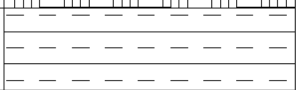
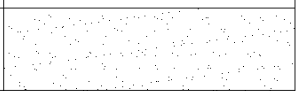
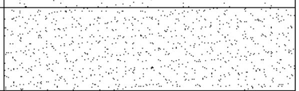
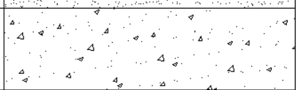
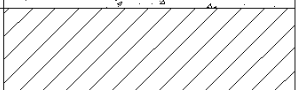
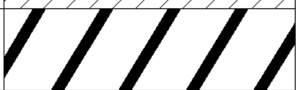
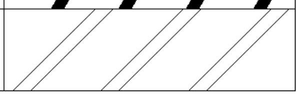
The necessary information concerning the locations, type, size and length of welds in welded joints and whether the welds are to be made in the shop or at the site shall be given on the drawings with the use of standard symbols.

All symbols shall be in accordance with AS 1101.3 - Graphical Symbols for General Engineering, Part 3: Welding and Non-destructive Examination.

Material symbols

Hatching of sections is to be represented on drawings in accordance with Table 2.13-1 - Material Symbols. Hatching may be drawn in a grey pen, such as colour 250 in AutoCAD.

Table 2.13-1 - Material Symbols

MATERIAL	EXAMPLE
Earth	
Rock	
Filling	
Concrete blinding	
Mortar	
Concrete	
Compressible filler	
Joint materials	
Deck wearing surface	

2.14 Chamfers

Chamfers are to be formed on the edges of reinforced concrete components as noted on the drawings.

Chamfers shall be shown in a view if the scale of the view is such that the chamfers will be clearly seen.

2.15 Titles

Each drawing generally comprises several Sections, Views and Details and each view shall be given the appropriate title using 5 mm (A1 drawing) text for the title (0.7 mm thick blue pen) and 3.5 mm (A1 drawing) text for the scale (0.35 mm thick yellow pen) as shown in Figure 2.7-2 - Examples of Sections and Details.

2.16 Abbreviations

Abbreviations fall into three categories:

- metric units
- accepted abbreviations
- when space is limited.

There is no need for a full stop in any abbreviation.

Metric units

A list of standard abbreviations for metric units is shown in Table 2.16-1 - Standard Abbreviations - Metric Units. The arrangement of upper and lower case letters for each abbreviation shall be strictly adhered to.

Table 2.16-1 - Standard Abbreviations - Metric Units

UNIT	SYMBOL
Degree (Celsius)	°C
Kilogram	kg
Kilometre	km
Kilopascal	kPa
Kilonewton	kN
Megapascal	MPa
Metre	m
Millimetre	mm
Pascal	Pa
Radian	Rad
Tonne	t

Accepted abbreviations

A list of accepted abbreviations is shown in Table 2.16-2 - Accepted Abbreviations. Some abbreviations are widely accepted and can be used freely.

Table 2.16-2 - Accepted Abbreviations

DESCRIPTION	ABBREVIATION
Approximate	Approx.
Australian Certification Authority for Reinforcing Steel	ACRS
Australian Height Datum	AHD
Average Recurrence Interval	ARI
Bore Hole	BH
Bench Mark	BM
Bridge Inventory System	BIS
Bottom Face	BF
Centreline	CL
Centres	Crs
Circular Hollow Section	CHS
Construction Joint	CJ
Control Line	CTRL
Countersink	CSK
Curve-Curve	CC
Curve-Tangent	CT
Deck Wearing Surface	DWS
Diameter	Dia
Downstream	D/S
Environmental Design Report	EDR
Environmental Management Plan	EMP
Far Face	FF
Geocentric Datum of Australia	GDA
Horizontal Curve	HC
Height	Ht
Hot-dip Galvanised	Galv
Inside Diameter	ID
International System of Units	SI
Intersection Point	IP
Maximum	Max
Mean High Water	MHW
Mean High Water Springs	MHWS
Mean Low Water	MLW

DESCRIPTION	ABBREVIATION
Mean Low Water Springs	MLWS
Minimum	Min
Modulus of Elasticity	E
Near Face	NF
Nominal	Nom
Number	No
Outside Diameter	OD
Parallel Flange Channel	PFC
Percentage	%
Pitch Circle Diameter	PCD
Polytetrafluoroethylene	PTFE
Polyvinylchloride	PVC
Prestressed Concrete	PSC
Queensland Rail	QR
Radius	R
Rectangular Hollow Section	RHS
Reinforced Concrete	RC
Required	Reqd
Revision	Rev
Reference Point	RP
Second	S
Tangent-Curve	TC
Taper Flange Beam	TFB
Taper Flange Channel	TFC
Top Face	TF
Transport and Main Roads	TMR
Ultimate Limit State	ULS
Ultimate Tensile Strength	UTS
Universal Beam	UB
Universal Bearing Pile	UBP
Universal Column	UC
Unplasticised Polyvinylchloride	Upvc
Upstream	U/S
Vertical Curve	VC

When space is limited

Other then in the previous examples, using abbreviations is generally discouraged in normal drafting practice. There are however some abbreviations that may be used, if necessary, when space is limited. Refer Table 2.16-3 - Other Abbreviations.

Table 2.16-3 - Other Abbreviations

DESCRIPTION	ABBREVIATION
Average	avg
Drawing Number	Drg No
Holding Down	HD
Road	Rd
Spaces	sps
Supplementary Specifications	Supp Specs
Typical	typ
Ultimate	Ult

2.17 Order of drawings as compiled in bridge schemes

The order of drawings in a typical bridge design scheme is shown below:

- drawing index
- general arrangements
- abutments
- piers
- precast headstocks
- PSC deck units
- PSC girders
- PSC piles
- precast panels
- decks, cross girders and concrete barriers
- kerbs
- relieving slabs
- miscellaneous details
- bridge traffic barrier
- balustrade
- bridge jacking, inspection and maintenance.

2.18 Title blocks

General

This section is read in conjunction with *TMR Drafting and Design Presentation Standards Manual*, Volume 1, Chapter 2-*General Standards*, Clause 2.3.5 Title Block Data.

Standard title block templates have been developed for bridge drawings. MRB_DETAIL shall be used on drawings produced by TMR, and MRB_DETAIL_CON shall be used on drawings produced Consultants.

The title block AutoCAD drawings can be downloaded from the TMR website. Drawings produced by Consultants do not show copyright details. Instead they show Transport and Main Roads. Refer Figure 2.18-10 - Contactor Drawing Requirements.

The following section details specific information for drafting title blocks for bridge projects. Examples are found in Figure 2.18-5 - Title Block.

Bridge design criteria

As stipulated in AS 5100 - Bridge Design, the following bridge design criteria, if relevant, is to be shown on all TMR bridge drawings in the area immediately above the title block:

- design code
- design loading
- design speed
- fatigue criteria (for concrete railway bridges, steel bridges)
- pedestrian loading
- collision loading
- wind speed
- earthquake zone
- barrier performance level
- bridge type
- significant variation from the code
- differential settlement.

Other bridge design criteria are to be shown on one of the General Arrangement drawings, if applicable, for example:

- limits of HLP 400 Vehicle Diagram
- pier Design Flood Force and flood data, including flood velocities and immunity Heights.

CAD files

All drawings that are to be registered with a drawing number shall also be recorded in an electronic filing system with an AutoCAD Reference Number that is unique and clearly identifies the relevant drawing. The following format, used in Bridge Design, is given as an example:

- 123_PR2_B .dwg.

Where:

- **123** denotes the bridge specific AutoCAD Reference Number
- **PR** denotes the Drawing Subtype Code. Refer *TMR Drafting and Design Presentation Standards Manual*, Volume 1, Chapter 2 – Appendix 2E - AutoCAD Drawing Environments
- **2** denotes the series number for this element, for example PIER – SHEET 2
- **B** denotes a drawing revision letter (A for 'Issued for Construction' issue, B for the first revision and so on)
- **.dwg** denotes the AutoCAD drawing file extension.

The example above refers to an AutoCAD drawing of the PIER – SHEET 2 (Revision B) for a bridge project with reference number 123.

Do not use spaces in the AutoCAD reference. Use an underscore to separate the divisions.

Once the drawing is signed and issued, external AutoCAD references should be bound into the drawings. If they are not, the references shall be listed after the AutoCAD Reference Number.

The previously mentioned CAD file requirements settings are internal TMR standards only, and not imposed on external consultants.

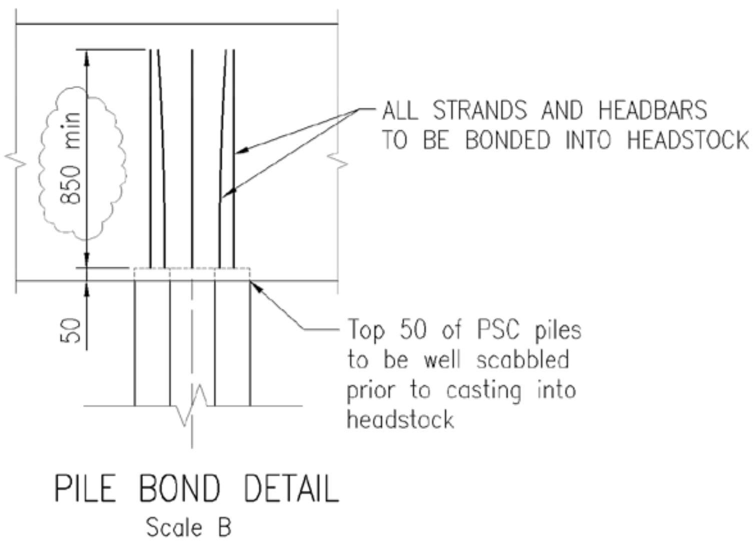
Revisions

Revision A is always 'Issue for Construction' issue [A1/A3], the latter being the paper size of final print.

All amendments and reissue of drawings after certification shall be carried out in the following manner:

- make amendments to drawing where required and highlight significant amendments with a revision cloud. Remove revision clouds from previous revisions if applicable. Ensure that the cloud is clear of other details like dimension lines, leader lines and so on. Refer Figure 2.18- 1 Revision Cloud.

Figure 2.18-1 - Revision Cloud



- add current revision letter to title block near drawing number
- type name, RPEQ number and date of original signing for the Design Reviewer and Engineering Certifier of the original drawing

- change current revision letter in the AutoCAD Reference Number and rename the AutoCAD drawing
- add revision letter and short description of the changes to the revision box
- print drawing on the same media and at the same size as the original drawing
- add certification signature and date to revision box
- add initials of certification signatory to AutoCAD drawing for future reference.

Associated job and drawing numbers

List job numbers and drawing numbers that are associated with this project, for example those numbers for the road works scheme. If unknown at time of release this may be left blank and added at a later stage by the Client.

Survey information

These boxes list pertinent survey information for the project including GDA logo (Geocentric Datum of Australia). The GDA logo is only to be shown if the survey was completed using this system.

Shire

Local Authority where the project is being constructed, for example SOMERSET REGIONAL COUNCIL.

Highway / road

Highway or main road and road section where the project is being constructed, for example BRUCE HIGHWAY (INNISFAIL – CAIRNS) or GULF DEVELOPMENTAL ROAD (NORMANTON – CROYDON).

If the project is not on a highway state the road only, for example INNISFAIL – JAPOON ROAD.

Information may be found on TMR Regional Maps.

Control chainage

Control Chainage represents the centreline chainages of Abutment A and Abutment B on the designated Control Line, for example CTRL CH 11988.175 to 12135.825 (MC01) on Control Line (MC01).

Reference points

This information is supplied by the Road Designer or TMR Region. Reference points are required before and after the structure, Preceding RP and Following RP, along with the distance to the start of the structure (Abutment A) in kilometres, distance from the start to the end of the structure, and the distance from the end of the structure (Abutment B) to the following RP.

Through chainage from start of road section, for example:

- through Chainage from start of road 23.4km.

Bridge name

Examples of typical bridge names are as follows:

- SANDY CREEK OVERFLOW BRIDGE
- MEWITT STREET OVERPASS
- SANDY CREEK BRIDGE WIDENING
- BALD HLLS RAILWAY OVERPASS
- TOOMBUL RAILWAY OVERPASS WIDENING
- SANDY CREEK PEDESTRIAN BRIDGE.

Drawing title

The drawing title refers to the elements being drawn, for example PIER or PIER – SHEET 2.

For ease of cross referencing, simplifying drawing series numbering, and to ensure that the whole set of element drawings are read in a set, the drawings shall not be split up into sub- elements, for example ABUTMENTS – PROFILE and ABUTMENTS – REINFORCEMENT.

Signing drawings

The first initial and surname of the relevant design / check drafters, design / verifying engineers are printed in the title block. These people do not need to hand sign the drawings.

The Design Reviewer and Engineering Certifier hand sign, date and enter their RPEQ number in the relevant area on the final print media when they are satisfied that the design is fit-for- purpose.

Job number and contract number

The Job Number is shown in the format 158/8102/2 where:

- **158** is Local Authority Number
- **8102** is the Road Section
- **2** is an identifier assigned by Client.

The Contract Number is shown in the format PEND-102 or 158-8102-2. Note the use of dashes in the Contract Number and forward slashes in the Job Number.

Drawing number

Drawing numbers are obtained from a block of numbers reserved for the project after the drawings required for the project have been identified. These numbers are issued by TMR Plan Room in the Spring Hill Office Complex, or by the TMR Region.

Drawing series number

Structural drawings have an additional drawing series requirements to those described in the TMR Drafting and Design Presentation Standards Manual, Volume 1, Chapter 2 *General Standards*.

A typical set of series numbers for a bridge with seven drawings would be as follows:

- BR1-GA-1 of 2
- BR1-GA-2 of 2
- BR1-AB-1 of 1
- BR1-DU-1 of 1
- BR1-KE-1 of 1
- BR1-TR-1 of 2
- BR1-TR-2 of 2.

Where:

- **BR1** is bridge number 1 (there may be more than one bridge in the contract)
- **GA-1** is General Arrangement – Sheet 1 of 2
- **GA-2** is General Arrangement – Sheet 2 of 2 etc.

Note that single digits have been used where possible, for example, 1 rather than 01.

In the lower-right corner of structural drawing title blocks, an additional series of numbers shall be shown that cover the full set of structural drawings. Using the previously mentioned seven drawings, this series would run from BR1 Drgs 1 of 7 through to BR1 Drgs 7 of 7.

Scheme approval status

Scheme approval is signed off on the first drawing in the scheme which is titled Locality Plan and Drawing Index. All other drawings in the scheme refer to the drawing number of this plan. If this drawing number has not been assigned when the drawings are ready to be signed it shall be left blank in the title block. The number shall then be stencilled onto the drawings once the number is assigned.

BIS number

The Bridge Inventory System (BIS) number is a unique number assigned to each structure and is assigned by the relevant TMR Region. The number may not be assigned until after the bridge is constructed. In this instance, leave the BIS number blank in the title block. The number shall then be stencilled onto the drawings once the number is assigned.

Preliminary drawings

It is good practice for all drawings produced in a design office to have a date stamp which includes the file path of the drawing, and the name of who plotted it. Drawings given to external parties that are either preliminary, concept, or for tender only purposes, shall always be stamped as such, and dated. The stamp should be approximately 80 mm wide. Refer Figure 2.18-2 - Preliminary Stamp.

Figure 2.18-2 - Preliminary Stamp

Scales

Scales shall be shown in the title block of a drawing, referenced by a letter and conforming to the format shown in Table 2.18-3 - Scale Format.

Quoting the scale used as a ratio, such as 1:200 at A1, is not permitted because it can lead to inaccuracy when the size of the drawing is slightly distorted during printing and/or copying.

All views are to be drawn to a recognised scale, for example 1:7 or 1:9.9 are not recognised scales, except where views are distorted for a specific purpose.

The scale is to be such that the drawing may be easily read when reduced to A3 size. Similar scales should not be used on the one drawing, for example 1:20 and 1:25.

Drawing views larger or smaller than needed and/or positioned sparsely on sheets necessitating extra drawings is to be avoided.

Sectional and detail views are to be shown at approximately twice the size of the view it is taken from where practical. Scales for typical bridge drawings are shown in Table 2.18-4 - Preferred Scales. When room on the drawing permits, the smaller of the preferred scales shall be used to fill the sheet.

Table 2.18-3 - Scale Format

APPLICATION	EXAMPLE
1:1 scale	A 0 20 40mm
1:2 scale	A 0 50 100mm
1:2.5 scale	A 0 50 100mm
1:5 scale	A 0 100 200mm
1:7.5 scale	A 0 200 400mm
1:10 scale	A 0 200 400mm
1:12.5 scale	A 0 250 500mm
1:15 scale	A 0 250 500mm
1:20 scale	A 0 500 1000mm
1:25 scale	A 0 500 1000mm
1:30 scale	A 0 500 1000mm
1:40 scale	A 0 1000 2000mm
1:50 scale	A 0 1000 2000mm
1:75 scale	A 0 1 2 3 4m
1:100 scale	A 0 1 2 3 4 5m
1:125 scale	A 0 1 2 3 4 5m
1:150 scale	A 0 2 4 6 8m
1:200 scale	A 0 2 4 6 8 10m
1:250 scale	A 0 2 4 6 8 10m
1:300 scale	A 0 5 10m
1:400 scale	A 0 10 20m
1:500 scale	A 0 5 10 15 20m

Table 2.18-4 - Preferred Scales

APPLICATION	SCALE
GENERAL ARRANGEMENTS	
Plan/Elevation for bridges up to 80 meters long	1:150 or 1:200
Plan/Elevation for bridges over 80 meters long	1:250, 1:300 or 1:40
Type Abutments and Piers	1:75 or 1:100
Section Deck	1:30 or 1:40
Anchorage Details	1:12.5 or 1:15
ABUTMENTS AND PIERS	
Plan/Elevation	1:30 or 1:40
Sections	1:15 / 1:20
BRIDGE BARRIERS	
Plan/Elevation	1:75 or 1:100
Sections, Post Assemblies, Joint Assemblies and Details	1:5, 1:7.5 or 1:10
PSC DECK UNITS AND PSC GIRDERS	
Plan/Elevation	1:40
Sections of Units and End Details	1:12.5
Anchors and Transverse Stressing Anchorage Details	1:7.5
CAST INSITU KERBS, CROSS GIRDERS AND DECKS	
Plan/Elevation	1:75 or 1:100
Sections	1:15

Figure 2.18-5 – Title Block

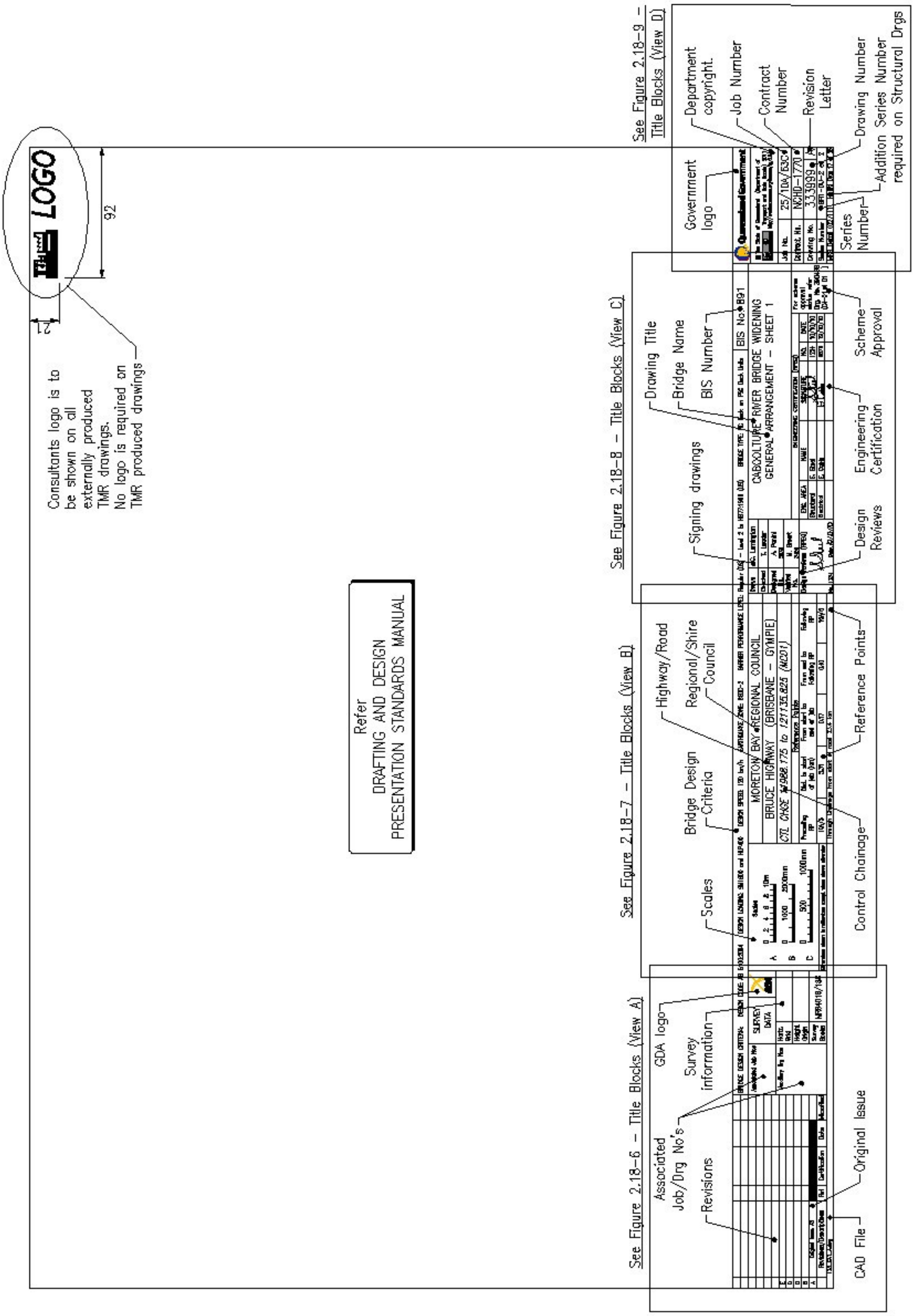


Figure 2.18-6 - Title Block (View A)

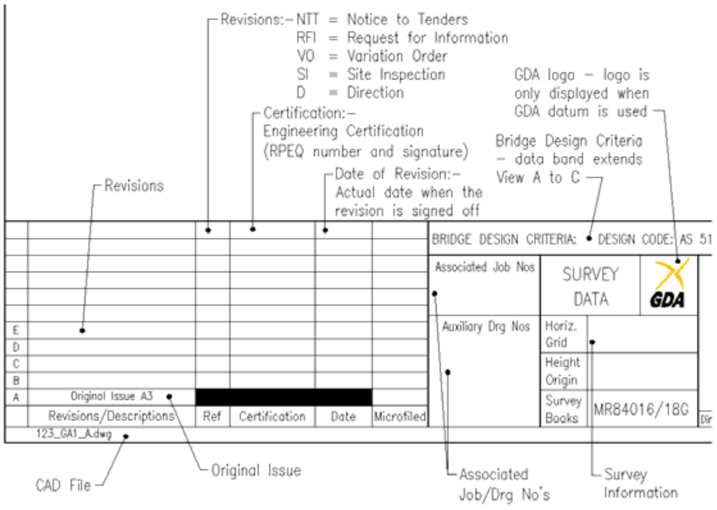


Figure 2.18-7 - Title Block (View B)

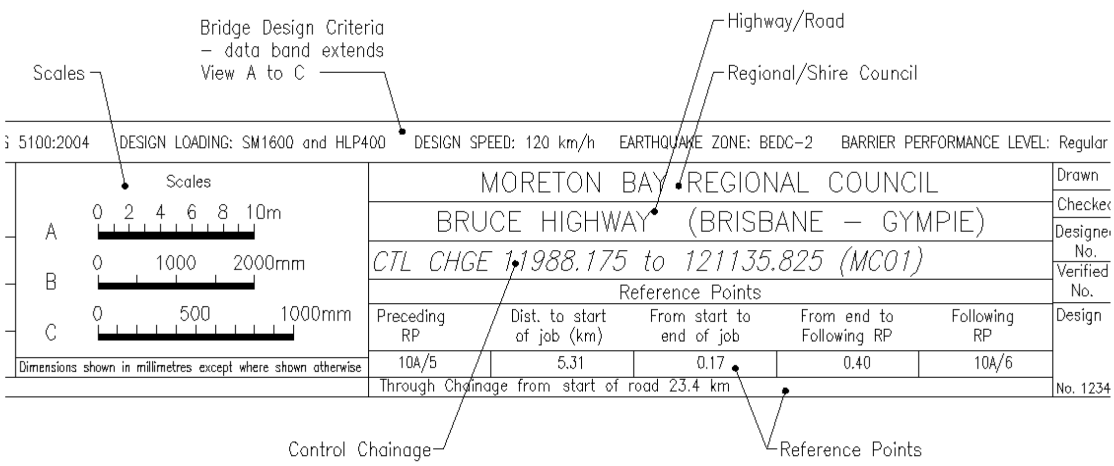


Figure 2.18-8 - Title Block (View C)

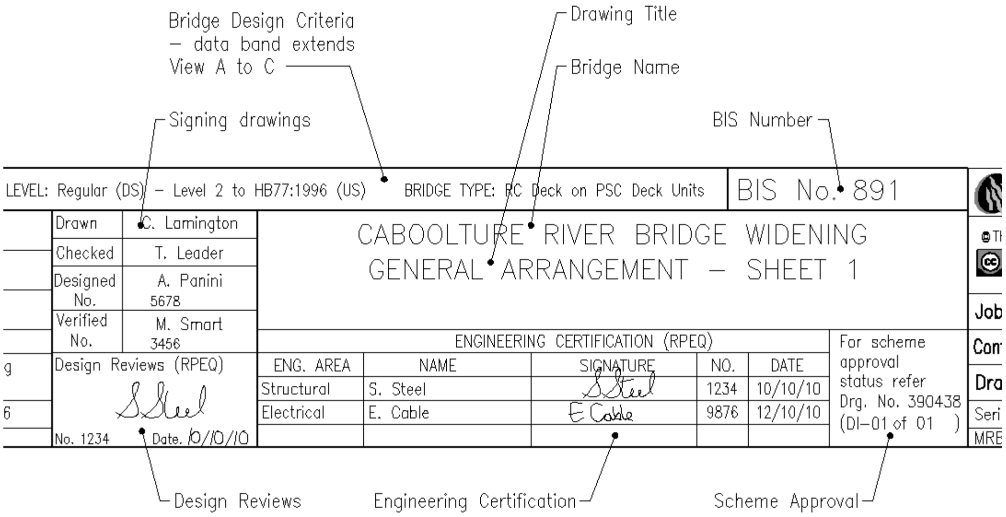


Figure 2.18-9 - Title Block (View D)

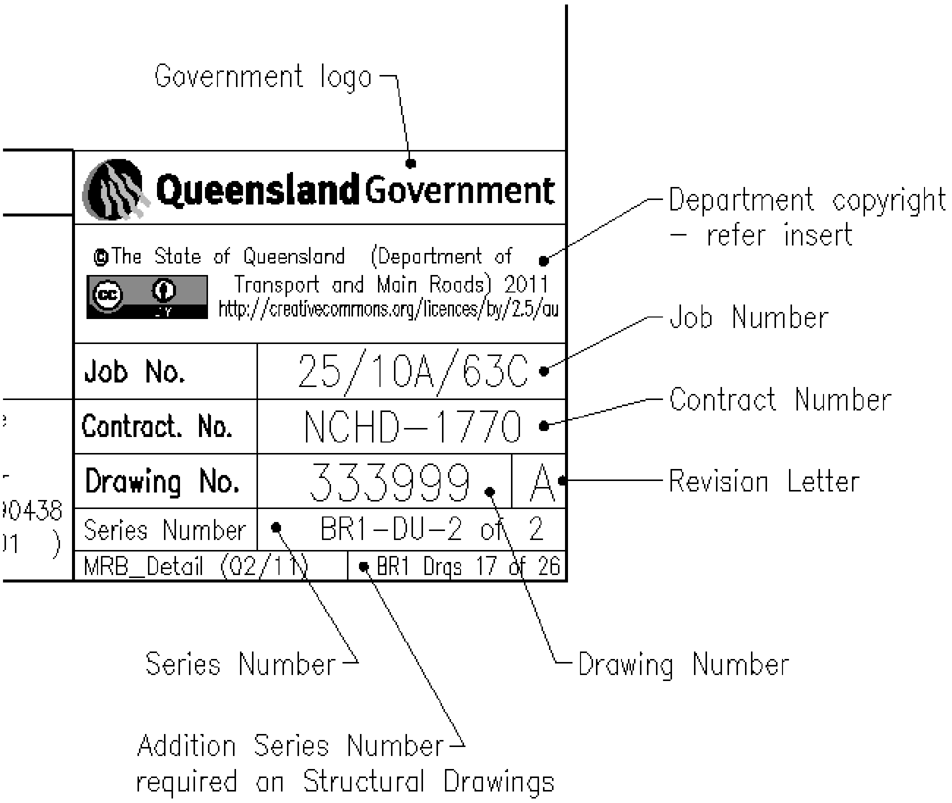
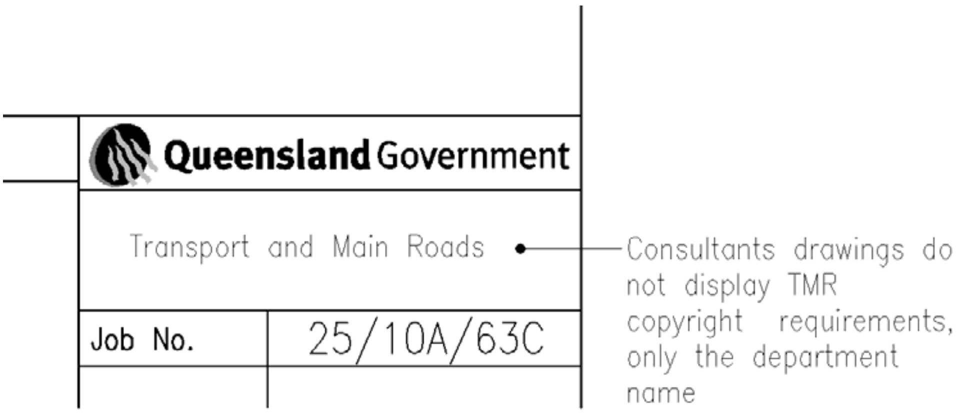


Figure 2.18-10 - Contactor Drawing Requirements



Drafting and Design Presentation Standards
Volume 3: Structural Drafting Standards

Chapter 3: Concrete and Reinforcement Detailing

November 2011

Queensland Government

Chapter 3 Amendments

Revision register

<table>
<tr><th>Issue/Rev No.</th><th>Reference section</th><th>Description of revision</th><th>Authorised by</th><th>Date</th></tr>
<tr><td>1</td><td>-</td><td>First issue</td><td>Manager (Structural Drafting)</td><td>Apr 2011</td></tr>
<tr><td rowspan="2">2</td><td>-</td><td>Document name change</td><td rowspan="2">Manager (Structural Drafting)</td><td rowspan="2">Nov 2011</td></tr>
<tr><td>3.12</td><td>Grade of bar for wire and square bar removed</td></tr>
</table>

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3 Concrete and Reinforcement Detailing

3.1 Glossary of terms

For a complete glossary of terms refer Chapter 1-*Introduction*.

3.2 Figures and examples shown in this volume

The figures and examples shown in this volume are for presentation purposes only, and may contain some details that are now superseded. These details have been included for ease of reference, to illustrate typical solutions, and to show the required standard of drafting presentation. The details are not to be used without an engineering check and certification by a Structural RPEQ to confirm that the details are appropriate for the specific project.

3.3 Concrete detailing

Concrete detail drawings should show the physical dimensions and heights of a concrete structure. It is important that sufficient information is shown to enable formwork to be built and erected and concrete quantities to be easily calculated.

Formed holes, cast-in steel work, construction joints and any necessary layers of blinding concrete shall be shown.

The location of formed holes and cast-in steel work shall be sufficiently dimensioned to enable their correct positioning inside the formwork.

Cast-in items, where applicable, shall be cross referenced to the drawing that shows its fabrication details.

3.4 Symbols and line work for concrete

Where necessary sectional views may be hatched with the relevant material symbol. Refer Chapter 2-*Standard of Presentation*, Table 2.5.1-Line Styles and Chapter 2-*Standard of Presentation*, Table 2.13.1 - *Material Symbols*.

The full cutting plane may be hatched however care needs to be taken not to hide any pertinent details on that view. If hatching is necessary but there are other relevant details on the view that are needed, part hatching is advised.

Hatching is to be avoided on sections showing reinforcement as it can lead to the reinforcement being obscured on the view.

3.5 Dimensioning

Dimensioning of concrete items shall be in accordance with Chapter 2-*Standard of Presentation*, 2.9- Dimensions.

3.6 Plan views

Plan views showing the location of such elements as footings, columns, headstocks and the like, may also be used to show reference markings, co-ordinates and chainages. Plan views shall be drawn as a view seen from a horizontal plane taken immediately above the element under consideration.

Hidden details such as piles, columns and footings shall be shown as dashed lines where appropriate in accordance with Chapter 2-*Standard of Presentation*, 2.5-Linework.

3.7 Elevations

Elevations shall be drawn as a view seen from a vertical plane immediately in front of the element under consideration and shall be projected from that elements plan view.

Hidden details, such as abutment wing walls and associated fillets and the like, are not required to be shown unless that part of the structure is referenced by a height or a dimension. Hidden detail lines are to be in accordance with Chapter 2-*Standard of Presentation*, 2.5-Linework.

3.8 Sections

Sections shall be drawn in accordance with Chapter 2-*Standard of Presentation*, 2.7-Sections Views and Details.

3.9 Holes in concrete structures

Holes required in concrete structures are either cast during construction, or are created in existing structures when needed. Holes are identified on drawings by the manner in which they are formed.

On bridge drawings there are three main types of holes.

1. Formed holes

There are two methods of creating formed holes in concrete.

By fixing a sacrificial block (of the required cross section) into the formwork of a structure to be cast, such that after casting, the block is removed (or sacrificed) leaving the area as a void in the element. The most common example is deck unit holding down bolt holes in headstocks.

By fixing a hollow pipe in the formwork so that it forms a permanent liner to the hole after casting, for example, the scupper holes in deck units.

2. Cored holes

Cored holes are created in existing structures by the use of a coring drill. The centre piece is removed as a circular core leaving a smooth sided hole in the structure. Cored holes are usually used when large hole diameters are required. Examples of cored holes in bridge work are holes through concrete elements for the attachment of footwalk frames, services brackets and replacement bridge traffic rails.

3. Drilled holes

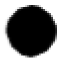
Drilled holes are formed by drilling with a spiral bit or rotary hammer into existing structures, for example, to bond new reinforcement into an existing headstock to facilitate an extension. Drilled holes with their rough surface provide a better bond for epoxy than cored holes do.

3.10 Symbols and line work for reinforcement

Reinforcing bars are to be shown on the drawings in accordance with Table 3.10-1 - Symbols and Line Work. Note: Bars shown in section should be drawn 1.5 x scale, where necessary, to improve clarity when reduced to A3 size. Alternatively they may be drawn in a 1 mm thick pen.

Refer Chapter 2-*Standard of Presentation*, Table 2.5-1 - Line Styles for line styles and AutoCAD layers. Hatching is to be avoided on sections showing reinforcement as it can lead to the reinforcement being obscured on the view.

Table 3.10-1 - Symbols and Line Work

DESCRIPTION	EXAMPLE
Bar bent toward observer	
Bar bent away from observer	
Hooked bar in elevation	
Hooked bar in plan	
Bar lapped inside	
Bars lapped (same plane)	
Bar lapped (cranked)	
Bar or stressing strand in section	1.5 x scale, where necessary 

3.11 Reinforcement detailing

Elevations, Plans and Views shall be treated as being transparent with the applicable reinforcement details being added.

Reinforcing details shall be in accordance with TMR Standard Drawings 1043 - Standard Bar Shapes and 1044 - Standard Hook Lap and Bend Details and General Steel Reinforcement Information.

3.12 Reinforcing bar identification

Reinforcing bars are nominated on drawings using the following convention: 11–16A15R at 150

Where 11 = number of identical bars

16 = diameter (mm) of the bar

A = bar shape

15 = sequence number of the bar

R = grade of bar

150 = maximum design spacing of reinforcing bars.

"at" may be replaced with "@", however the presentation should be similar throughout the entire drawing.

Bar shapes – standard

Included in TMR Standard Drawing 1043 is a standard set of bar shapes. All standard bar shapes are to be identified in accordance with this drawing. The standard bar shapes letters on this drawing are reserved for these shapes. Non-standard bar shapes must use different letters.

When steel schedules are not part of the bridge contract documentation, enough information shall be shown on the drawings to define these bars for future steel scheduling.

Bar shapes – non-standard

Bars shapes that are not detailed on TMR Standard Drawing 1043 are non-standard bars and must be fully detailed. Refer Chapter 4-*Computer Preparation of Steel Schedules*.

Sequence numbers

Sequence numbers are to be allocated in accordance with the following:

- numbers are to be assigned in ascending order starting at bar number one for each element of the bridge, for example, abutments, piers, cast insitu decks etc.
- numbers are to advance in order of placement in the structure i.e. from bottom to top
- sequence numbers are not to be duplicated in any element unless the bars are identical.

Grade of bar

D – Grade D500N (deformed bars)

R – Grade R250N (round bars)

The grade of bar is not shown if the bar is Grade D500N, for example 11–16A15 at 150.

The grade of bar shall align to AS/NZS 4671 - Steel Reinforcing Materials.

3.13 Presentation

Calling up and labelling

Bars are to be called up along a line between limit bars or by arrows to individual bars.

Where a dimension is required to show the distance between the first bar and the last bar of the sequence, the bars shall be called up as follows:

- 11–16A15 at 150 maximim = 1400

The number of bars required for any set is to be called up once only on the drawing, preferably on the main view, for example if the number of bars in the set is called up on the elevation, that number is then omitted from the other views.

Each bar shall be shown in at least two views on any drawing. Refer Figure 3.13-1 - Typical Reinforcement Detailing.

Fitment

Drafters are to ensure that the drawings accurately show a clear picture of the fitment of reinforcing bars relative to any recesses, cast-in items, or any other obstruction that may be present in any concrete element which is being detailed.

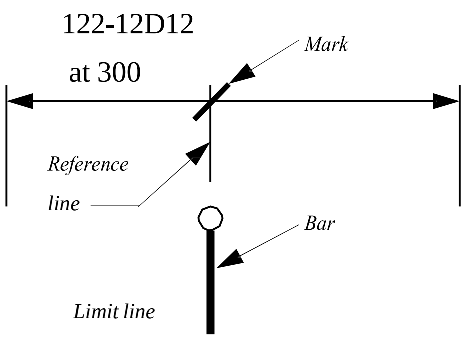
All views shall be drawn to scale, where possible, especially where clearances are critical. Hooks, laps and bends are to be drawn to scale as there can be clashes between ligatures and voids, recesses, cast-in items and the like. These clashes are readily identified if drawn to scale.

When interference is of a minor nature and not critical, for example the placing of shear reinforcement, a suitable note is to be added to the drawing. For example, *Spacing of ligatures in headstock may be altered slightly, if necessary, to clear formed holes*.

Dimensioning

Dimensions on drawings shall be taken as follows unless clearly shown otherwise:

- spacing is bar centre to bar centre
- cover is to the extremity of the designated bar
- the extent of the reinforcement is to be shown by limit lines. These are represented by a 5 mm long, 0.7 mm thick line (A1 drawing). The dimension line is to be 3 mm from this limit line
- a reference line and mark is to be drawn from the bar to the dimension line in all instances. The mark is to be at 45 degrees to the reference line starting at bottom left and finishing at top right (looking normal to the text). The mark shall be a 5 mm long, 0.7 mm thick line (A1 drawing).



Laps and anchorage lengths

Standard laps and anchorage lengths for all horizontal reinforcement shall be multiplied by 1.25 when there is greater than 300 mm of concrete below the bar. The laps shall be shown on the drawings. Refer Figure 3.13-1 - *Typical Reinforcement Detailing*.

If laps are not specified by the designer the lengths shall be shown in accordance with TMR Standard Drawing 1044.

Multi layered reinforcement

Where multiple layers of the same reinforcement are to be detailed, for example faces of deck slabs or walls, the following nomenclature is to be used:

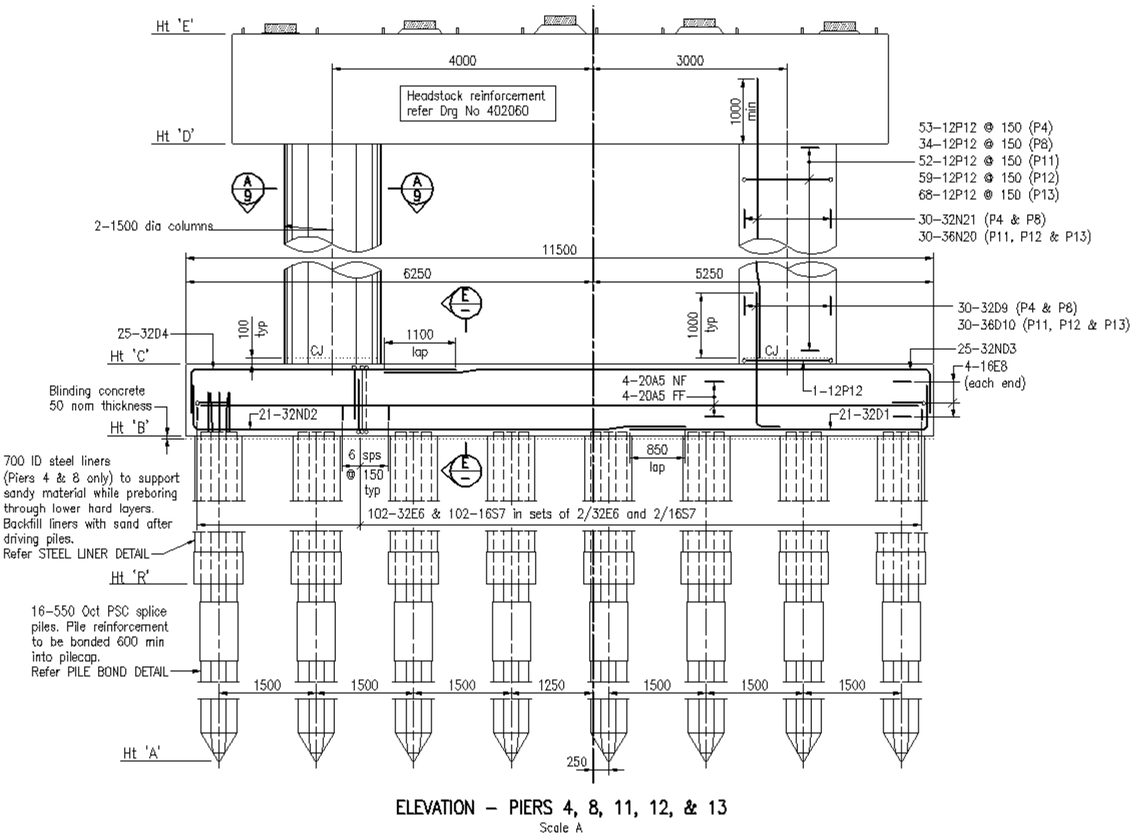
- NF (near face)
- FF (far face)
- T (top face)
- B (bottom face)
- C (central face).

Using the nomenclature EF (each face) can be confusing and may lead to inaccuracies in quantity calculations, therefore its use is not permitted. For example, writing 8-12A1 EF may be confusing. Are there eight bars on the NF and eight on the FF? Writing 4-12A1 NF and 4-12A1 FF leaves no room for error.

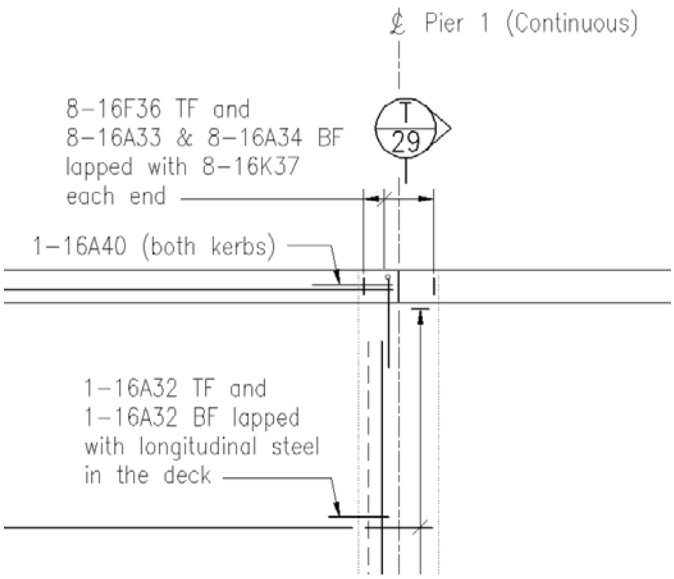
Sections

Stirrups and ligatures shown in section shall be drawn to clearly show the shape of the bar. For typical details for lap and anchorage lengths, spacing of reinforcement, multilayered reinforcement and sections, refer to the four diagrams in Figure 3.13-1 - Typical Reinforcement Detailing.

Figure 3.13-1 - Typical Reinforcement Detailing



Lap and Anchorage Lengths

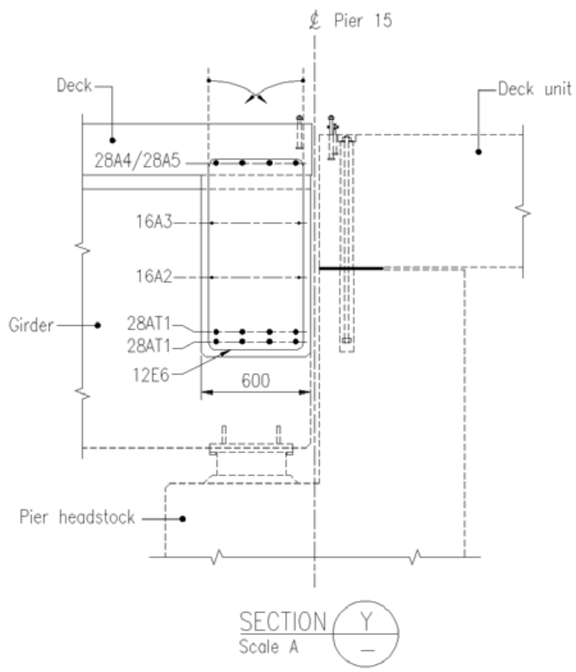


PLAN – DECK
Multilayered Reinforcement

Bars bent on site

Bars to be bent on site are to be clearly shown on the drawings by a note indicating that a site bend is necessary and that approved safety caps are to be used if the protruding reinforcement is not hooked. Refer Figure 3.13-2 - Bars Bent On Site.

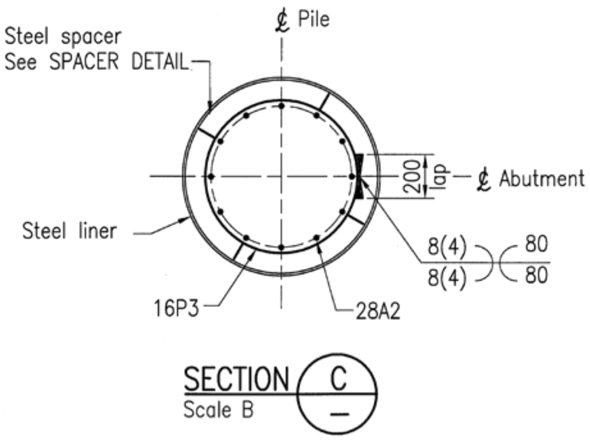
Figure 3.13-2 - Bars Bent On Site



Welded laps of reinforcement

The size and length of the weld required is to be shown on the drawings. For P and SD shaped bars the weld details shall match those shown on TMR Standard Drawing 1043. Refer Figure 3.13-3 - Welded Laps.

Figure 3.13-3 - Welded Laps



The same information will be shown automatically on the output of the reinforcing steel schedule. Refer Chapter 4-*Computer Preparation of Steel Schedules.*

Multiple laps

If a bar requires one or more laps, it is to be called up on the drawings in the usual fashion. The details of the laps are to be entered in the steel schedule. Refer Chapter 4-*Computer Preparation of Steel Schedules*.

Spiral reinforcement – bar shape Q

Spiral reinforcement used in cast in place piles shall conform to the following requirements:

- bar diameter no greater than 16 mm
- spiral diameter no greater than 2 m
- 1.5 turns anchorage each end of spiral
- laps to be a minimum of 50 times bar diameter.

The spirals are to be identified as bar shape *Q* in the steel schedule and will include the following details:

- the finished length, dimension C, is to include 2 x 1.5 turns (three pitches) added to the required length. For example, a spiral 10 m long with a pitch of 100 mm shall be scheduled as being 10.3 m long
- if the bar length is greater than 12 m, the following note is to be added on the drawing and in the steel schedule on a comment line: Laps in spiral to be 50 times bar diameter. Bar length does not include extra length required for laps.

The following note shall point to the *Q* shaped bar on the relevant drawing: Supplied spiral to be adjusted on site to achieve anchorage at each end of 1.5 turns. Laps in spiral to be 50 times bar diameter.

Coupled reinforcement

Structures which are cast in stages or provide for future extensions often require reinforcing bars to be coupled together when the subsequent stage is constructed.

In such cases special notation is required to be shown on the drawings and the steel schedule. The note on the drawing shall be placed adjacent to the elevation where the bars are shown and shall state: Screwed couplers to be used to couple reinforcement between Stage 1 and Stage 2.

Notes on the steel schedule shall be placed on comment lines adjacent to the respective bars and shall state for Stage 1: Bar numbers to be supplied at one end only with an approved screwed coupler. Dimension ‘A’ includes coupler and plastic end cap.

For Stage 2: Bar numbers are to connect to Stage 1 screwed couplers. Dimension “A” is measured from construction joint to end of bar. The actual dimension needs to be adjusted to suit the coupler system used in Stage 1. Lengthening or shortening of the bar to conform to manufacturer’s specifications. Thread type and length may change depending on screwed coupler system used. Thread to conform to manufacturer’s specifications.

3.14 Maximum cutting length of reinforcing bars

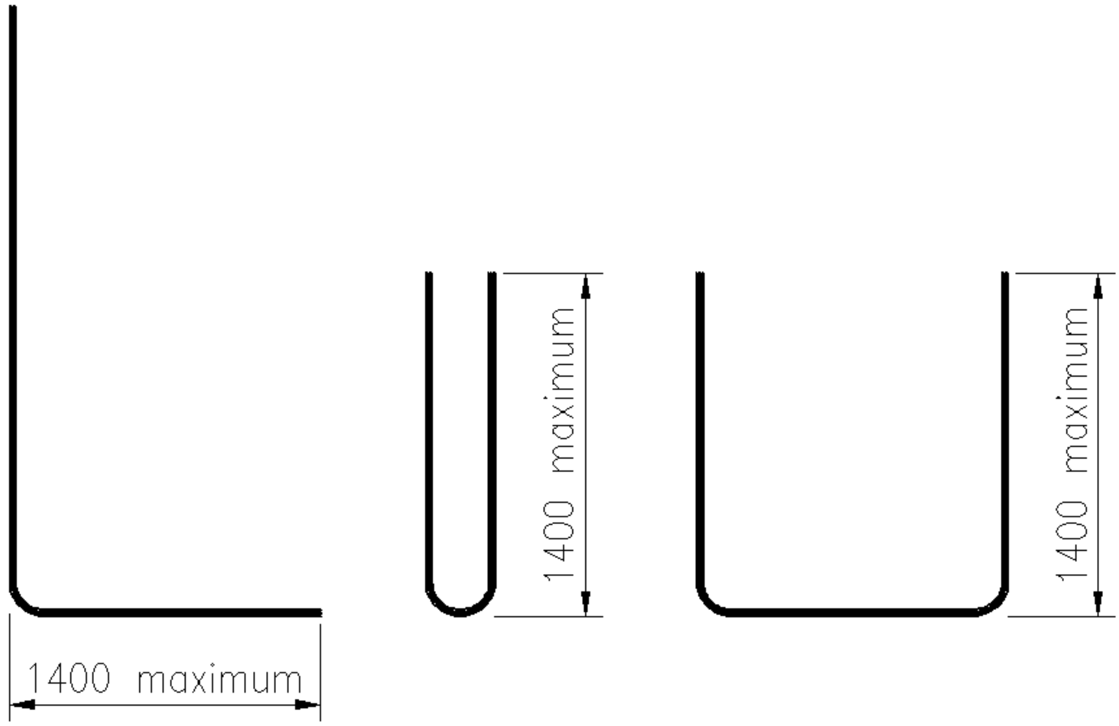
The maximum cutting length of steel reinforcing bars is 12 m and has been determined allowing for availability of standard lengths and for practical handling purposes during transportation and placement of the reinforcement.

3.15 Maximum leg length

When designing reinforcement bar shapes, consideration shall be given to the practicality of bending the bar. Bending a bar with a long leg length may not suit the bar bending equipment at some factories. Often, safety fences are positioned around the bar bending machine, and the leg may hit the fence. For these reasons, the leg length should be limited to 1.4 m wherever possible. This can usually be achieved by putting addition straight bars and laps in the reinforcement.

Refer Figure 3.15-1 Maximum Leg Length.

Figure 3.15-1 - Maximum Leg Length



Drafting and Design Presentation Standards
Volume 3: Structural Drafting Standards

Chapter 4: Computer Preparation of Steel Schedules

May 2013

Queensland Government

Feedback: Please send your feedback regarding this document to: tmr.techdocs@tmr.qld.gov.au

Chapter 4 Amendments

Revision register

Issue/Rev No.	Reference Section	Description of Revision	Authorised by	Date
1	-	First issue	Manager (Structural Drafting)	Apr 2011
2	-	Document name change	Manager (Structural Drafting)	Nov 2011
	4.16	Add section Further Assistance with the Steel Schedule Program		
	4.17	Add section Mass of Reinforcement		
3	4.16	Contact Name change in Further Assistance with the Steel Schedule Program	Team Leader (Structural Drafting)	May 2013

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Figure 4.11-1 - Fanned Variable VE Shaped Bar 6

Figure 4.11-2 - Fanned Variable C Shaped Bar 8

Figure 4.14-1 - Cranked Bars 10

4 Computer Preparation of Steel Schedules

4.1 Glossary of terms

For a complete glossary of terms refer Chapter 1-*Introduction*.

4.2 Figures and examples shown in this volume

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4.3 Scope

This instruction covers the use of the TMR steel schedule computer program used for the production of steel reinforcement schedules and is read in conjunction with TMR Standard Drawings 1043 Standard Bar Shapes and 1044 Standard Hook, Lap and Bend Details and General Steel Reinforcing Information.

Other steel schedule programs may be used if they produce the following output as a minimum:

- individual bar shape dimensions
- quantity, cutting length and mass for each individual bar
- individual bar shape location in the structure
- mass of reinforcement in each element of the bridge i.e. abutments, piers and deck
- diagram of non-standard bar shapes.

When using the TMR steel schedule computer program, input data is entered into a Microsoft Word file in the format shown in Appendix A - *Example of Input Data*. An example of the format of the word file is shown in Appendix C - *Example of Steel Schedule Input*.

The computer compiles the data and produces an output containing information that is required for the cutting and bending process, total mass for each bar mark and subtotal masses for minor elements of the project. At the end of the schedule a steel summary for each grade and diameter of bar is produced, plus a summary of masses for individual sections of the job as defined by subtotal controls on the input sheet.

4.4 General

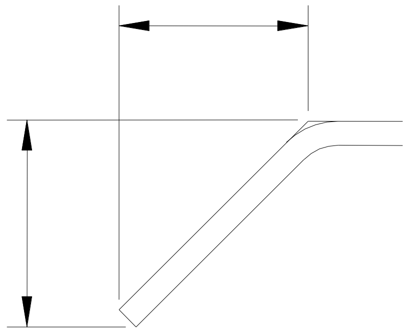
The steel program uses standard bar shapes shown on TMR Standard Drawing 1043 and details bars as per TMR Standard Drawing 1044. Bar shapes must be identical to that shown on TMR Standard Drawing 1043 including the position of hooks on applicable bars otherwise they will become non-standard. Refer 4.12 Non-standard Bars.

Except for some dimensions for variable bars (refer 4.11 Variable Bars), the computer will not calculate data for bar shapes other than those on TMR Standard Drawing 1043.

Note: Using tabs when entering text or entering data in the wrong columns will prevent the program from running correctly.

4.5 Dimensions

Dimensions are taken from the extremities of bars. Refer below:



When the angle for a bar shape can be either acute or obtuse, for example bar shape U, the computer calculates the angle and dimension C.

For a given bar shape, all dimensions shown on TMR Standard Drawing 1043, excluding those calculated automatically by the computer, must be given in the data sheet. A zero dimension is not allowable. Pin diameters must be given on the input data forms for all bars where P (pin diameter) is indicated on bar shape.

4.6 Titles

The first three lines of the input data sheet will be reproduced as a title on the top of every output page.

This title is divided into two sections; the General Title and the Job Number.

The General Title may occupy Columns 1 to 64 and the Job Number columns 65 to 80.

The computer will output the General Title centrally, and the Job Number in the top right hand corner of the page.

If the title does not require three lines the symbol "-" should be inserted in Column 1 of the remaining lines so that the first three lines on the input data sheet contain text. Alternatively the lines may be left blank.

4.7 Control of input and output

Control of input and output is afforded by control letters and numerals placed in Columns 1 to 4 as shown on the example input data sheet. Refer Appendix A - Example of Input Data.

Control letters and their purpose are as follows:

S - Leaves a blank line in the output. It shall be on a line by itself.

Blank (nothing is entered in the first line) - The rest of the line contains information about a reinforcing bar

C - This is used for any special comments or for extending the location description. The comment is printed on the same line as "C" and may occupy any location from Column 2 to 80. Input comment information is then listed on the output.

H - This is used for obtaining sub headings in the printout and for dividing the steel schedule into major elements, for example: H Abutment A

Note: “H” controls may only be preceded by controls “R”, “$” and “P” or the title of the job. The use of any other control or text on the preceding line will cause the program to malfunction.

P - This is used to divide major elements, for example Abutment A, into a number of minor elements and to obtain a sub total for these minor elements, for example: P Subtotal Footings

$R 1 - See ‘W’ on Appendix A - *Example of Input Data*, Page 1. Data for major elements including “P” lines are copied into files which can be recalled in total or in part to duplicate steel for other similar sections of the job. The $R control should be on a line by itself preceding the major element to be copied A total of nine files can be created and identified by numerals 1 to 9 in Column 4 of the input data sheet.

RT 1 - See ‘X’ on Appendix A - *Example of Input Data*, Page 2. Except for subheading, this control repeats all data stored in the file $R1. This control must be followed by control “H” and a new subheading.

RP 1 - See “Y” on Appendix A - *Example of Input Data*, Page 2. This control should be used when only part of the data stored in the file $R1 is required to duplicate steel for another similar section of the job. This control must be followed by control “H” and a new major element subheading, followed by “P” controls for minor elements conforming to those in the $R file which are to be duplicated. This process should incorporate variations as required for individual cases as described in items following. There is to be an equal number of minor elements in the new major element as there was in the $R file.

- if all of the stored data in a minor element is required to be duplicated, the previous “H” or “P” control line shall be followed by the relevant “P”
- if the whole of the minor element is to be overwritten, the new data is written before the appropriate “P” control
- if some of the old minor element is to altered, proceed as follows:
  - control “+” followed on subsequent lines by details of bars to be added for this section of the steel schedule
  - control “-” and on the same line, bar mark only. This process deletes bars that are not required for this section.

V - Linear Variable Bar. Refer Section 4.11 Variable Bars - Linear Variable.

VF - Fanned Variable Bar. Refer 4.11 Variable Bars

M - Reinforcing mesh. Refer 4.13 Reinforcing Mesh

E - End of this job, but there is another job to follow. A steel summary will be printed and the data on the next three lines will be taken as title. Control “E” is on a line by itself

F – Finish. There is no more input data. Control “F” is on a line by itself.

4.8 Subtotals and summaries

The total mass for individual bar marks and mesh sheets is printed at the right hand side of the output sheet.

Subtotals are printed out at the end of minor elements where controls “P” are input on the coding sheet.

Summaries of steel by location and also by diameter, grade and mesh type are printed out at the end of the steel schedule.

Summaries by diameter and grade give lengths and masses for the various bar diameters as well as a total mass of the various grades for the whole job.

Summaries of mesh give area in square metres and masses for various mesh types as well as a total mass of mesh for the whole job.

Summaries by location give subtotals for minor elements as well as total mass for major elements.

4.9 Details of individual bars

Column 1, Control Letter

A blank in Column 1 indicates the rest of the data on that line refers to an individual bar.

Columns 2-3, Bar size

This is the bar size in millimetres. If there is only one figure this has to be in the right hand column (Column 3). Sizes of bars that can be processed by the computer program are as follows: 10 mm diameter to 36 mm diameter, 6.3 mm and 8 mm hard drawn wire and bars 20 mm, 25 mm and 28 mm square. Wire 6.3 mm diameter should be entered on the input data sheet as 6 mm.

Columns 4-5, Bar shape

This is the letter representing a bar shape as shown on TMR Standard Drawing 1043. If there is only one letter this has to be in the left hand column (Column 4). Bars with shape letters different from TMR Standard Drawing 1043 will be assumed to be non-standard.

Columns 6-9, Bar sequence number

Except with variable bars this is of no interest to the computer and is merely reproduced in the output.

Column 10, Steel grade and type

This is the grade and type of steel used in the bar. If this column is left blank, steel grade and type will be assumed to be D500N. Other grades and types of reinforcing steel are:

- **R** - Grade R250N (round bars)
- **N** or blank - Grade D500N (deformed bars)
- **W** - Plain hard drawn wire
- **Q** - Square bars.

Columns 11-28, Location of bar

A description of the location of the bar is written here. The location is reproduced in the output and may be continued onto the next line by control letter 'C'.

Note: Bar details shall be entered in Columns 29-80 in free format, that is, each data entry separated by a space. Refer Appendix C - Example of Steel Schedule Input.

Columns 29-69

These contain the dimensions of bars corresponding to those shown on TMR Standard Drawing 1043. Dimensions must be given to the nearest millimetre. Dimensions are to be as far right in each section as possible. Columns 59 to 63 refer Section 4.10 *Pin Diameters*.

Columns 70-71 Laps

These contain the number of laps for a length of bar that exceeds the maximum allowable length of 12 m. 12 m is the maximum allowed for ease of transport.

Use Column 71 for 1-9 laps, Columns 70 and 71 for 10+ laps.

Column 72

Lap type as follows:

- **S** denotes straight lap
- **H** denotes hooked lap.

Columns 73-76

Length of lap(s).

Columns 77-80, Number required

This is the number of bars required and is written as far to the right as possible.

4.10 Pin diameters

Pin diameters must be given for all bars where "P" is indicated on TMR Standard Drawing 1043. Refer to TMR Standard Drawing 1044 for details of minimum bends. Minimum pin diameter for galvanised bars is to be five x diameter for bars bent prior to galvanising and eight x diameter for bars bent after galvanising.

4.11 Variable bars

The steel schedule programme will calculate two types of variable bar.

- linear variable which is most commonly used
- fanned variable which is used mostly in super T-girders.

Linear variable

A set of variable bars is represented by the first bar and the last bar of the set which are written on two consecutive lines of the data sheets.

The letter V is placed in Column 1of the first bar.

Every bar in the set is assumed to have the same shape, diameter, steel grade and type, location description, lap details, and number required as this bar.

The sequence number and dimensions corresponding to the last bar are written on the next line.

The computer will then print out a set of bars starting from the first bar with sequence numbers increasing in steps of one until the sequence number corresponding to the last bar is reached.

When any particular dimensions given for the two extreme bars are the same they are the same for all the intermediate bars.

When any particular dimensions differ there is a linear change from the dimension given for the first bar to that for the last bar.

Dimensions of intermediate bars shown in the output are rounded to the nearest millimetre. The variable bar control will work for both standard and non-standard bars.

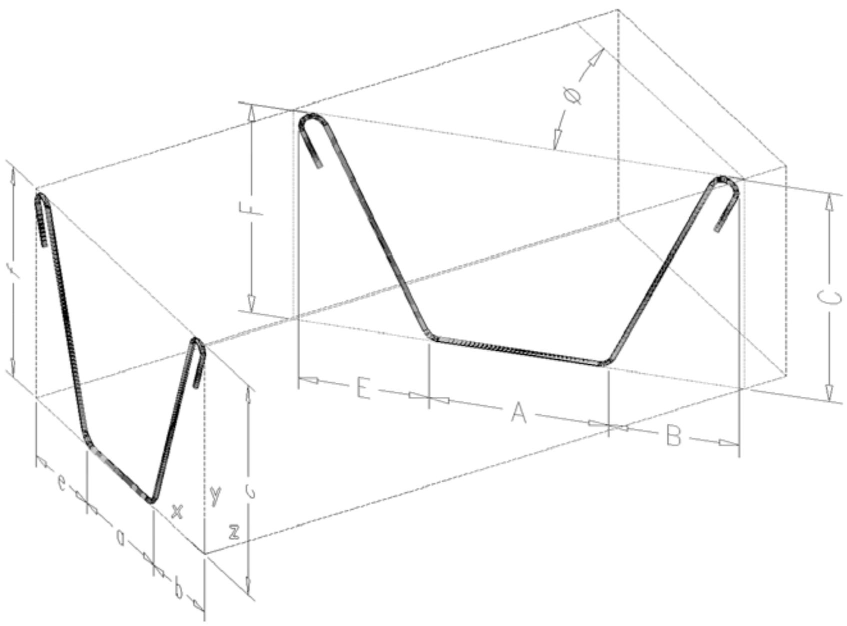
Fanned variable

The steel schedule program can calculate the varying dimension of bars placed on varying skew angles in a reinforced concrete section. This applies particularly to the skewed ends of super T- girders or headstocks where the general run of transverse reinforcement is placed square to the section while the end few transverse bars are splayed in a fan formation to ensure that the end bar is parallel to the skewed end of the section.

A linear variation of bar lengths is not appropriate as the difference from bar to bar is quite small where the bar is nearly square to the concrete section but can become quite large where the bar is at a considerable angle to the section. The actual variation has to be a function of the cosine of the skew angle of each individual bar.

A VE bar shape is used to demonstrate how the program is set up, however, the program works equally well for any shape you choose. Refer Figure 4.11-1 Fanned Variable VE Shaped Bar.

Figure 4.11-1 - Fanned Variable VE Shaped Bar



VE bar with dimensions on square section parallel to x and y.

Consider that the VE shaped bar, which has dimensions A, B, C, E and F, is to be placed at a skew angle Ø to the axis of the concrete member and that the projection on the concrete cross section of the bar dimensions are a, b, c, e and f. The program is set up to read in the projected dimensions a, b, c, e and f and the angle Ø and calculates the bar dimensions A, B, D, E and F using the following formulas:

- **A** = a/cos Ø
- ***B** = b/cos Ø C = c
- ***E** = e/cos Ø F = f

* The skewed dimensions B and E are automatically adjusted in the program to accommodate the constant pin diameter of the hook so that uniform cover is maintained between the bar and the sloping side formwork.

For a series of skewed bars, where the skew changes from bar to bar in a fanned arrangement, the skew angles of the first and last bars in the set $Ø_1$ and $Ø_2$ are read in and the program calculates the skew angles of all the intervening bars.

Note that c and f are "vertical" dimensions not affected by the value of Ø, a, b and e are "horizontal" dimensions.

The program is general and works for any shape that is defined by a combination of "horizontal" and "vertical" dimensions. Therefore it must be told each time which dimensions are to be considered variable and which are constant. This is done by encoding the word VARIABLE, followed by the names of the "horizontal" dimensions in the location field of the input data sheets, for example for VE bars, VARIABLE ABE shows that a, b and e are to be divided by cos Ø while c and f are not.

The required data is a three line set similar to the V type linear variable bar sets:

Line 1	Columns 1, 2	VF	
Line 2	Columns 1	[blank]	
	Columns 2, 3	Bar diameter	
	Columns 4, 5	Shape	
	Columns 6-9	Bar number of 1st bar in set	
	Columns 10	Grade	
	Columns 11-28	Location	
	Column 29	a b c e f pin dia No	Leaving out values for letters that are not required
Line 3	Column 1	[blank]	
	Columns 2, 3	Bar diameter	
	Columns 4, 5	Shape	
	Columns 6-9	Bar number of last bar in set	
	Column 10	Grade	
	Columns 11-28	VARIABLE ABE	Indicates that dimensions A, B and E vary with the skew, C and F are constant
	Columns 29-80	$Ø_1$ $Ø_2$	The skew angle in degrees of first and last bar in set

If the bar number in line three is coded the same as the bar number in line two, then only one bar is generated and $Ø_1$ and $Ø_2$ should be entered with the same value. This is useful if all transverse bars in a section are parallel but skewed.

The following input data example shows a 16VE bar varying in skew by 45°. There are sixteen different bars with bar marks from 16VE62 to 16VEF77. There is two of each bar mark:

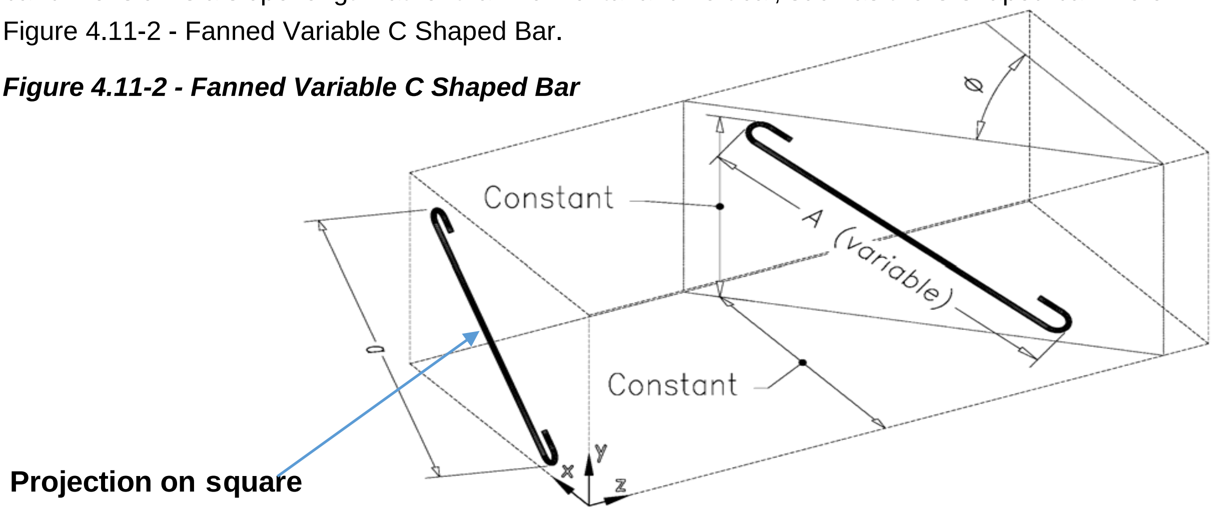
VF

16VE 62 RADIAL BARS 265 200 1400 200 1400 60 2

16VE 77 VARIABLE ABE 0 45.

The only bar shape for which the fanned variable command does not work is one in which the required bar dimension is a slope length rather than horizontal and vertical, such as the C shaped bar. Refer Figure 4.11-2 - Fanned Variable C Shaped Bar.

Figure 4.11-2 - Fanned Variable C Shaped Bar



C bar without dimensions parallel to x and y axis cannot be solved by the steel program

4.12 Non-standard bars

Bars with shapes that differ from those shown on TMR Standard Drawing 1043 are non-standard bars. These bars are to be given a shape letter or pair of letters different to those shown on TMR Standard Drawing 1043 and will be detailed as shown in 'Z' on Appendix A - *Example of Input Data*, Sheet one and the example in Appendix B - *Example of Steel Schedule Appendix*. The Appendix for non-standard bars shall be placed at the end of the reinforcing steel schedule.

The cutting length for these bars is calculated manually and must be entered in Column L of the input data sheets. The computer transfers this to the appropriate column for output and adds the relevant quantity to the steel summary.

The other dimensions of the bar should be written in the columns corresponding to the lettered dimensions shown on the drawing of the non-standard bar. These dimensions together with the length of bar in Column L will be reproduced in the output.

The number of bars required should be entered in the columns 77 to 80 of the data sheet.

4.13 Reinforcing mesh

Details should be entered in the steel schedule by use of control M. Input information format is as follows:

- M in Column 1
- fabric Type/Size in Columns 2-6
- description/location in Columns 11-28
- length of sheet in the A Columns 29-34
- width of sheet in the B Columns 35-40
- number of sheets required in Columns 77-80.

If the mesh is not a full standard sheet (6m x 2.4 m) it may be necessary to add a diagram to the output sheet to define the orientation of the different wire sizes and cutting details. The steel program processes all types of mesh as listed below:

RL1218	RL1018	RL818
SL102	SL92	SL82
SL81 SL72	SL62	
L12TM	L11TM	L8TM.

The following input data example shows full sheets of SL81 mesh and four half sheets of RL1218 mesh:

MSL81	*MESH*	*6000*	*2400*	*2*
MRL1218	*MESH*	*3000*	*2400*	*4.*

4.14 Tolerances for scheduling reinforcement

The correct application of tolerances will assist in avoiding the problem of reinforcement being theoretically correct, but incorrect in practice due to construction tolerances. Cover to reinforcement is liable to variation on account of the cumulative effect of small errors in the dimensions of formwork and the cutting, bending, and fixing of the reinforcement (constructions tolerances).

Except where they are used as fitment bars, the following tolerances shall be added to the overall length of straight A shaped bars:

- 25 mm for bar lengths up to 600 mm
- 40 mm for bar lengths over 600 mm.

Tolerance shall not be applied to fitment bars because adequate construction tolerances are allowed for in the following TMR Standard Specifications:

PSC deck units and girders

- Formwork for girders and deck units shall in accordance with MRTS73 *Manufacture of Prestressed Concrete Members and Stressing Units*, 7.3.5 Out of Square
- Cover to reinforcement shall be in accordance with MRTS73 *Manufacture of Prestressed Concrete Members and Stressing Units*, 7.3.3 Location of Tendons and Reinforcing Steel

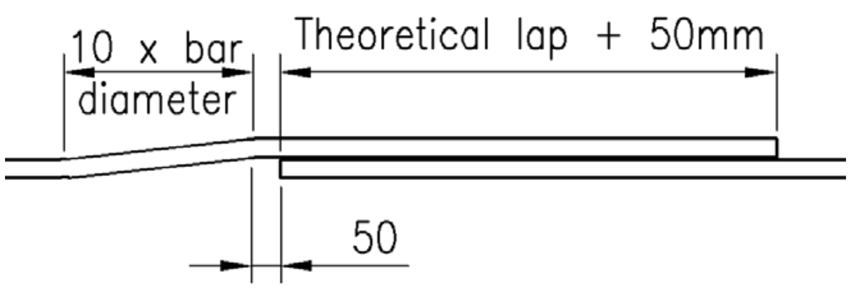
- Reinforcement is bent in accordance with the tolerances shown in MRTS71 *Reinforcing Steel*, 7 Cutting and Bending.

Cast insitu concrete

- Concrete cross sectional dimensions and cover to reinforcement shall be in accordance with MRTS70 *Concrete*, Table 22.2 - Dimensional Tolerance
- Reinforcement is bent in accordance with the tolerances shown in MRTS71 *Reinforcing Steel*, 7 Cutting and Bending.

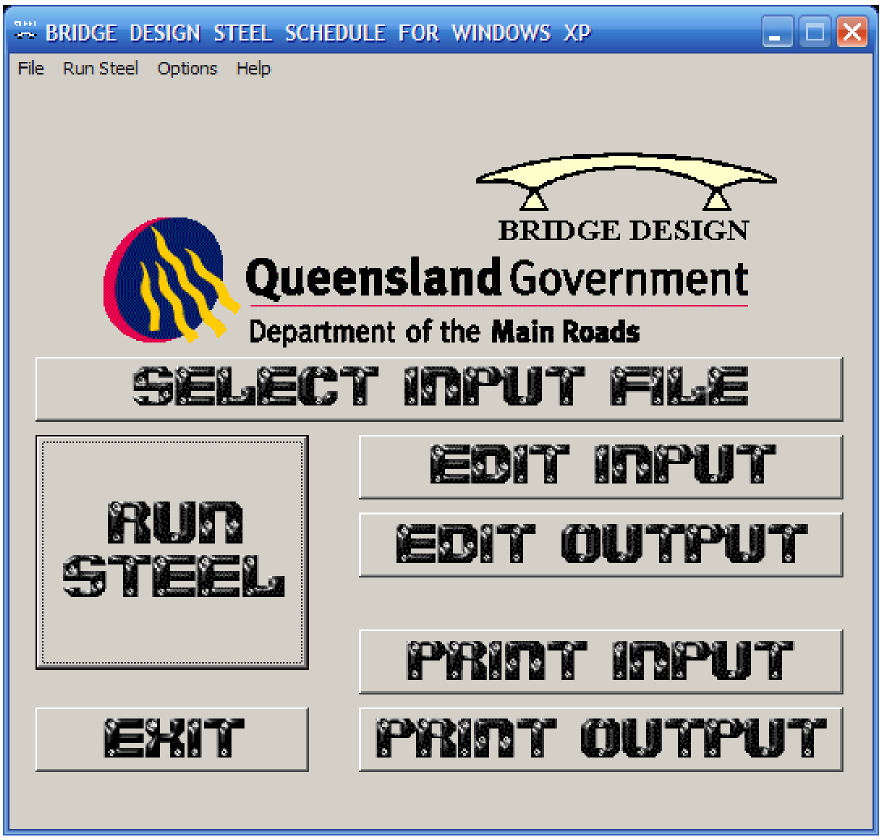
50 mm of tolerance shall be added to the lap of cranked bars. Refer Figure 4.14-1 - Cranked Bars.

Figure 4.14-1 - Cranked Bars



4.15 Printing steel schedule output

The steel schedule program is written to print output to Hewlett Packard printers. In the menu hit the 'PRINT OUTPUT' button after hitting the 'RUN STEEL' button.



To print output on other printers hit the 'RUN STEEL' button then the 'EDIT OUTPUT' button.

In Microsoft Word, set the page to landscape then highlight all the text and make sure it is eight points high, plain text and courier new font. Delete the first page as it is not relevant, then print the steel schedule. Refer Appendix D - Example of Steel Schedule Output.

4.16 Further assistance with the steel schedule program

For further assistance with the steel scheduling program, contact Sean Flanagan (TMR Bridge and Marine Engineering Section) on 07 3066 6377 or sean.m.flanagan@tmr.qld.gov.au

4.17 Mass of reinforcement

The steel scheduling program uses the following details to calculate the mass of reinforcement:

Deformed reinforcement

- 10 mm diameter bar - 0.632 kg/m
- 12 mm diameter bar - 0.910 kg/m
- 16 mm diameter bar - 1.619 kg/m
- 20 mm diameter bar - 2.528 kg/m
- 24 mm diameter bar - 3.640 kg/m
- 25 mm diameter reidbar - 3.854 kg/m
- 28 mm diameter bar - 4.955 kg/m
- 32 mm diameter bar - 6.471 kg/m
- 36 mm diameter bar - 8.190 kg/m
- 40 mm diameter bar - 10.112 kg/m.

Round bar reinforcement

- 6 mm diameter bar - 0.222 kg/m
- 10 mm diameter bar - 0.617 kg/m
- 12 mm diameter bar - 0.888 kg/m
- 16 mm diameter bar - 1.578 kg/m
- 20 mm diameter bar - 2.466 kg/m
- 24 mm diameter bar - 3.551 kg/m
- 28 mm diameter bar - 4.834 kg/m
- 32 mm diameter bar - 6.313 kg/m
- 36 mm diameter bar - 7.990 kg/m
- 40 mm diameter bar - 9.864 kg/m.

Rectangular mesh (6m x 2.4m sheet)

- RL718 – 67 kg/sheet
- RL818 – 79 kg/sheet
- RL918 – 93 kg/sheet
- RL1018 – 109 kg/sheet
- RL1118 – 1300 kg/sheet
- RL1218 – 157 kg/sheet.

Square mesh (6m x 2.4m sheet)

- SL52 – 20 kg/sheet
- SL62 – 33 kg/sheet
- SL72 – 41 kg/sheet
- SL82 – 52 kg/sheet
- SL92 – 66 kg/sheet
- SL102 – 80 kg/sheet
- SL81 – 105 kg/sheet.

Trench mesh (6m long)

- L8TM200 (200 mm wide strip) – 7 kg/sheet
- L8TM300 (300 mm wide strip) - 9.1 kg/sheet
- L8TM400 (400 mm wide strip) - 11.2 kg/sheet
- L11TM200 (200 mm wide strip) - 13.5 kg/sheet
- L11TM300 (300 mm wide strip) -17.8 kg/sheet
- L11TM400 (400 mm wide strip) – 22 kg/sheet
- L12TM200 (200 mm wide strip) - 16.8 kg/sheet
- L12TM300 (300 mm wide strip) - 22.1 kg/sheet
- L12TM400 (400 mm wide strip) - 27.3 kg/sheet.

Appendix A - Example of Input Data – Sheet 1

PAGE 1 of 4

FORM 63HV (/12/73)

CONTROL	BAR SIZE	SHAPE	BAR NO.	GRADE	LOCATION	DIMENSIONS (mm) A	B	C	E	F	P	L	LAPS No.	TYPE	LENGTH	No. REQ'D
1	2 3	4 5	6 7 8 9	10	11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28	29 30 31 32 33 34	35 36 37 38 39 40	41 42 43 44 45 46	47 48 49 50 51 52	53 54 55 56 57 58	59 60 61 62 63 64	65 66 67 68 69	70 71	72	73 74 75 76	77 78 79 80
N	EB	O	CREE	K	BRIDGE							JOB N	UM	B	ER	
N	EB	O	SHIR	E	SUTTOR DEVLEOPME	NTAL R	OAD (	NEBO-MT	COOLON)			90/82	A/	1	1	
T	44	L	OADI	N	G AND MULTI AXLE V	EHICLE		(The job title must take 3 lines)				(Job No. in columns 65-80)				
H					ABUTMENT A (DRG N	o. 279	000)									
	28	E	1		FOOTING	2900	500	500			140					8
	24	S	2		FOOTING	1900	900				120					6
	20	XX	3		FOOTING	3000	480	5600	90		100	9030				24
G																
P									FOOTING	SUB-	TOTAL	'SUB-TOTAL' Always in cols 55-63				
V	16	D	4		FRONT WALL	2300	250	first of variable bar								2
	16	D	25		FRONT WALL	3400	250	last of variable bar								2
P								FRONT	WALL	SUB-	TOTAL					
	24	E	26		HEADSTOCK	8985	500	500			120					8
	16	S	27		HEADSTOCK	600	650				80					30
	10	D	28	R	HEADSTOCK	675	180				30					34
C					BARS MARKED 20	D28-Y	TO BE	HOT	DIP GAL	VANISED	Comments may occupy columns 2 to 80					
S			Leaves a blank line in the output								- follow with 'S' control					
P								HE	ADSTOCK	SUB-	TOTAL					
W $	R	1	Places the following major element data in File 1													
H					PIER 1 (Drg.	No ---	)									
	12	P	29		CYLINDERS US & DS	1050							I	S	200	26
			Welded lap details for 'P' bars are printed automatically in the output													
S																
			30		CYLINDERS US & DS	3600										36

Leave column 10 blank for grade 410y bars. All other grades of bars are to be designated in column 10.

Appendix A - Example of Input Data – Sheet 2

PAGE 2 OF 4

FORM 63HV (/12/73)

	CONTROL	BAR SIZE	SHAPE	BAR NO.	GRADE	LOCATION	DIMENSIONS (mm) A	B	C	E	F	P	L	LAPS No.	TYPE	LENGTH	No. REQ'D
		28	A	31		CYLINDERS US & DS	2900										6
		16	S	32		CYLINDERS US & DS	500	400				48					4
	P								CYLINDERS SUB-TOTAL								
		28	A	33		COLUMNS US & DS	2500										12
		12	S	34		COLUMNS US & DS	600	400				36					8
		12	SX	35		COLUMNS US & DS	300	200				36					8
	P									COLUMNS SUB-TOTAL							
		28	D	36		HEADSTOCK	5000	600				140					8
		28	ND	37		HEADSTOCK	5000	1000	280	60	600	140					8
		16	S	38		HEADSTOCK	650	600				48					20
	P								HEADSTOCK SUB-TOTAL								
X	R	T	1														
	H					PIER 2 (Drg No. - - -)		Repeats total data in File 1 but									
Y	R	P	1					shows a new subheading - Pier 2									
	H					PIER 3 (Drg No. - - -)		Repeats part of data in File 1									
	+							shows a new subheading - Pier 3									
		28	A	39		CYLINDERS US & DS	4500	Adds bar 28A39-Y at the start of the minor element									36
	-	28	A	31				Deletes bars 28A31-Y & 16S32Y, but repeats details of bars 12P29-Y & 28A30-Y									
	-	16	S	32													
	P								CYLINDERS SUB-TOTAL								
		24	E	50		COLUMNS	7050	500	500			120					11
		28	E	51		COLUMNS	7050	500	500			140	Replaces bars 33,34 & 35				6
		28	A	52		COLUMNS	7000						with bars 50-53				5
		16	S	53		COLUMNS	1800	700				48					24

Appendix A - Example of Input Data – Sheet 3

PAGE 3 of 4 FORM 63HV (/12/73)

CONTROL	BAR SIZE	SHAPE	BAR NO.	GRADE	LOCATION	A	B	C	E	F	P	L	LAPS No.	LAPS TYPE	LAPS LENGTH	No. REQ'D
P									COLUMNS	SUB-TOTAL						
P									HEADSTOCK	SUB-TOTAL						
									Repeats bars 28D36-Y, 28ND37-Y & 16S38Y							
R	P	1														
H					PIER 4 (Drg No. - - -)											
	32	E	41		FOOTING	2900	900	900			160					12
	16	S	42		FOOTING	1900	830				80	Adds footing bars				10
	32	D	43		FOOTING	2400	300				160	for PIER 4				10
P									FOOTING	SUB-TOTAL						
P									COLUMN	SUB-TOTAL		Repeats colums and				
P									HEADSTOCK	SUB-TOTAL		headstock details for PIER 4				
					Note: Cylinder bars automatically deleted as control P &											
					description CYLINDERS SUB-TOTAL is not entered											
					on the data sheet											
R	P	1														
H					PIER 5 (Drg No. - - -)											
P									CYLINDERS	SUB-TOTAL						
P									COLUMN	SUB-TOTAL						
-	28	D	36		Deletes bar 28D36-Y											
+																
	28	D	41		HEADSTOCCK	4000	600				140					10
					Inserts 28D41-Y in the position previously occupied by 28D36-Y											
					Repeats bars 28ND37-Y & 16S38-Y											
P									HEADSTOCK	SUB-TOTAL						

Appendix A - Example of Input Data – Sheet 4

PAGE 4 OF 4 FORM 63HV (/12/73)

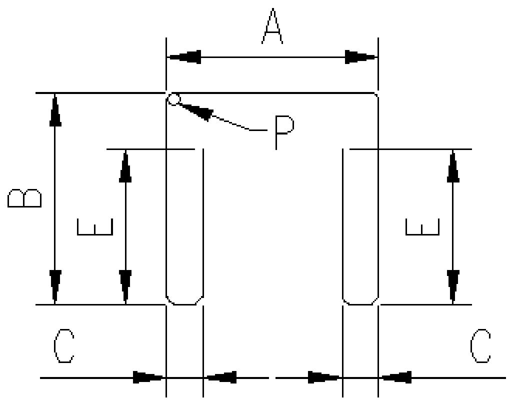
CONTROL	BAR SIZE	SHAPE	BAR NO.	GRADE	LOCATION	DIMENSIONS (mm) A	B	C	E	F	P	L	LAPS No.	TYPE	LENGTH	No. REQ'D
1	2 3	4 5	6 7 8 9	10	11–30	31–34	35–40	41–46	47–52	53–56	57–62	63–69	70 71	72	73–76	77–80
$	R	6														
H					ABUTMENT A RELIEVING SLAB			(Drg No. - - -)								
	20	A	1		LONGIT.	8500										6
	20	A	2		TRANSVERSE	3000										8
M	F9	2			MESH	6000	2400									2
M	F1	21	8		MESH	3000	2400									1
P							RELIEVING SLAB SUB-TOTAL									
						1. If the standard shows 2½ sheets of Mesh enter 2 whole sheets (6000 X 2400 X 1 off)										
						but enter the ½ sheet as 3000 X 2400 X 1 off										
						2. Add diagram to output wheet to show cutting diagram where necessary										
R	T	6														
H					ABUTMENT B RELIEVING SLAB			(Drg. No. - - -)								
F																

Appendix B - Example of Steel Schedule Appendix

APPENDIX

GILBERT RIVER BRIDGE
CARPENTARIA SHIRE
SM1600 and HLP400 LOADING

JOB NUMBER
31/89B/30



PIN DIA = 64 mm
CUTTING LENGTH = 4350 mm

16XE2 BAR

STEEL SCHEDULE APPENDIX_A.DWG

Appendix C - Example of Steel Schedule Input

GILBERT RIVER BRIDGE PRECAST HEADSTOCKS				JOB NUMBER
MT ISA CITY BARKLY HIGHWAY (CAMOOWEAL-BORDER) SM1600 LOADING				13/212/16
H	ABUTMENT HEADSTOCK (DRG NO 376311)			
C	NUMBER OF BARS SHOWN IS FOR ONE HEADSTOCK ONLY			
C	ABUTMENT HEADSTOCK NO OFF = 2			
S				
16S	1	HEADSTOCK	570 880 64 60	
16XE	2	HEADSTOCK	880 880 140 800 64 4350 15	
32E	3	HEADSTOCK	9280 700 700 160 8	
P		ABUTMENT HEADSTOCK SUB-TOTAL		
F				

Appendix D - Example of Steel Schedule Output – Sheet 1

```
       DEPARTMENT OF MAIN ROADS QUEENSLAND     STEEL SCHEDULE  (Ver 14.01)     SHEET NO.  1 OF   3     DATE  26 OCT 2011
/---------\
|OUTPUT   |          GILBERT RIVER BRIDGE PRECAST HEADSTOCKS                        JOB NUMBER
|CHECK    |          MT ISA CITY  BARKLY HIGHWAY (CAMOOWEAL-BORDER)                 13/212/16
|         |          SM1600 LOADING
|         |
\---------/       Datafile =  I:\Drafting\Steel\MANUAL.txt
DIA SHAPE  GRADE                       A       B       C       E       F      PIN DIA      L      LAPS     BAR    NO   TOTAL MASS      DIAGRAM
      SEQ NO       LOCATION            MM      MM      MM      MM      MM     P    MM      MM    NO LGTH LENGTH REQD     (KG)
____________________________________________________________________________________________________________________________
             ***********************************************************************************
             *            ABUTMENT HEADSTOCK (DRG NO 376311)                                   *
             ***********************************************************************************

                     NUMBER OF BARS SHOWN IS FOR ONE HEADSTOCK ONLY

                     ABUTMENT HEADSTOCK NO OFF = 2


 16 S     1     HEADSTOCK             570     880                                 64                      3280   60       318.6

 16 XE    2     HEADSTOCK             880     880     140     800                 64                      4350   15       105.6 See Appendix

 32 E     3     HEADSTOCK            9280     700     700                        160                     10533    8       545.3
---------------------------------------------------------------------------------------------------------------------------
                                  ABUTMENT HEADSTOCK SUB-TOTAL                GRADE D500N BARS                            970 KGS
___________________________________________________________________________________________________________________________


NOTES: 1. FOR FURTHER DETAILS SEE DRAWINGS 1043 AND 1044.          2. LAP TYPE:- "S"=STRAIGHT LAP, "H"=HOOKED LAP.
       3. ALL REINF. STEEL TO BE ACRS CERTIFIED, GRADE D500N OR R250N TO AS/NZS 4671 [D500N Grade "Blank", R250N Grade "R"]
```

Appendix D – Example of Steel Schedule Output – Sheet 2

```
DEPARTMENT OF MAIN ROADS QUEENSLAND     STEEL SCHEDULE  (Ver 14.01)     SHEET NO.  2 OF   3     DATE  26 OCT 2011

           GILBERT RIVER BRIDGE PRECAST HEADSTOCKS                          JOB NUMBER
           MT ISA CITY  BARKLY HIGHWAY (CAMOOWEAL-BORDER)                   13/212/16
           SM1600 LOADING


                                    STEEL SUMMARY BY LOCATION


      ********************************************************************************
      *            ABUTMENT HEADSTOCK (DRG NO 376311)                                *
      ********************************************************************************
-------------------------------------------------------------------------------------------------------------------
                    ABUTMENT HEADSTOCK SUB-TOTAL               GRADE D500N BARS                    970 KGS
___________________________________________________________________________________________________________________

                              TOTAL . . . BARS       970 KGS
                              ______________________________


DEPARTMENT OF MAIN ROADS QUEENSLAND     STEEL SCHEDULE  (Ver 14.01)     SHEET NO.  3 OF   3     DATE  26 OCT 2011

           GILBERT RIVER BRIDGE PRECAST HEADSTOCKS                       J        OB NUMBER
           MT ISA CITY  BARKLY HIGHWAY (CAMOOWEAL-BORDER)                1        3/212/16
           SM1600 LOADING


                                         STEEL  SUMMARY   BY  DIAMETER  AND  GRADE

     GRADE D500N
      BARS          (MM)   10        12        16        20        24        25        28        32        36        40

        MASS/METRE        0.632     0.910     1.619     2.528     3.640     3.854     4.955     6.471     8.190    10.112

        LENGTH  (METRE)   0.000     0.000   262.000     0.000     0.000     0.000     0.000    84.000     0.000     0.000

        MASS (KG)         0.00      0.00    424.26      0.00      0.00      0.00      0.00    545.27      0.00      0.00

        TOTAL MASS          969.53 KG                     0.970 TONNE


     /-----------------------------------------------------------------\
     | GRAND TOTAL MASS          969.53 KG                0.970 TONNE |
     \-----------------------------------------------------------------/
```

Drafting and Design Presentation Standards
Volume 3: Structural Drafting Standards

Chapter 5: Notes

August 2018

Queensland Government

Feedback: Please send your feedback regarding this document to: tmr.techdocs@tmr.qld.gov.au

Chapter 5 Amendments

Revision register

Issue/Rev No.	Reference Section	Description of Revision	Authorised by	Date
1	-	First Issue.	Manager (Structural Drafting)	April 2011
2	-	Document name change.	Manager (Structural Drafting)	November 2011
	-	Additional/amended drainage, concrete and reinforcement notes.		
	5.6	Minimum DWS thickness for superelevated deck unit bridges increased to 80 mm (including 10 mm bituminous waterproof membrane).		
	5.16	Bridge traffic rail changed to bridge traffic barrier.		
3	-	Welding notes in the whole chapter amended: Removal of stick electrode types and change of Aust Std for welding consumables and adding /NZS to Stainless Steel welding.	Team Leader (Structural Drafting)	December 2012
	5.5	Sample Notes: Concrete wording amended in paragraph four and Figure 5.5-1 Example Construction Procedure Notes changed.		
	5.7	Steelwork note amended.		
	5.8	Concrete and Steelwork note amended.		
	5.9	Steelwork note amended.		
	5.11	Deformed wire Grade D500L deleted Strand size and force changed.		
	5.14	Reinforcing Steel: Stainless steel reinforcement notes amended. Unbrako screws notes amended		
	5.16	Delineation note added		
4	5.3	Note Added: Notes to be shown on each bridge project where there is more than one bridge in the scheme.	Team Leader (Structural Drafting)	August 2015
	Fig 5.5-1	Size and clarity of text improved		
	5.6	Project Surveyors Note changed to reference TMR Surveying Standards. DWS minimum heights modified to match design criteria. Nuts Class 5 changed to Class 8/NZS added to AS 1252		
	5.7	Welding consumables amended Ref to AS/NZS 2717.1 changed		
	5.8	Compaction wording amended Axial shortening note separated Steel plate grade specified as 250 min Weld note amended		

Issue/Rev No.	Reference Section	Description of Revision	Authorised by	Date
	5.9	Compaction wording amended Chamfer Note added Pretensioning force at stressing = 187.5kN per strand (Deflected strands removed) Plate Grade added Steel plate grade specified as 250 min Welding consumables amended Final Deck Unit Length note added Concrete vibration note		
	5.10	Plate Grade added Welding consumables amended		
	5.11	Concrete vibration note Welding consumables amended Strand dia 12.7, Pretensioning force 147kN		
	5.12	Plate Grade added Welding consumables amended		
	5.13	Note 1 added.to reference MRTS77 Plate Grade added Note 5 – Instructions added. Note 6 – Revised Welding consumables amended		
	5.14 to 5.18	Steel Plate Grade added Welding consumables amended		
	5.19	Cast-In Place Piles Notes added		
5	5.6	DWS minimum depths updated	Team Leader (Structural Drafting)	October 2016
	5.6, 5.8, 5.9, 5.11	Change ACRS from 'Australian' to 'Australasian'		
6	5.6	Cross reference updated to match October 2017 MRTS30 "Refer Table 8.6.1 – Nominated layer thickness limits".	Senior Designer	August 2018

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5 Notes

5.1 Glossary of terms

For a complete glossary of terms refer Chapter 1 - *Introduction.*

5.2 Figures and examples shown in this volume

The figures and examples shown in this volume are for presentation purposes only, and may contain some details that are now superseded. These details have been included for ease of reference, to illustrate typical solutions, and to show the required standard of drafting presentation. The details are not to be used without an engineering check and certification by a Structural RPEQ to confirm that the details are appropriate for the specific project.

5.3 General

This chapter sets out the requirements for the positioning, content and form that notation will take on bridge drawings.

Notes on drawings shall be clear and concise with regard to information and instructions.

Notes are more likely to be followed if they are on the drawing in question, rather than being on a separate drawing dedicated only to notes. Sub-contractors may not be given the drawing of notes, and consequently, may make construction mistakes. For this reason, all precast concrete, steelwork, and other drawings that may be given to a sub-contractor, shall have their specific notes on the drawing in question.

For other elements of the structure, TMR prefers that the notes are shown on their relevant drawing, however TMR appreciates the complexities this may cause, particularly on large projects. Therefore, these notes may be compiled together on a single drawing. For projects that have more than one bridge in a set, each bridge shall have its own set of notes.

In the sample notes […] represents user input for specific project information and is to be replaced with that information. Some square brackets in the sample notes contain information that may be applicable. Delete the options that are not appropriate to the project.

The general notes are to reference relevant Australian Standards.

Grades/class of materials shall be referenced on the relevant views on the drawing. Where there are different grades or classes of material these are also referenced in the general notes, for example, Bolts Class 4.6 to AS 1111.1 and Bolts Class 8.8 to AS/NZS 1252.

Notes shall also be listed in each category in order of importance. If a note is critical to the element it shall be listed at the top of the category. Each category should follow a logical order.

Accepted abbreviations, refer Chapter 2 *Standard of Presentation*, 2.16 *Abbreviations*, can be used however other abbreviations should only be used if necessary, for example due to limited space on the drawing.

Trade names may be stated on the drawing, for example “Swiftlift Anchor Type 10t x 340”. However, or approved equivalent shall be appended to the proprietary product, for example “Swiftlift Anchor Type 10t x 340” or approved equivalent. Alternatively the note TRADE NAMES have been used for a particular product requirement but equivalent products may be submitted for approval, may be added to the notes for the General Arrangement drawing and on each drawing that proprietary products appear on.

On any drawing, where a note or reference applies to a particular view, section or detail only, it is to be placed as close as possible to the point to which it applies. The leader dimension should be placed at the beginning of the note text or at the end of the note text, for example:

200 dia holes for scuppers

(Girder Type G1)

200 dia holes for scuppers

(Girder Type G1)

Where a note is of greater significance it is to be presented in box so that it increases its visibility on the drawing, for example:

- for headstock reinforcement refer Drg No 123456

Or use capital letters for greater visibility, for example:

- fastener Type 1 only to be galvanised

DO NOT ISOLATE TEXT. For example Class 4.6 shall not be shown with Class on one line and 4.6 on the next line. Similarly keep text such as AS/NZS 1252 together on one line. It is not good practice to have one word isolated on the last line, for example:

- blinding concrete 50 nominal thickness.

5.4 Notes for bridge elements

The notes shall be placed under the heading NOTES at the bottom right-hand corner of the drawing.

The notes are grouped in categories that may include, but are not limited to:

- General notes such as lifting of precast components and foundation reports
- Concrete
- Reinforcement
- Strands
- Steelwork
- Transverse stressing bars
- Welding
- Voids
- Details of existing structures, and
- Notes for widenings.

Other project specific notes that may be applicable to an element should be added in the appropriate section within the notes or at the end. The first word or words of the notes indicating the category of that group are to be capitalised, for example HEIGHTS are calculated, TRADE NAMES have been used.

5.5 Sample notes

Typical notes for drawing elements are shown on the following pages as a guide. Only the notes relevant to the specific project should be used.

Add only the project specific information from the square brackets within the sample notes. Information shown in bold italic text in brackets at the end of each sample note is not to be shown and is provided as an example of where these notes should be used.

In general the grade of steel, finish of stainless steel and so on, should be called up on the relevant detail on the drawing and the relevant Australian Standard should be referred to in the notes. In cases where there is only one grade of material mentioned on the drawing the grade should be called up in the general notes.

Concrete Class and Strength and cover to reinforcing steel values in the sample notes are based on exposure classification B2. These values are to be adjusted accordingly if another exposure classification is used. Refer to AS 5100, Bridge Design for the full range of exposure classifications.

In some cases a construction procedure is needed for an element, for example girder anchorages. In these cases the construction procedure is to be positioned as near as possible to the relevant view. Refer Figure 5.5 1 Example Construction Procedure Notes.

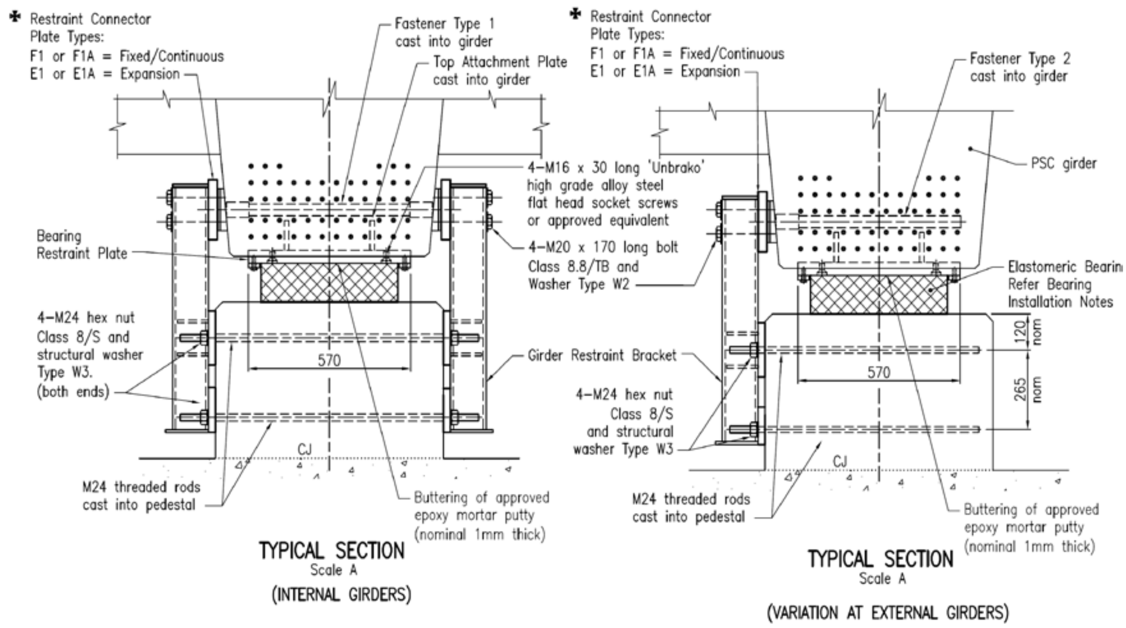
Figure 5.5-1 Example construction procedure notes

BEARING INSTALLATION NOTES:

1. Bearing design is based on the girders and restraints being installed at 100 days from casting. Approval to proceed must be obtained from the designer if not installed after 85 days and before 180 days from casting.
2. Bearing design is based on the ambient temperature at installation of 25°C. Approval to proceed must be obtained from the designer if temperature is less than 20°C or more than 30°C at time of installation.

GIRDER INSTALLATION AND RESTRAINT PROCEDURE:

1. Install restraint bracket assembly (loose M24 nuts initially - tighten at Step four).
2. Install temporary adjustable stools / jacks on top of the headstock, positioned to support the girder. Stools to be of sufficient strength to support the weight of the girder, and of such a height under load that the soffit of the girder will clear the top of the bearing pads by 1 mm at the closest point.
3. Immediately prior to installing the girder, apply a 1 mm nominal thick approved epoxy putty between the bearing and the underside of the bearing restraint plate. The epoxy shall have a cured compressive strength of not less than 60MPa.
4. The girder shall then be lowered into position and supported on the temporary stools. Any excess epoxy squeezed out shall be removed before it has set.
5. If the epoxy sets before completion of this operation, the girder shall be lifted off and all contact surfaces cleaned before repeating the process.
6. After the epoxy has fully cured over a period of not less than 48 hours, the temporary stools shall be removed without dislodging the girder.
7. During installation, the girders shall be restrained longitudinally and laterally by the Girder Restraint Brackets fitted to the bearing pedestals.



5.6 General arrangement notes

1. TRADE NAMES have been used for a particular product requirement but equivalent products may be submitted for approval. (***This note may be used instead of labelling each product with "or approved equivalent"***)

2. THE BRIDGE FOUNDATION INVESTIGATION REPORT [number] [date] is included in the scheme documents. Tenderers are able to view the core samples, if available, by arrangement with the Regional Director

3. PROJECT SURVEYORS may obtain an electronic project model (EPM), which sets out the substructure and superstructure of the bridge in real world coordinates, by arrangement with the Regional Director. All construction survey setting out and as constructed requirements are to adhere to the procedures and guidelines as prescribed in the *TMR Surveying Standards*

4. NO FILLING to be placed above the soffit of the abutment headstocks until at least two days after erection of the end spans and grouting of the [dowel bar/holding down bolt holes] (***PSC deck units***)

   NO FILLING to be placed above the soffit of the abutment headstocks until at least seven days after erection of the end spans and casting of the deck (***RC deck bridges***)

5. HEIGHTS are calculated allowing for DWS and bituminous waterproof membrane at abutments and piers to be [ ] thick at the centreline and [ ] thick at the kerbs. When laying the DWS, allowance shall be made for the upward deflection of the deck units so that the finished surface is true to grade. The thickness of DWS and bituminous waterproof membrane at any point shall not be less than 85 (75 minimum DWS and 10 bituminous waterproof membrane). (***PSC deck units - crossfall. For DWS tonnage calculation purposes the surfacing layer is 45 thick***)

   HEIGHTS are calculated allowing for DWS and bituminous waterproof membrane at abutments and piers to be 60 thick from kerb to kerb. The thickness of DWS and bituminous waterproof membrane at any point shall not be less than 60 (50 minimum DWS and 10 bituminous waterproof membrane). (***RC deck – crowned with two way crossfall. For DWS tonnage calculation purposes the surfacing layer is 45 thick***)

HEIGHTS are calculated allowing for DWS and bituminous waterproof membrane at nd piers to be [ ] thick from kerb to kerb. When laying the DWS, allowance shall be made for the upward deflection of the deck units so that the finished surface is true to grade. The thickness of DWS and bituminous waterproof membrane at any point shall not be less than 85 (75 minimum DWS and 10 bituminous waterproof membrane). (***PSC deck units – superelevation. For DWS tonnage calculation purposes the surfacing layer is 45 thick***)

HEIGHTS are calculated allowing for DWS and bituminous waterproof membrane at abutments and piers to be 95 thick from kerb to kerb. The thickness of DWS and bituminous waterproof membrane at any point shall not be less than 95 (85 minimum DWS and 10 bituminous waterproof membrane). (***RC deck – superelevation. For DWS tonnage calculation purposes the surfacing layer is 50 thick***)

Note: The DWS notes above are based on a corrector course and a surfacing layer for a high speed environment (motorways or roads with a speed limit of 100km/h or greater). For calculation purposes, bituminous waterproof membrane is 10 mm thick, and is not included when calculating DWS quantities. Smaller thicknesses of DWS can be achieved in lower speed environments. Refer Table 8.6.1 – Nominated layer thickness limits in MRTS30 *Asphalt Pavements.*

6. A CLEAR GAP shall be maintained between abutment sidewall and outside face of the kerb and shall not be filled with cement mortar

7. FORMWORK for the deck shall be supported by the [PSC girders/deck units]. On no account is the formwork to be tommed from the ground

8. {REINFORCING STEEL to be read in conjunction with Standard Drawings 1043 and 1044. Reinforcing steel to be in accordance with AS/NZS 4671 and MRTS71 *Reinforcing Steel*. Deformed bars Grade D500N. Round bars Grade R250N

   All carbon reinforcing steel to be Australasian Certification Authority for Reinforcing Steel (ACRS) certified.} (***Only add these notes on General Arrangement and precast product drawings***)

   Reinforcement to be hot dip galvanised to AS/NZS 4680 where shown

   Stainless steel reinforcing to be in accordance with BS 6744 and MRTS71A *Stainless Steel Reinforcing*. (***S/S reinforcement***)

   Stainless steel reinforcing to be Duplex Grade 2205 or 316L. (***S/S reinforcement***)

9. STEELWORK to be fabricated to MRTS78 *Fabrication of Structural Steelwork*

   Deck unit dowel bars Grade D500N to AS/NZS 4671, hot dip galvanised to AS/NZS 4680. (Bridges with deck units seated on cement mortar only, where the soffit of the bridge super-structure is above a 2000 ARI flood)

   Holding down bolts for deck units Class 4.6 to AS 1111, nuts Class 5 to AS 1112.1 and washers to AS/NZS 3678. (***Bridges with deck units seated on cement mortar only***)

Holding down bolts for deck units Class 8.8, nuts Class 8 to AS 1252, and washers to AS/NZS 3678. (***Bridges with provision for future jacking***)

Holding down bolts for steel girders Class 8.8, nuts Class 8 and washers for

Class 8.8 bolts to AS/NZS 1252

All anchors, bolts and nuts to be hot dip galvanised to AS 1214. All other steelwork to be hot dip galvanised to AS/NZS 4680 unless shown otherwise. Prior to galvanising all weld splatter and welding slag is to be removed

10. FOR DETAILS OF EXISTING STRUCTURE (BIS No [ ]) refer Drawing No's [ ] to [ ] in the scheme documents. (***Bridge widenings or when removing an existing bridge***)
11. HEIGHTS AND DIMENSIONS to be verified on site before commencement of work

    (***Bridge Widenings***).

5.7 Abutments and pier notes

1. TRADE NAMES have been used for a particular product requirement but equivalent products may be submitted for approval. (***This note may be used instead of labelling each product with "or approved equivalent"***)
2. CONCRETE to be in accordance with MRTS70 *Concrete*. Concrete to be S40/20, except as follows:
   - Bearing pedestals S40/10
   - Mass concrete N20/20
   - Blinding concrete N20/20

   Exposure classification B2. (***Concrete Class, strength grade, and exposure classification may differ in accordance with AS 5100.5 Concrete***)

   All exposed edges to have 19 x 19 chamfers unless shown otherwise
3. REINFORCING STEEL to be read in conjunction with Standard Drawings 1043 and 1044 Reinforcing steel to be in accordance with AS/NZS 4671 and MRTS71 *Reinforcing Steel*

   Minimum cover to reinforcing steel to be 55 unless shown otherwise

   Spacing of ligatures in headstock may be altered slightly, if necessary, to clear formed holes

   Reinforcement to be hot dip galvanised to AS/NZS 4680 where shown. (***Where reinforcement is to be galvanised, for example bond bars into relieving slabs***)
4. TOP 50 OF PSC PILES to be well scabbled prior to casting into [headstock/pile cap]. (***This note may be shown on a detailed view on the abutment and pier drawings***)
5. STEELWORK to be fabricated to MRTS78 *Fabrication of Structural Steelwork*. Steel liners to be Grade 250 (minimum) to AS/NZS 3678. (***Cast-in-place piles***) Steel piles to be Grade 300 (minimum) to AS/NZS 3679.1. (***Driven steel piles***)

   Bolts Class 4.6 to AS 1111.1, nuts Class 5 to AS 1112.1, washers for Class 4.6 bolts to AS 1237.1

   Bolts Class 8.8, nuts Class 8 and washers for Class 8.8 bolts to AS/NZS 1252

All bolts and nuts to be hot dip galvanised to AS 1214. All other steelwork to be hot dip galvanised to AS/NZS 4680 unless shown otherwise. Prior to galvanising, all weld splatter and welding slag is to be removed

6. WELDING symbols to AS 1101.3

   Structural Steel

   All welding to AS/NZS 1554.1

   All welds, except location tack welds, to be SP category

   Welding consumables to be controlled hydrogen type: G493 to AS/NZS ISO 14341-B, or T493 to AS/NZS ISO 17632-B unless shown otherwise

   Field joint welds shall be full penetration butt welds. (***Cast-in-place piles***)

   Stainless Steel

   Welding to AS/NZS 1554.6

   Weld quality – Category 2B

   Welding consumables to be 316L unless shown otherwise

   Welding consumables to AS/NZS 1167.2 and/or AS/NZS 4854

   Reinforcing Steel

   (***For reinforcing steel that shows welded laps - enter this group of notes***)

   Welding of bar splices to AS/NZS 1554.3

   All welds, except location tack welds, to be SP category

   Tack welding for location purposes to AS/NZS 1554.3

   Welding shall not be carried out within 75 from any bent portion of the bar

   Welding consumables to be controlled hydrogen type: G49X to AS/NZS ISO 14341-B or T49X to AS/NZS ISO 17632-B unless shown otherwise

   (***Direct butt splice and anchorage splice welds require the following consumables: G57X to AS/NZS ISO 14341-B, or T57X to AS/NZS IS0 17632-B***)

   Welding consumables to AS/NZS ISO 14341 or AS/NZS ISO 17632

   (***For reinforcing steel that shows NO welded laps - enter these notes only***)

   Tack welding for location purposes to AS/NZS 1554.3

   Welding consumables to be controlled hydrogen type: G49X to AS/NZS ISO 14341-B or T49X to AS/NZS ISO 17632-B unless shown otherwise

7. A DATE PLATE is to be cast into the outside face of the left hand wingwall at Abutment A. (***Abutments only***)

8. A PERMANENT SURVEY MARK is to be cast into the top of the left hand wingwall at Abutment A. (***Abutments only***)

9. A 20 DEEP SAW CUT is to be made at the junction with new work prior to breaking back existing concrete. (***Bridge widenings***)

10. EXISTING CONCRETE SURFACES to be well scabbled and cleaned with water blasting to remove all dust and loose particles before new work is placed. (Bridge widenings)

5.8 PSC deck unit notes

1. PSC DECK UNITS to be manufactured to MRTS73 *Manufacture of Prestressed Concrete Members and Stressing Units*
2. CONCRETE to be in accordance with MRTS70 *Concrete*. Concrete to be S50/20

   Strength at transfer to be 40MPa minimum

   Exposure classification B2. (Concrete Class, strength grade, and exposure classification may differ in accordance with AS 5100.5 Concrete)

   Concrete shall be cast in rigid forms and subjected to intense compaction, utilising a combination of internal and external vibration. All chamfers where shown to be 25 x 25 unless shown otherwise. Top surface of all units to be treated as a construction joint unless shown otherwise. (***Reinforced concrete deck bridges only***)
3. REINFORCING STEEL to be read in conjunction with Standard Drawings 1043 and 1044. Reinforcing steel to be in accordance with AS/NZS 4671 and MRTS71 *Reinforcing Steel*. Deformed bars Grade D500N. Round bars Grade R250N. Minimum cover to reinforcing steel and strands to be 35 unless shown otherwise

   All carbon reinforcing steel to be Australasian Certification Authority for Reinforcing Steel (ACRS) certified
4. STRANDS to MRTS73 *Manufacture of Prestressed Concrete Members and Stressing Units* and to AS/NZS 4672.1-7 wire ordinary-12.7-1870-Relax two and testing requirements to AS/NZS 4672.2. Pretensioning force at stressing = 147kN per strand. (***12.7 mm strands***)
   STRANDS to MRTS73 *Manufacture of Prestressed Concrete Members and Stressing Units* and to AS/NZS 4672.1-7 wire ordinary-15.2-1750-Relax two and testing requirements to AS/NZS 4672.2. Pretensioning force at stressing = 187.5kN per strand. (***15.2 mm strands***)

   Ends of strands to be coated with three coats minimum of surface tolerant epoxy after grinding flush with ends of units. Each coat to be a minimum of 0.3 mm dry thickness
5. STEELWORK to be fabricated to MRTS78 *Fabrication of Structural Steelwork*

   Steel plate to be Grade 250 minimum to AS/NZS 3678. Bolts Class 4.6 to AS 1111.1

   All bolts and nuts to be hot dip galvanised to AS 1214. All other steelwork to be hot dip galvanised to AS/NZS 4680 unless shown otherwise. Prior to galvanising, all weld splatter and welding slag is to be removed. Stainless steel plate to ASTM A240M. (***Cast in sockets for expansion joints***)

   Stainless steel round bar to ASTM A276. (***Cast in sockets for expansion joints***)
6. TRANSVERSE STRESSING BARS to MRTS73 *Manufacture of Prestressed Concrete Members and Stressing Units* and to AS/NZS 4672.1-bar-29-1030-P (with 300 mm minimum coarse tread at each end) and testing requirements to AS/NZS 4672.2. Transverse stressing force at lock off shall be 500kN

   Coupler bars to AS/NZS 4672.1-bar-45-1030-T and testing requirements to AS/NZS 4672.2. (***Bridge widenings and stage construction***)

7. TACK WELDING for location purposes to AS/NZS 1554.3 Clauses 3.3.1 and 3.3.2

   Welding consumables to be G49X or T49X. (***Direct butt splice and anchorage splice welds require the following consumables: G57X or T57X***) Welding consumables to AS/NZS ISO 14341-B or AS/NZS ISO 17632-B

   Welding symbols to AS 1101.3

   <u>Stainless Steel</u>

   Welding to AS/NZS 1554.6

   Weld quality – Category 2B

   Welding consumables to be E316L unless shown otherwise

   Welding consumables to AS/NZS 1167.2 and/or AS/NZS 4854

8. Voids shall be cellular polystyrene Grade SL to AS 1366.3. (***13-25 m long PSC deck units***)
9. PVC DRAINAGE PIPES to AS/NZS 1260. (***Units with scuppers***)
10. FINAL DECK UNIT DIMENSIONS – When casting units the manufacturer shall make allowance in formwork for end formwork kick due to hog and axial shortening (equal amounts each end) so that the units assume the detailed dimensions shown at 100 days.

5.9 PSC girder notes

1. PSC GIRDERS to be manufactured to MRTS73 *Manufacture of Prestressed Concrete Members and Stressing Units*
2. CONCRETE to be in accordance with MRTS70 *Concrete*. Concrete to be S50/20

   Strength at transfer to be 40MPa minimum

   Exposure classification B2. (***Concrete Class, strength grade, and exposure classification may differ in accordance with AS 5100.5 Concrete***)

   Concrete shall be cast in rigid forms and subjected to intense compaction, utilising a combination of internal and external vibration. Top surface of all girders to be treated as a construction joint unless shown otherwise

   All chamfers where shown to be 25 x 25 maximum unless shown otherwise

3. REINFORCING STEEL to be read in conjunction with Standard Drawings 1043 and 1044 Reinforcing steel to be in accordance with AS/NZS 4671 and MRTS71 *Reinforcing Steel* Deformed bars Grade D500N. Round bars Grade R250N. Minimum cover to reinforcing steel and strands to be 35 unless shown otherwise

   All carbon reinforcing steel to be Australasian Certification Authority for Reinforcing Steel (ACRS) certified. Stainless steel reinforcing to be in accordance with BS 6744 and MRTS71A *Stainless Steel Reinforcing*. (***S/S reinforcement***)

   Stainless steel reinforcing to be Duplex Grade 2205 or 316L. (***S/S reinforcement***)

4. STRANDS to MRTS73 *Manufacture of Prestressed Concrete Members and Stressing Units* and to AS/NZS 4672.1-7 wire ordinary-12.7-1870-Relax 2 and testing requirements to AS/NZS 4672.2. STRANDS to MRTS73 *Manufacture of Prestressed Concrete Members and Stressing Units* and to AS/NZS 4672.1-7 wire ordinary-15.2-1750-Relax 2 and testing requirements to AS/NZS 4672.2

   Pretensioning force at stressing = [ ]kN per strand (Straight Strands)

   = [ ]kN per strand (Deflected Strands)

   Ends of strands to be coated with three coats minimum of surface tolerant epoxy after grinding flush with ends of units. Each coat to be a minimum of 0.3 mm dry thickness

5. STEELWORK to be fabricated to MRTS78 *Fabrication of Structural Steelwork*

   Steel plate to be Grade 250 minimum to AS/NZS 3678

   All steelwork to be hot dip galvanised to AS/NZS 4680 unless shown otherwise. Prior to galvanising, all weld splatter and welding slag is to be removed

6. WELDING symbols conform to AS 1101.3

   <u>Structural Steel</u>

   All welding to AS/NZS 1554.1

   All welds, except location tack welds, to be SP category

   Welding consumables to be controlled hydrogen type: G493 to AS/NZS ISO 14341-B or T493 to AS/NZS ISO 17632-B unless shown otherwise

   <u>Reinforcing Steel</u>

   (***For reinforcing steel that shows welded laps - enter this group of notes***)

   Welding of bar splices to AS/NZS 1554.3

   All welds, except location tack welds, to be SP category

   Tack welding for location purposes to AS/NZS 1554.3 Clauses 3.3.1 and 3.3.2. Welding shall not be carried out within 75 from any bent portion of the bar

   Welding consumables to be controlled hydrogen type: G493 to AS/NZS ISO 14341-B or T493 to AS/NZS ISO 17632-B unless shown otherwise

   (***Direct butt splice and anchorage splice welds require the following consumables: G57X to AS/NZS ISO 14341-B, or T57X to AS/NZS IS017632-B***)

   (***For reinforcing steel that shows NO welded laps - enter these notes only***)

   Tack welding for location purposes to AS/NZS 1554.3 Clauses 3.3.1 and 3.3.2

   Welding consumables to be controlled hydrogen type: G49X to AS/NZS ISO 14341-B or T49X to AS/NZS ISO 17632-B unless shown otherwise

7. VOIDS are based on a length of 5 m maximum. Alternative void arrangements may be submitted for approval

8. PVC DRAINAGE PIPES to AS/NZS 1260 (***Girders with scuppers***)

9. FINAL GIRDER DIMENSIONS – When casting girders the manufacturer shall make allowance in formwork for end kick and axial shortening (equal amounts each end) so that the girder assumes the dimensions shown on the drawings at 100 days.

5.10 Steel girder notes

1. STEELWORK to be fabricated to MRTS78 *Fabrication of Structural Steelwork*

   UB GIRDERS to be Grade 300 to AS/NZS 3679.1

   Steel plate to be Grade 250 (minimum) to AS/NZS 3678

   Shear studs to AS/NZS 1554.2

   All steel work to be hot dip galvanised to AS/NZS 4680. Prior to galvanising all weld splatter and welding slag is to be removed

   Members to be branded with suitable type number after fabrication. (If required).

2. WELDING symbols conform to AS 1101.3

   <u>Structural Steel</u>

   Stud welding to AS/NZS 1554.2. All other welding to AS/NZS 1554.1

   All welds, except location tack welds, to be SP category

   Welding consumables to be controlled hydrogen type: G493 to AS/NZS ISO 14341-B or T493 to AS/NZS ISO 17632-B unless shown otherwise.

5.11 PSC pile notes

1. PILES to be manufactured to MRTS73 *Manufacture of Prestressed Concrete Members and Stressing Units*

2. FOR LIFTING DETAILS OF PILES refer MRTS65 *Precast Prestressed Concrete Piles*

3. CONCRETE to be in accordance with MRTS70 *Concrete*. Concrete to be S50/20

   Strength at transfer to be 35MPa minimum

   Exposure classification B2. (***Concrete Class, strength grade, and exposure classification may differ in accordance with AS 5100.5 Concrete***)

   Concrete shall be cast in rigid forms and subjected to intense compaction, utilising a combination of internal and external vibration

4. REINFORCING STEEL to be in accordance with AS/NZS 4671 and MRTS71 *Reinforcing Steel*. Deformed bars Grade D500N

   Round bars Grade R250N

   All carbon reinforcing steel to be Australasian Certification Authority for Reinforcing Steel (ACRS) certified. Minimum cover to main spiral steel to be 50 unless shown otherwise

5. STRANDS to MRTS73 *Manufacture of Prestressed Concrete Members and Stressing Units* and AS/NZS 4672.1-7 wire ordinary-12.7-1870-Relax 2 and testing requirements to AS/NZS 4672.2. Pretensioning force at stressing = 147kN per strand

6. STEELWORK to be fabricated to MRTS78 *Fabrication of Structural Steelwork*. Bolts Class 4.6 to AS 1111.1

7. GREY IRON CASTING Grade H-187 to AS 1830
8. WELDING symbols to AS 1101.3

   Welding of bar splices and tack welding for location purposes to AS/NZS 1554.3

   Welding consumables to be controlled hydrogen type: G49X to AS/NZS ISO 14341-B or T49X to AS/NZS ISO 17632-B unless shown otherwise.

5.12 Deck notes

1. CONSTRUCTION of the reinforced concrete deck shall be to MRTS77 *Bridge Deck*
2. TRADE NAMES have been used for a particular product requirement but equivalent products may be submitted for approval. (***This note may be used instead of labelling each product with "or approved equivalent"***)
3. CONCRETE to be in accordance with MRTS70 *Concrete*

   Concrete to be S40/20

   Exposure classification B2. (***Concrete Class, strength grade, and exposure classification may differ in accordance with AS 5100.5 Concrete***)

   All exposed edges to have 19 x 19 chamfers unless shown otherwise
4. FORMWORK for the deck shall be supported by the [PSC girders/ PSC deck units/steel girders]. On no account is the formwork to be tommed from the ground
5. REINFORCING STEEL to be read in conjunction with Standard Drawings 1043 and 1044. Reinforcing steel to be in accordance with AS/NZS 4671 and MRTS71 *Reinforcing Steel*

   Minimum cover to reinforcing steel to be 40 to underside of deck and 55 elsewhere unless shown otherwise

   Spacing of reinforcement in kerbs may be altered slightly, if necessary, to clear [***bridge traffic barrier post anchorages, junction boxes and scupper recesses***]

   Reinforcement to be hot dip galvanised to AS/NZS 4680 where shown. (***Where reinforcement is to be galvanised***)
6. STEELWORK to be fabricated to MRTS78 *Fabrication of Structural Steelwork*

   Steel plate to be Grade 250 (minimum) to AS/NZS 3678

   Stainless steel sheet and plate to ASTM A240M

   Stainless steel flat bar and round bar to ASTM A276

   Bolts and set screws Class 4.6 to AS 1111.1, nuts Class 5 to AS 1112.1, washers for Class 4.6 bolts to AS 1237

   Bolts Class 8.8, nuts Class 8 and washers for Class 8.8 bolts to AS/NZS 1252

   All bolts and nuts to be hot dip galvanised to AS 1214. All other steelwork to be hot dip galvanised to AS/NZS 4680 unless shown otherwise. Prior to galvanising, all weld splatter and welding slag is to be removed.

7. WELDING symbols to AS 1101.3.

   Structural Steel

   All welding to AS/NZS 1554.1

   All welds, except location tack welds, to be SP category

   Welding consumables to be controlled hydrogen type: G493 to AS/NZS ISO 14341-B or T493 to AS/NZS ISO 17632-B unless shown otherwise

   Stainless Steel

   Welding to AS/NZS 1554.6

   Weld quality – Category 2B

   Welding consumables to be 316L unless shown otherwise. Welding consumables to AS/NZS 1167.2 and/or AS/NZS 4854

   Aluminium

   Welding to AS/NZS 1665

   Welding quality to AS/NZS 1665, Category A

   Welding consumables to be E5356 unless shown otherwise to AS/NZS ISO 18273. (E5356 is used for welding aluminium expansion joints. Different consumables may be needed for different grades of aluminium)

   Reinforcing Steel

   (***For reinforcing steel that shows NO welded laps - enter these notes only***)

   Tack welding for location purposes to AS/NZS 1554.3 Clauses 3.3.1 and 3.3.2

   Welding shall not be carried out within 75 from any bent portion of the bar

   Welding consumables to be G49X or T49X to AS/NZS ISO 14341-B or AS/NZS ISO 17632-B. (***Direct butt splice and anchorage splice welds require the following consumables: G57X to AS/NZS ISO 14341-B, or T57X to AS/NZS IS0 17632-B***)

   (***For reinforcing steel that shows welded laps - enter this group of notes***)

   Welding of bar splices to AS/NZS 1554.3

   All welds, except location tack welds, to be SP category

   Tack welding for location purposes to AS/NZS 1554.3 Clauses 3.3.1 and 3.3.2

   Welding consumables to be controlled hydrogen type: G493 to AS/NZS ISO 14341-B or T493 to AS/NZS ISO 17632-B

8. COAT FINISHED DECK SURFACE with bituminous waterproofing membrane for the full length of the bridge including relieving slabs

9. A 20 DEEP SAW CUT is to be made at the junction with new work prior to breaking back existing concrete. (***Bridge widenings***)

10. EXISTING CONCRETE SURFACES to be well scabbled and cleaned with water blasting to remove all dust and loose particles before new work is placed. (***Bridge widenings***)

Refer to Chapter 17 Cast Insitu Kerbs and Decks, Appendix A - Deck Design Sketches for additional notes which shall be shown on the drawings. These may include, but are not limited to, the following topics:

- using a different expansion joint system and adjusting the dimensions
- pre-camber details, and
- deck casting notes.

5.13 Cast insitu kerb notes

1. CONSTRUCTION of the reinforced concrete kerbs shall be to MRTS77 *Bridge Deck*
2. TRADE NAMES have been used for a particular product requirement but equivalent products may be submitted for approval. (***This note may be used instead of labelling each product with "or approved equivalent"***)
3. CONCRETE to be in accordance with MRTS70 *Concrete*. Concrete to be S40/20

   Exposure classification B2. (***Concrete Class, strength grade, and exposure classification may differ in accordance with AS 5100.5 Concrete***)

   All exposed edges to have 19 x 19 chamfers unless shown otherwise
4. REINFORCING STEEL to be read in conjunction with Standard Drawings 1043 and 1044

   Reinforcing steel to be in accordance with AS/NZS 4671 and MRTS71 *Reinforcing Steel*

   Minimum cover to reinforcing steel to be 55 unless shown otherwise

   Reinforcement in kerbs may be cut if necessary to provide cover to scupper recesses

   Reinforcement to be hot dip galvanised to AS/NZS 4680 where shown. (***Where reinforcement is to be galvanised***)
5. STEELWORK to be fabricated to MRTS78 *Fabrication of Structural Steelwork*

   Steel plate to be Grade 250 minimum to AS/NZS 3678

   Flat bar to be Grade 300 to AS/NZS 3679.1

   Bolts Class 4.6 to AS 1111.1, nuts Class 5 to AS 1112.1, washers for Class 4.6 bolts to AS 1237.1

   Bolts Class 8.8, nuts Class 8 and washers for Class 8.8 bolts to AS/NZS 1252

   All bolts and nuts to be hot dip galvanised to AS 1214. All other steelwork to be hot dip galvanised to AS/NZS 4680 unless shown otherwise. Prior to galvanising all weld splatter and welding slag is to be removed. (This Note 5 is only added when steelwork, such as anchorages are included on the drawing)
6. WELDING symbols to AS 1101.3

   Welding of bar splices to AS/NZS 1554.3. All welds, except location tack welds, to be SP category.

   Tack welding for location purposes to AS/NZS 1554.3 Clauses 3.3.1 and 3.3.2.

   Welding shall not be carried out within 75 from any bent portion of the bar

Welding consumables to be controlled hydrogen type: G49X to AS/NZS ISO 14341-B or T49X to AS/NZS ISO 17632-B unless shown otherwise.

5.14 Miscellaneous details notes

1. TRADE NAMES have been used for a particular product requirement but equivalent products may be submitted for approval. (***This note may be used instead of labelling each product with "or approved equivalent"***)

2. REINFORCING STEEL to be read in conjunction with Standard Drawings 1043 and 1044. Stainless steel reinforcing to be in accordance with BS 6744 and MRTS71A *Stainless Steel Reinforcing*. Stainless steel reinforcing to be Duplex Grade 2205 or 316L

3. STEELWORK to be fabricated to MRTS78 *Fabrication of Structural Steelwork*

   Steel plate to be Grade 250 unless noted otherwise to AS/NZS 3678

   Flat bar, angles and channels to be Grade 300 to AS/NZS 3679.1

   Stainless steel sheet and plate to ASTM A240

   Stainless steel flat bar and round bar to ASTM A276

   [Bolts and set screws] Class 4.6 to AS 1111.1, nuts Class 5 to AS 1112.1 and washers for Class 4.6 bolts to AS 1237.1

   Bolts Class 8.8, nuts Class 8 and washers for Class 8.8 bolts to AS/NZS 1252

   Dowel bars Grade D500N to AS/NZS 4671, hot dip galvanised to AS/NZS 4680

   All bolts and nuts to be hot dip galvanised to AS 1214. All other steelwork to be hot dip galvanised to AS/NZS 4680 unless shown otherwise. Prior to galvanising all weld splatter and welding slag is to be removed

   "Unbrako" socket heads screws to AS/NZS 1421 or approved equivalent

   "Unbrako" socket heads screws shall be mechanically plated to the requirements of Fe/Zn 25c2A – AS 1789

   Stainless steel set screws to AS/NZS 1SO 3506.3

   Members to be branded with suitable type number after fabrication

4. WELDING symbols to AS 1101.3

   <u>Structural Steel</u>

   All welding to AS/NZS 1554.1

   All welds, except location tack welds, to be SP category.

   Welding consumables to be controlled hydrogen type: G493 to AS/NZS ISO 14341-B or T493 to AS/NZS ISO 17632-B unless shown otherwise

   <u>Stainless Steel</u>

   Welding to AS/NZS 1554.6

   Weld quality – Category 2B

   Welding consumables to be E316L unless shown otherwise

Welding consumables to AS/NZS 1167.2 and/or AS/NZS 4854

Aluminium

Welding to AS/NZS 1665

Welding quality to AS/NZS 1665, Category A

Welding consumables to be E5356 unless shown otherwise to AS/NZS ISO 18273. (***E5356 is used for welding aluminium expansion joints. Different consumables may be needed for different grades of aluminium***).

5.15 Relieving slab notes

1. RELIEVING SLABS are to be constructed on blinding concrete
2. CROSSFALL OR SUPERELEVATION of the slab is to be the same as that of the adjacent bridge. The slab is to finish flush with the top of the bridge deck and the deck wearing surface is to be carried through from the bridge over the slab. Change of crossfall, if any, to that of the adjacent pavement should be made clear of the slab over a distance of 15 metres
3. CONCRETE to be in accordance with MRTS70 *Concrete*

   Concrete to be S40/20, except as follows:

   - blinding concrete N20/20.

   Exposure classification B2. (Concrete Class, strength grade, and exposure classification may differ in accordance with AS 5100.5 Concrete)

   Construction joints are not necessary, but may be used to permit traffic flow during construction. Continuity of reinforcement across the joint is essential
4. REINFORCING STEEL to be read in conjunction with Standard Drawings 1043 and 1044. Reinforcing steel to be in accordance with AS/NZS 4671 and MRTS71 *Reinforcing Steel*

   Minimum cover to reinforcing steel to be 55 unless shown otherwise

   Reinforcement to be hot dip galvanised to AS/NZS 4680 where shown. (***Where reinforcement is to be galvanised***)
5. STEELWORK to be fabricated MRTS78 *Fabrication of Structural Steelwork*. (***Stage construction***)

   Dowel bars Grade D500N to AS/NZS 4671, hot dip galvanised to AS/NZS 4680. (***Stage construction***)
6. TACK WELDING for location purposes to AS/NZS 1554.3 Clauses 3.3.1 and 3.3.2

   Welding consumables to be controlled hydrogen type: G49X to AS/NZS ISO 14341-B or T49X to AS/NZS ISO 17632-B unless shown otherwise
7. IMMEDIATELY PRIOR TO PLACING STAGE TWO CONCRETE, adjoining concrete is to be well scabbled and cleaned with water blasting to remove all dust and loose particles before new work is placed. (***Stage construction***)

5.16 Bridge traffic barrier notes - Steel

1. DELINEATION on the bridge traffic barrier system shall be installed in the location and to the spacing shown on the drawing. Delineators shall be consistent with the requirements specified in MRTS14 *Road Furniture*
2. STEELWORK to be fabricated to MRTS78 *Fabrication of Structural Steelwork*

   RHS and SHS to be Grade C450L0 to AS/NZS 1163

   CHS to be Grade C250L0 to AS/NZS 1163. (***Bicycle safety rail***)

   All hollow section material manufactured to AS/NZS 1163 will require abrasive blasting to develop a surface profile of 50μm prior to hot dip galvanizing. All plate material manufactured to AS/NZS 1594 will require abrasive blasting to develop a surface profile of 50μm prior to hot dip galvanizing. Steel plate to be Grade 250 (minimum) to AS/NZS 3678

   Flat bar to be Grade 300 to AS/NZS 3679.1

   Bolts Class 8.8, nuts Class 8 and washers for Class 8.8 bolts to AS/NZS 1252, thin nuts Class 5 to AS 1112.4

   All bolts and nuts to be hot dip galvanised to AS 1214. All other steelwork to be hot dip galvanised to AS/NZS 4680 unless shown otherwise. Prior to galvanising all weld splatter and welding slag is to be removed

   Members to be branded with suitable type number after fabrication
3. WELDING symbols conform to AS 1101.3

   All welding to AS/NZS 1554.1

   All welds, except location tack welds, to be SP category

   Welding consumables to be controlled hydrogen type: G493 to AS/NZS ISO 14341-B or T493 to AS/NZS ISO 17632-B unless shown otherwise.

5.17 Balustrade notes - Steel

1. STEELWORK to be fabricated to MRTS78 *Fabrication of Structural Steelwork*

   RHS and SHS to be Grade C350L0 to AS/NZS 1163

   CHS to be Grade C250L0 to AS/NZS 1163. (***Bicycle safety rail***)

   All hollow section material manufactured to AS/NZS 1163 will require abrasive blasting to develop a surface profile of 50μm prior to hot dip galvanizing. Steel plate to be Grade 250 (minimum) to AS/NZS 3678

   Flat bar to be Grade 300 to AS/NZS 3679.1

   Bolts Class 4.6 to AS 1111.1, nuts Class 5 to AS 1112.1 and thin nuts Class 5 to AS 1112.4, washers for Class 4.6 bolts to AS 1237.1

   All bolts and nuts to be hot dip galvanised to AS 1214. All other steelwork to be hot dip galvanised to AS/NZS 4680 unless shown otherwise. Prior to galvanising all weld splatter and welding slag is to be removed.

   Members to be branded with suitable type number after fabrication

2. WELDING symbols conform to AS 1101.3

   All welding to AS/NZS 1554.1

   All welds, except location tack welds, to be SP category

   Welding consumables to be controlled hydrogen type: G493 to AS/NZS ISO 14341-B or T493 to AS/NZS ISO 17632-B unless shown otherwise.

5.18 Drainage system notes

1. TRADE NAMES have been used for a particular product requirement but equivalent products may be submitted for approval. (***This note may be used instead of labelling each product with "or approved equivalent"***)
2. STEELWORK to be fabricated to MRTS78 *Fabrication of Structural Steelwork*

   RHS and SHS to be Grade C450L0 to AS/NZS 1163

   CHS to be grade C250L0 to AS/NZS 1163

   All hollow section material manufactured to AS/NZS 1163 will require abrasive blasting to develop a surface profile of 50µm prior to hot dip galvanizing. All plate material manufactured to AS/NZS 1594 will require abrasive blasting to develop a surface profile of 50µm prior to hot dip galvanizing. Steel plate to be Grade 250 (minimum) to AS/NZS 3678

   Flat bar to be Grade 300 to AS/NZS 3679.1

   Coach screws Class 4.6 to AS 1393, bolts Class 4.6 to AS 1111.1, nuts Class 5 to AS 1112.1 and thin nuts Class 5 to AS 1112.4, washers for Class 4.6 bolts to AS 1237.1

   All bolts and nuts to be hot dip galvanised to AS 1214. All other steelwork to be hot dip galvanised to AS/NZS 4680 unless shown otherwise. Prior to galvanising all weld splatter and welding slag is to be removed

   Members to be branded with suitable type number after fabrication. The steel drain pipe shall be fabricated in accordance with the requirements and tests of API 5L Grade B

   The joint fittings and shoulders shall be fabricated in accordance with the requirements and tests of ASTM A-234 Grade WPB. Steelwork shall be joined using 'Tubemakers Victaulic' shouldered coupling system or approved equivalent
3. WELDING symbols conform to AS 1101.3

   All welding to AS/NZS 1554.1

   All welds, except location tack welds, to be SP category

   Welding consumables to be controlled hydrogen type: G493 to AS/NZS ISO 14341-B or T493 to AS/NZS ISO 17632-B unless shown otherwise
4. All field cutting, drilling and welding to be cleaned and painted with two coats of organic zinc-rich primer applied by brush.

5.19 Cast-in place piles

1. TRADE NAMES have been used for a particular product requirement but equivalent products may be submitted for approval. (***This note may be used instead of labelling each product with "or approved equivalent"***)

2. STEELWORK to be fabricated to requirements of MRTS78 *Fabrication of Structural Steelwork*

   Steel liners to be Grade 250 (minimum) to AS/NZS 3678

3. All welding to AS/NZS 1554.1

   All welds, except location tack welds, to be SP category

   Welding consumables to be controlled hydrogen type: G493 to AS/NZS ISO 14341-B or T493 to AS/NZS ISO 17632-B unless shown otherwise

   Field joint welds shall be full penetration butt welds.

Drafting and Design Presentation Standards
Volume 3: Structural Drafting Standards

Chapter 6: Welding

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Queensland Government

Feedback: Please send your feedback regarding this document to: tmr.techdocs@tmr.qld.gov.au

Chapter 6 - Amendments

Revision Register

Issue/Rev No.	Reference Section	Description of Revision	Authorised by	Date
1	-	First Issue	Manager (Structural Drafting)	April 2011
2	-	Document name change	Manager (Structural Drafting)	November 2011
	6.8	Weld preparation details amended in Figures 6.8-7 and 6.8-8		
3	6.6	Direct butt splice and anchorage splice welds for reinforcing bar – Welding consumables updated	Team Leader (Structural Drafting)	March 2017
	6.7	Welding Hollow Sections added.		
	6.8.5	Intermittent or Stitch Welds section removed		
	6.10	Australian Standards – updated to match current publications		

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6 Welding

6.1 Glossary of terms

For a complete glossary of terms refer Chapter 1 - *Introduction*.

6.2 Figures and examples shown in this volume

The figures and examples shown in this volume are for presentation purposes only, and may contain some details that are now superseded. These details have been included for ease of reference, to illustrate typical solutions, and to show the required standard of drafting presentation. The details are not to be used without an engineering check and certification by a Structural RPEQ to confirm that the details are appropriate for the specific project.

6.3 Notes format

For general welding notes refer Chapter 5 – *Notes*. Show only the welding notes applicable to the details on the Standard Drawing.

6.4 Welding of stainless steel

Welds shall be Category 2B in accordance with AS/NZS 1554.6 *Structural Steel Welding* Part 6: Welding Stainless Steels for Structural Purposes.

6.5 Welding Splice of reinforcing bar

Design details

The welded splice for a reinforcing bar shall be a flare-v-butt weld in accordance with AS 1554.3 *Structural Steel Welding*.

The diameter of the smallest bar is the controlling factor for the size of the weld.

The minimum throat thickness (D) shall not be less than 0.25 x smallest bar diameter. The minimum width of the weld (W) shall not be less than 0.45 x smallest bar diameter.

Welds are not permitted on a bent portion of a bar. Welds shall be kept clear of any bent portion of a bar by a minimum distance of twice the diameter of the bar being bent.

Weld tables for welded splice

The following tables show welding requirements for nominated bar diameters. Refer Table 6.5-1 - Welded Lap Lengths - One Side of Bar Welded, Table 6.5-2 - Welded Lap Lengths - Both Sides of Bar Welded, and Figure 6.5-3 - Welded Splice. The preferred splice is a weld on both sides of the bar.

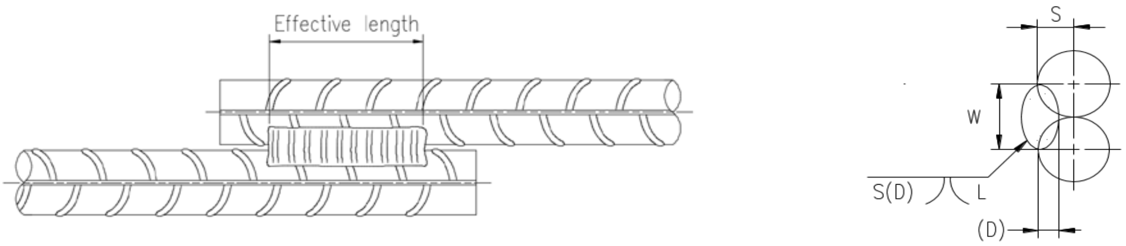
Table 6.5-1 - Welded Lap Lengths - One Side of Bar Welded

Bar Diameter	S (mm)	D (mm)	W (mm)	Welding Consumable	Weld Length (mm) (SP Category Weld)
R10	5	3	6	G49X to AS/NZS ISO 4341-B or T49X to AS/NZS ISO 17632-B	100
N12	6	3	6		110
N16	8	4	7		150
N20	10	5	9		180
N24	12	6	11		220
N28	14	7	13		260
N32	16	8	15		290
N36	18	9	16		330

Table 6.5-2 - Welded Lap Lengths - Both Sides of Bar Welded

Bar Diameter	S (mm)	D (mm)	W (mm)	Welding Consumable	Weld Length (mm) (SP Category Weld)
R10	5	3	6	G49X to AS/NZS ISO 14341-B or T49X to AS/NZS ISO 17632-B	50
N12	6	3	6		60
N16	8	4	7		80
N20	10	5	9		100
N24	12	6	11		120
N28	14	7	13		140
N32	16	8	15		160
N36	18	9	16		180

Figure 6.5-3 - Welded Splice



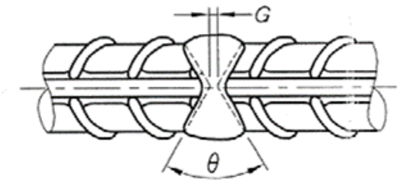
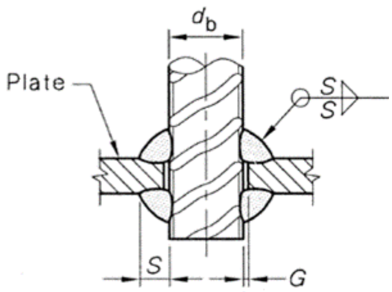
The following conditions apply:

- all welds to be SP Category (note to be shown on drawings)
- weld width "W" not shown on drawing
- 4 mm minimum throat thickness

- Minimum weld length on both sides of the bar shall be in accordance with AS 1554.3 *Structural Steel Welding* Part 3: Welding of Reinforcing Steel, Table 3.2.

6.6 Direct butt splice and anchorage splice welds for reinforcing bar

The preferred welding consumables for direct butt splice welds and anchorage splice welds for reinforcing bar are shown below:

Weld Type	Detail	Consumable
Direct Butt Splice	Double-V butt splice  NOTE: Wherever possible, horizontal bars should be welded in the flat position.	G55X or G62X to AS/NZS ISO 14341-B, or T55X or T62X to AS/NZS IS0 17632-B
Anchorage Splice	Double-side external fillet weld 	G55X or G62X to AS/NZS ISO 14341-B, or T55X or T62X to AS/NZS IS0 17632-B

The following conditions apply:

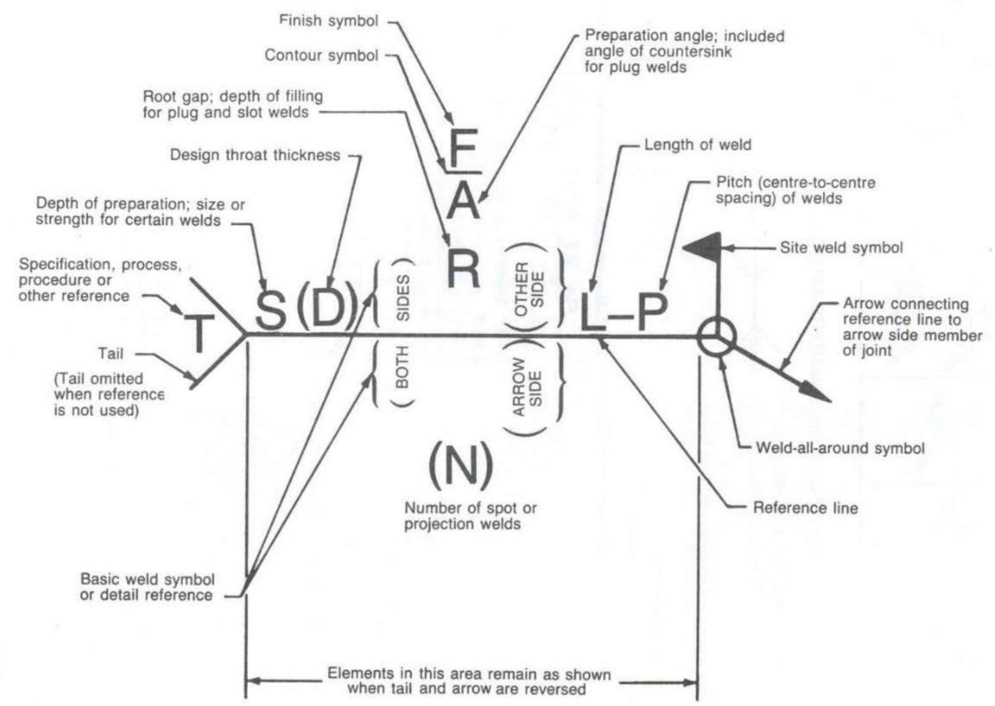
- All welds to be SP Category (note to be shown on drawings)
- The Design Engineer shall nominate all the weld sizes, but the minimum throat thickness for anchorage splice welds shall be 4 mm.

6.7 Welding symbols

Welding symbols on drawings are to conform to AS 1101.3 *Graphical Symbols for General Engineering* Part 3: Welding and Non-destructive Examination.

The standard location of elements of a welding symbol is shown in Figure 6.7-1 - Standard Location of Elements of a Welding Symbol.

Figure 6.7-1 - Standard Location of Elements of a Welding Symbol



6.8 Presentation details

The following is a basic cross section of commonly detailed welding symbols that may be encountered on drawings.

Examples have been provided on the following pages that cover most fillet weld and butt weld joints.

Figure 6.8-1 - Basic Elements of a Weld Symbol

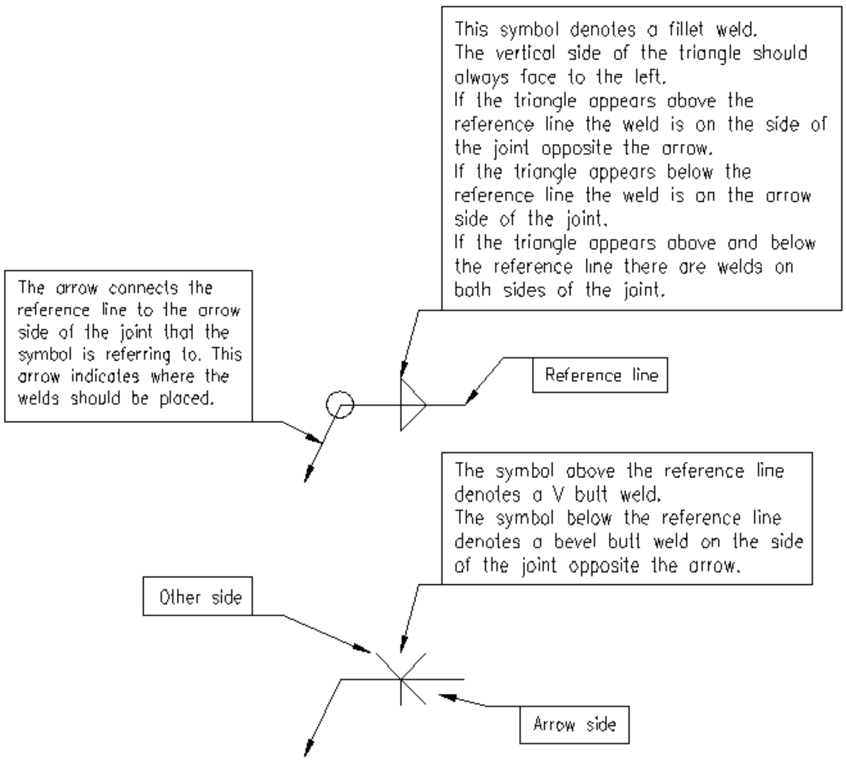


Figure 6.8-2 - Determining Size of a Fillet Weld shows how the size of a fillet weld is determined. Accurate measurement of fillet welds requires the use of a weld fillet gauge.

Figure 6.8-2 - Determining Size of a Fillet Weld

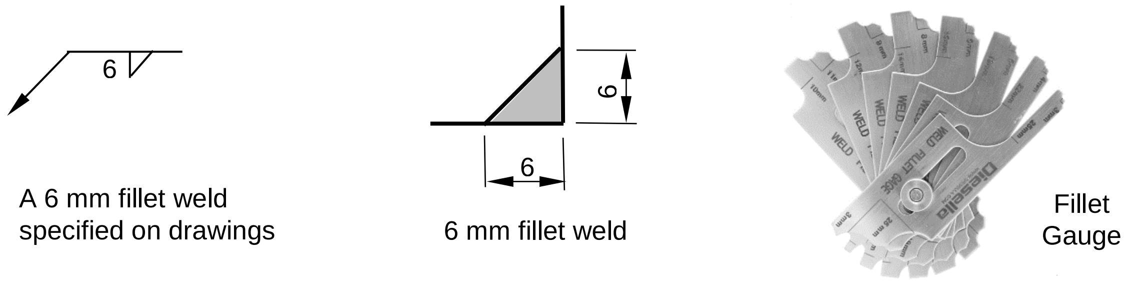


Figure 6.8-3 - Weld on Arrow Side of Joint

The following sketch shows a 6 mm fillet weld is needed on the side of the joint that the arrow is pointing.

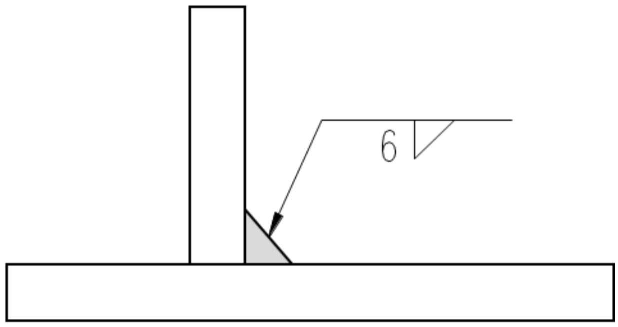


Figure 6.8-4 - Weld on Both Sides of Joint

The following sketch shows a 6 mm fillet weld is needed on both sides of the joint.

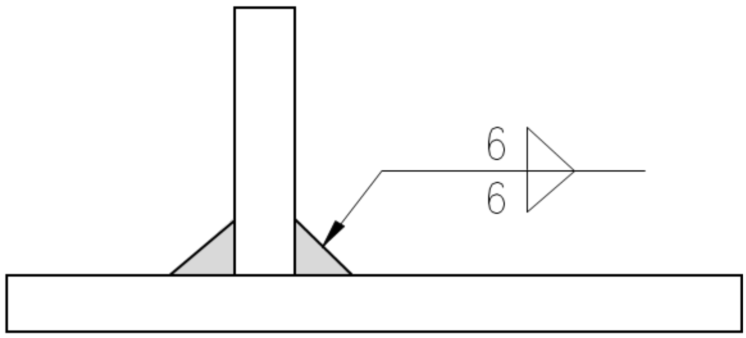
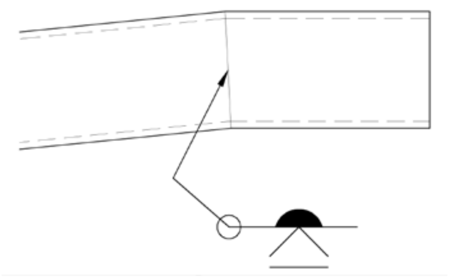


Figure 6.8-5 - Butt Weld



This symbol indicates that the two RHS components are to be joined by a full penetration vee butt weld all around the joint

indicates full penetration

indicates vee butt weld

indicates all-round the joint

The weld shown in Figure 6.8-6 - Bridge Traffic Barrier Post to Base Plate is a critical structural weld and its conformance to specification is vital to the performance of bridge traffic barrier posts under load. This is a complete penetration butt weld (compound butt weld placed first followed by a fillet weld). Refer Figure 6.8-8 - Combination Butt and Fillet Welds for description.

The weld shown in Figure 6.8-8 - Bridge Traffic Barrier Post to Anchor Plate describes the welds to connect the bridge traffic barrier posts and anchor plates.

Figure 6.8-6 - Bridge Traffic Barrier Post to Base Plate

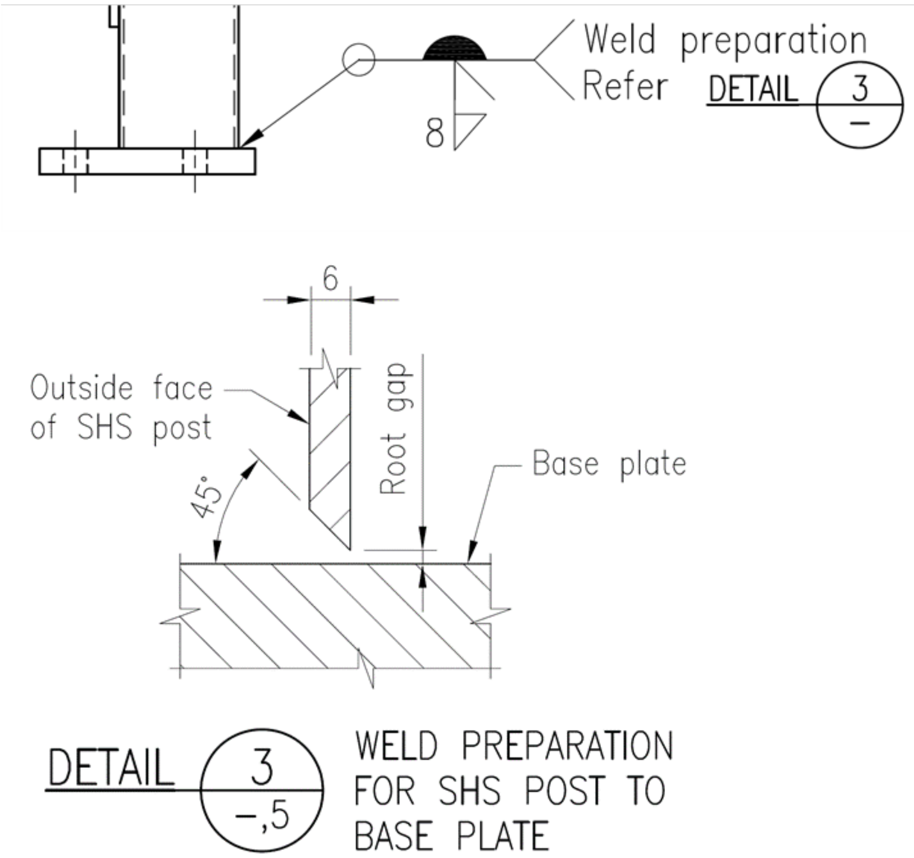


Figure 6.8-7 - Combination Butt and Fillet Welds

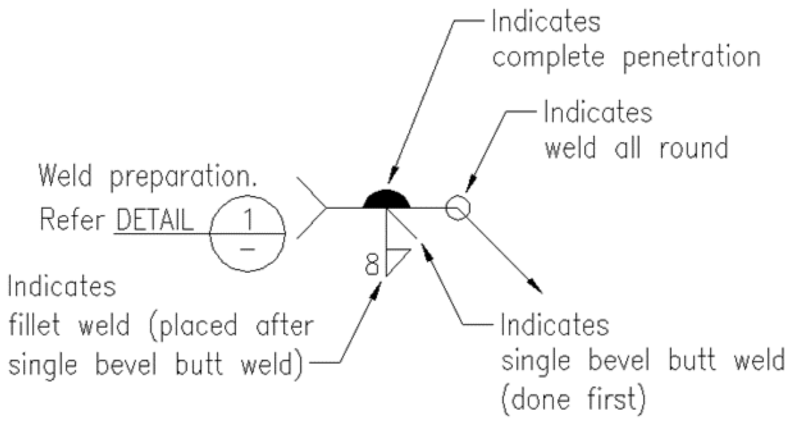
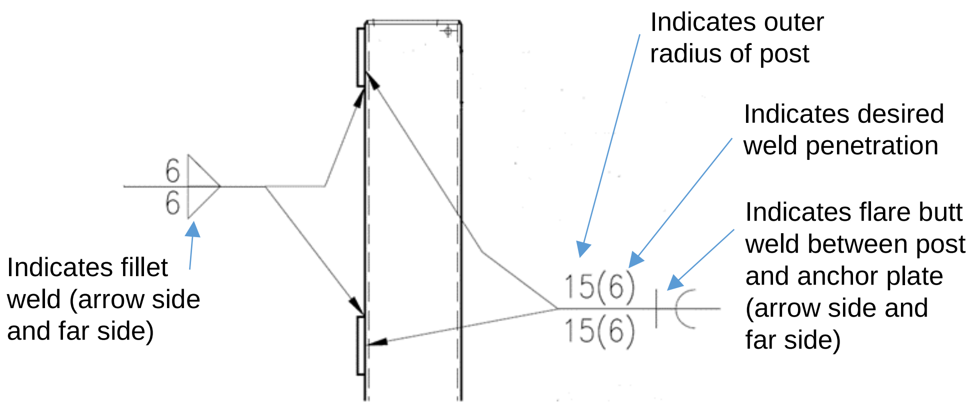


Figure 6.8-8 - Bridge Traffic Barrier Post to Anchor Plate



References

Drafters should be familiar with the following Australian Standards:

- AS 1101.3-2005 *Graphical Symbols for General Engineering* Part 3: Welding and Non-destructive Examination
- AS/NZS 1554.1-Amdt 1 2015 *Structural Steel Welding* Part 1: Welding of Steel Structures
- AS/NZS 1554.3-2014 *Structural Steel Welding* Part 3: Welding of Reinforcing Steel
- AS/NZS 1554.6-2012 *Structural Steel Welding* Part 6: Welding Stainless Steels for Structural Purposes
- AS/NZS 1665-2004 *Welding of Aluminium Structures*
- AS/NZS 4855-2007 *Welding Consumables* – Covered Electrodes for Manual Metal Arc Welding of Non-alloy and Fine Grain Steels – Classification

Drafting and Design Presentation Standards
Volume 3: Structural Drafting Standards

Chapter 7: Deck Wearing Surface

October 2016

Queensland Government

Feedback: Please send your feedback regarding this document to: tmr.techdocs@tmr.qld.gov.au

Chapter 7 Amendments

Revision register

Issue/Rev No.	Reference Section	Description of Revision	Authorised by	Date
1	-	First Issue	Manager (Structural Drafting)	April 2011
2	-	Document name change	Manager (Structural Drafting)	November 2011
	7.4	Minimum DWS thickness for superelevated deck unit bridges increased to 80 mm (including 10 mm bituminous waterproof membrane).		
3	7.4	Minimum DWS thickness for crossfall deck unit bridges increased from 55 to 85 mm (including 10 mm bituminous waterproof membrane). Example calculations revised accordingly. Rewording of horizontal curve section and minor revisions to tables 7.4.5 and 7.4.6	Team Leader (Structural Drafting)	September 2016

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7 Deck Wearing Surface

7.1 Glossary of terms

For a complete glossary of terms refer Chapter 1 *Introduction*.

7.2 Figures and examples shown in this volume

The figures and examples shown in this volume are for presentation purposes only, and may contain some details that are now superseded. These details have been included for ease of reference, to illustrate typical solutions, and to show the required standard of drafting presentation. The details are not to be used without an engineering check and certification by a Structural RPEQ to confirm that the details are appropriate for the specific project.

7.3 General

This chapter is to be read in conjunction with MRTS84 *Deck Wearing Surface* and MRTS84A *Cold Milling Bridge Deck Wearing Surface*.

On bridges the most common use for Deck Wearing Surface (DWS) is on PSC deck unit bridges. The deck units hog during curing and the amount of hog varies over time, culminating in the design hog at 100 days after casting. This design hog at 100 days is used in calculating the depth of DWS. These design hogs, in reality, vary significantly and an uneven deck surface is formed. DWS is used to eliminate these variances and to provide an even running surface.

DWS on bridges is comprised of a tack coat, bituminous waterproof membrane, and a surfacing layer. Sometimes a corrector course is laid between the bituminous waterproof membrane and the surfacing layer. The corrector course is used to take out most of the variances due to the hogs of the units and construction of the bridge. This provides a more even surface for the final surfacing layer.

DWS can also be used on an RC deck, however, most of the variances are taken out by the final concrete deck surface. In this case there is usually only a final surfacing layer applied to the deck surface to produce an even running surface. This chapter will mainly concentrate on the first type of bridge deck, DWS on deck units.

The thickness of DWS on a structure should be kept to a minimum to reduce the dead load on the bridge, but it shall be thick enough to account for the effect of the hog, crossfall of the pavement each way from the bridge centreline (if appropriate) and any minor alignment variations over the length of the bridge.

To prevent aquaplaning, the minimum crossfall or superelevation of the running surface is 2.5%. Historically only 1.5% was required. While the mass of DWS has now increased significantly, creating a larger dead load, the deck units are able to accept this increased load and the larger crossfall or superelevation enhances the drainage aspects of the structure. For further information refer Chapter 10 - *Bridge Geometry*, Section 10.8 - *Vertical Alignment – Transverse Alignment*.

Dense graded asphalt DG10 is the preferred road corrector course layer. The corrector coarse sits above a 10 mm nominal thick layer of bituminous waterproof membrane.

Dense graded asphalt DG14 is the preferred road surfacing layer. The layer is 45 mm thick for transversely stressed deck unit bridges and 50 mm thick for bridges with a RC deck. Refer MRTS30 *Asphalt Pavements*, Table 12.2.6.5 for thickness limits and Chapter 5 -Notes, Section 5.6 - *General Arrangement Notes* for additional details.

7.4 Thickness of DWS on PSC deck units

Deck wearing surface profiles generally fall into two categories, decks with crossfall (crowned) and decks with constant crossfall (or superelevation).

Decks with Crossfall (Crowned pavement). Refer Figure 7.4-1 - Decks with Crossfall (Crowned).

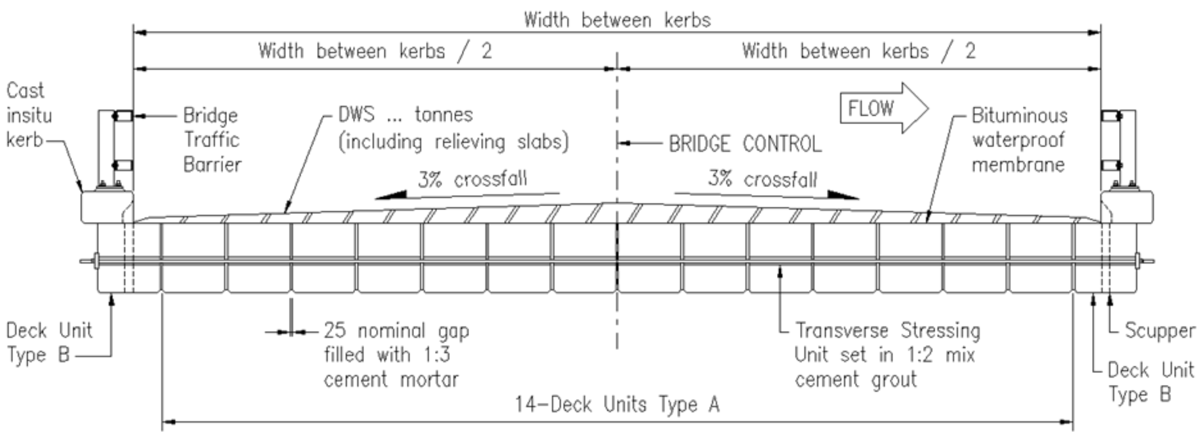
Crossfall is 2.5% minimum each way from bridge centreline. This may not be possible however when widening existing bridges. The design of these bridges will need to deal with the specific site conditions. Refer Chapter 10 – *Bridge Geometry*.

The minimum thickness of DWS at any point is 85 mm consisting of bituminous waterproof membrane and 75 mm thick asphalt. For calculation purposes, the thickness of bituminous waterproof membrane is 10 mm and is not included when calculating DWS quantities. The thickness of DWS varies along the length of the span due to the hog of the deck units, with the minimum thickness occurring at midspan. Refer Figure 7.7-2 - Mass of DWS for Deck Units.

At abutments and piers, the nominal DWS thickness at the centreline of roadway is calculated as follows:

- width between kerbs (mm) / 2 x crossfall (%) + design hog (mm) at 100 days + 85 mm, for example:
  - width between kerbs = 9220 mm. Crossfall = 3% Design hog at 100 days = 35 mm The thickness of DWS at the centreline of abutments and piers will be:
    - 9220 / 2 x 0.03 + 35 + 85 = 258 mm (round up to 260 mm).

Figure 7.4-1- Decks with Crossfall (Crowned)



Decks with Constant Crossfall or Superelevation. Refer Figure 7.4-2 - Decks with Constant Crossfall/Superelevation.

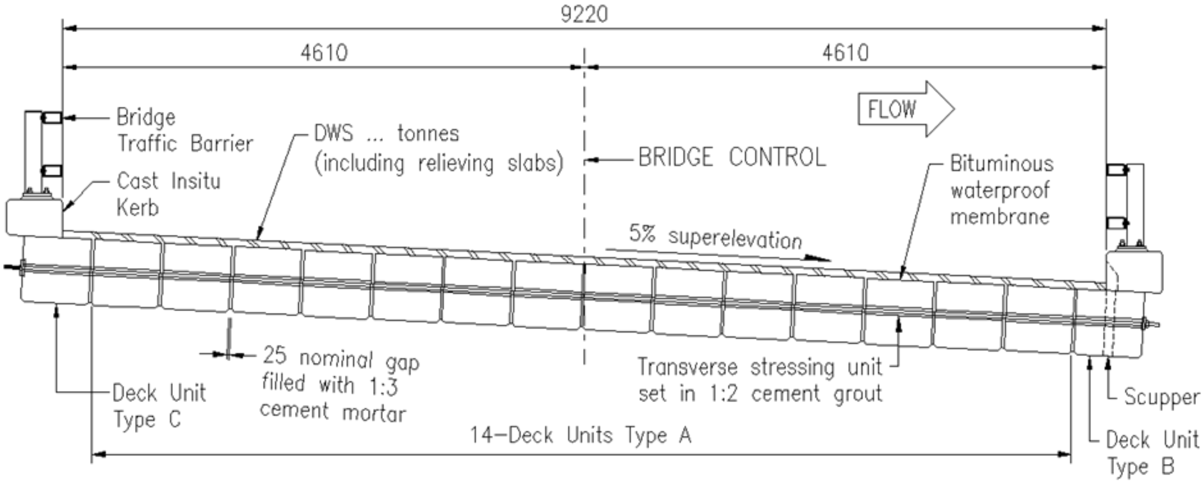
The DWS is a nominally constant thickness across the width of the deck. The minimum thickness of DWS at any point is 85 mm consisting of 10 mm bituminous waterproof membrane and 75 mm asphalt.

The thickness of DWS varies along the length of the span due to the hog of the deck units, with the minimum thickness occurring at midspan.

At abutments and piers, the nominal DWS thickness is calculated as follows:

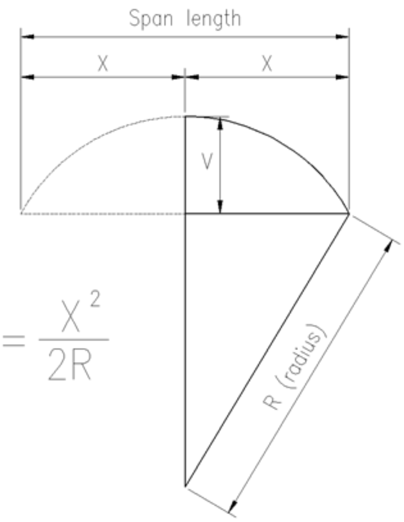
- design hog (mm) at 100 days + 85 mm, for example:
  - superelevation = 5% (however this has no effect on the DWS thickness) Design hog at 100 days = 35 mm
  - the thickness of DWS at the centreline of abutments and piers will be:
    - 35 + 85 = 115 mm.

Figure 7.4-2 - Decks with Constant Crossfall/Superelevation



Vertical Curves (VC)

Vertical curves are not true circles, rather they are parabolic curves. The following formula may be used to calculate the vertical off set (V) on a vertical curve. Note that because the curve is parabolic, the formula is not completely accurate, however it is usually accurate enough for the purpose of calculating vertical offsets.



$$V = \frac{X^2}{2R}$$

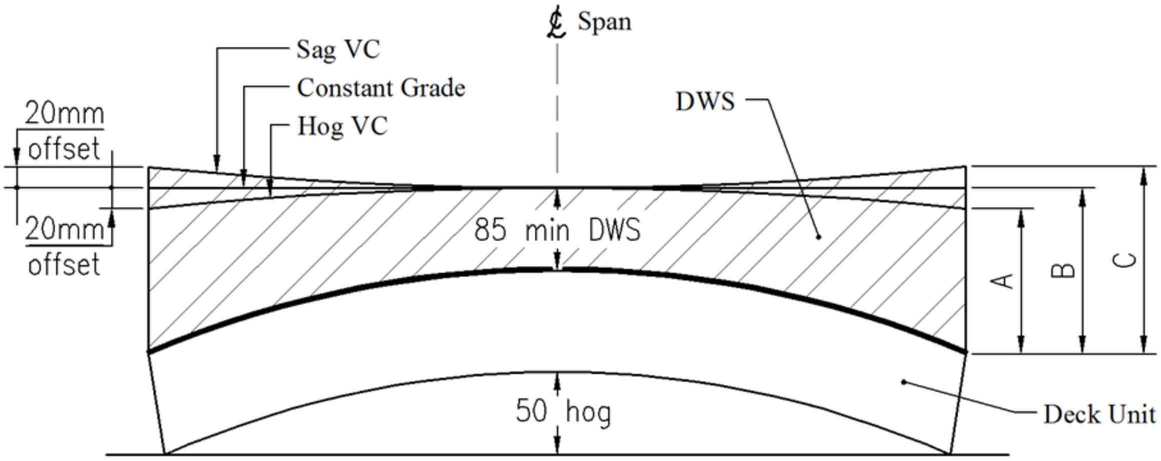
Consider the following example:

A bridge with a crowned deck is on a crest VC producing a vertical offset of 20 mm per span. This gives an extra 20 mm of DWS thickness from the deck unit at the centre of the span to the running surface. The designers can then reduce the thickness of DWS required at the abutments and piers by

20 mm and still maintain the minimum 85 mm thickness (75 mm DWS and 10 mm waterproof membrane) at the centre of the span. Refer to Figure 7.4-3 - Deck Wearing Surface Profiles (Crown) and the accompanying calculations.

Figure 7.4-3 - Deck Wearing Surface Profiles (Crown)

Note: Dimensions shown in the diagram are examples only



Thickness of DWS at kerb at abutments and piers (crowned pavement).

For Hog VC: A = 50 hog + 85 minimum – 20 offset = 115 mm.

For constant grade B = 50 hog + 85 minimum = 135 mm.

For Sag VC: C = 50 hog + 85 minimum + 20 offset = 155 mm.

In cases where the offset due to the crest VC is greater than the hog of the deck unit, the minimum 85 mm applies at the abutment and pier kerbs.

The DWS thickness on the kerb line at the centre of the span will therefore be 85 mm minimum

+ offset due to VC.

Horizontal Curves (HC)

Superelevation of a horizontally curved bridge deck results in the DWS being shaped in 3d like the edge of a dish. If you cut the edge of a dish in a straight line the profile of the cut in elevation will be a sagging curve. This simple imagery represents the profile of DWS on a curved deck over a straight deck unit. The effect causes a loss of DWS depth, unless it is accommodated by increasing the depth at the abutments and piers.

In most cases the effect will not be significant but should be accommodated especially for tighter curves. Refer to Tables 7.4.5 and 7.4.6 for fall values calculated for 3% and 6%

Fall Value = Offset to curve x Superelevation

Figure 7.4-4 - Offset Allowance

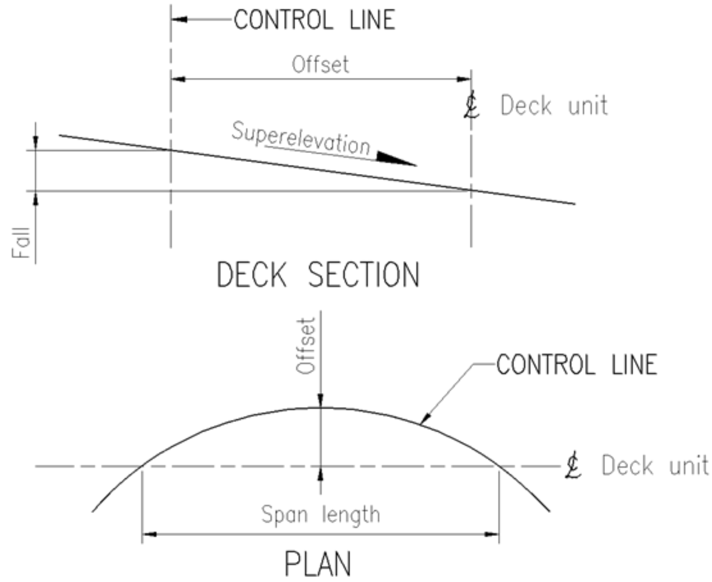


Table 7.4-5 - Fall Values (in mm's) with 3% Superelevation

	Span Length (m)													
Radius (m)	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
Shaded cells are for span and radius combinations that do not meet clause 10.4.4 of the Bridge Geometry chapter and are provided for information only where exceptions to these constraints are approved														
100	5	6	7	8	10	11	12	14	15	17	18	20	22	23
150	4	4	5	6	6	7	8	9	10	11	12	13	14	16
200	3	3	4	4	5	5	6	7	8	8	9	10	11	12
250	2	3	3	3	4	4	5	5	6	7	7	8	9	9
300	2	2	2	3	3	4	4	5	5	6	6	7	7	8
350	2	2	2	2	3	3	3	4	4	5	5	6	6	7
400	1	2	2	2	2	3	3	3	4	4	5	5	5	6
450	1	1	2	2	2	2	3	3	3	4	4	4	5	5
500	1	1	1	2	2	2	2	3	3	3	4	4	4	5
550	1	1	1	2	2	2	2	2	3	3	3	4	4	4
600	1	1	1	1	2	2	2	2	3	3	3	3	4	4
650	1	1	1	1	1	2	2	2	2	3	3	3	3	4
700	1	1	1	1	1	2	2	2	2	2	3	3	3	3
750	1	1	1	1	1	1	2	2	2	2	2	3	3	3
800	1	1	1	1	1	1	2	2	2	2	2	2	3	3
850	1	1	1	1	1	1	1	2	2	2	2	2	3	3
900	1	1	1	1	1	1	1	2	2	2	2	2	2	3
950	1	1	1	1	1	1	1	1	2	2	2	2	2	2
1000	1	1	1	1	1	1	1	1	2	2	2	2	2	2
1100	0	1	1	1	1	1	1	1	1	2	2	2	2	2
1200	0	1	1	1	1	1	1	1	1	1	2	2	2	2
1300	0	0	1	1	1	1	1	1	1	1	1	2	2	2
1400	0	0	1	1	1	1	1	1	1	1	1	1	2	2
1500	0	0	0	1	1	1	1	1	1	1	1	1	1	2

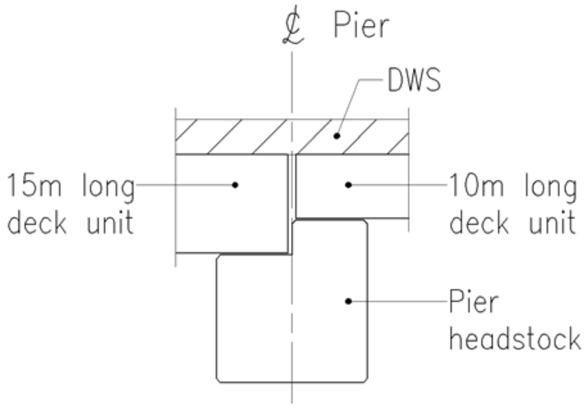
Table 7.4-6 - Fall Values (in mm's) with 6% Superelevation

	Span Length (m)													
Radius (m)	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
Shaded cells are for span and radius combinations that do not meet clause 10.4.4 of the Bridge Geometry chapter and are provided for information only where exceptions to these constraints are approved														
100	11	13	15	17	19	22	24	27	30	33	36	40	43	47
150	7	8	10	11	13	14	16	18	20	22	24	26	29	31
200	5	6	7	8	10	11	12	14	15	17	18	20	22	23
250	4	5	6	7	8	9	10	11	12	13	15	16	17	19
300	4	4	5	6	6	7	8	9	10	11	12	13	14	16
350	3	4	4	5	5	6	7	8	9	9	10	11	12	13
400	3	3	4	4	5	5	6	7	8	8	9	10	11	12
450	2	3	3	4	4	5	5	6	7	7	8	9	10	10
500	2	3	3	3	4	4	5	5	6	7	7	8	9	9
550	2	2	3	3	3	4	4	5	5	6	7	7	8	9
600	2	2	2	3	3	4	4	5	5	6	6	7	7	8
650	2	2	2	3	3	3	4	4	5	5	6	6	7	7
700	2	2	2	2	3	3	3	4	4	5	5	6	6	7
750	1	2	2	2	3	3	3	4	4	4	5	5	6	6
800	1	2	2	2	2	3	3	3	4	4	5	5	5	6
850	1	1	2	2	2	3	3	3	4	4	4	5	5	6
900	1	1	2	2	2	2	3	3	3	4	4	4	5	5
950	1	1	2	2	2	2	3	3	3	3	4	4	5	5
1000	1	1	1	2	2	2	2	3	3	3	4	4	4	5
1100	1	1	1	2	2	2	2	2	3	3	3	4	4	4
1200	1	1	1	1	2	2	2	2	3	3	3	3	4	4
1300	1	1	1	1	1	2	2	2	2	3	3	3	3	4
1400	1	1	1	1	1	2	2	2	2	2	3	3	3	3
1500	1	1	1	1	1	1	2	2	2	2	2	3	3	3

Dissimilar Deck Unit Heights

Pier headstocks that support deck units of different heights due to varying span lengths shall be stepped so that the tops of the deck units are at the same level when seated on the pier. This prevents the upper ends of the deck units being damaged when the DWS is compacted. In this instance the smaller span will be carrying additional DWS, therefore, the Design Engineer must check the deck units are designed to accommodate it. Refer Figure 7.4-7 - Alignment of Units.

Figure 7.4-7 - Alignment of Units



7.5 DWS on RC decks

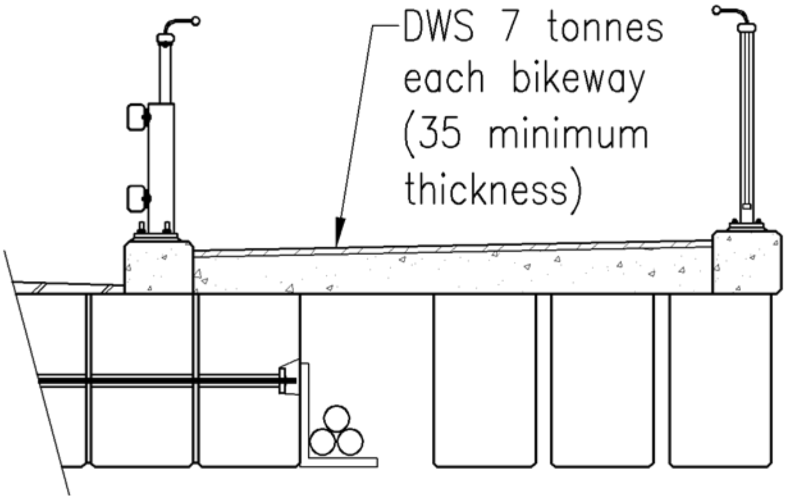
The finished surface of an RC deck is built to the nominated vertical alignment and road cross section less the DWS thickness. DWS is laid on the deck at a constant thickness to the finished road alignment level. The minimum thickness of DWS is 60 mm (50 + 10 bituminous waterproof membrane). Bituminous waterproof membrane is required over the entire bridge length including the relieving slabs.

7.6 DWS on footways/bikeways

Adopt the following criteria for DWS on footways and bikeways:

- maximum crossfall is 2.5%, though 2% is preferred
- footways to be sloped to drain onto the roadway or into scuppers if the footway surface is lower than the top of the kerbs
- when drained into scuppers the DWS should be graded to match the vertical alignment of the roadway
- the minimum thickness of DWS in any application is 35 mm of DG10. Refer Figure 7.6-1 - Examples of DWS on Footways/Bikeways.

Figure 7.6-1 - Examples of DWS on Footways/Bikeways



7.7 Mass of DWS

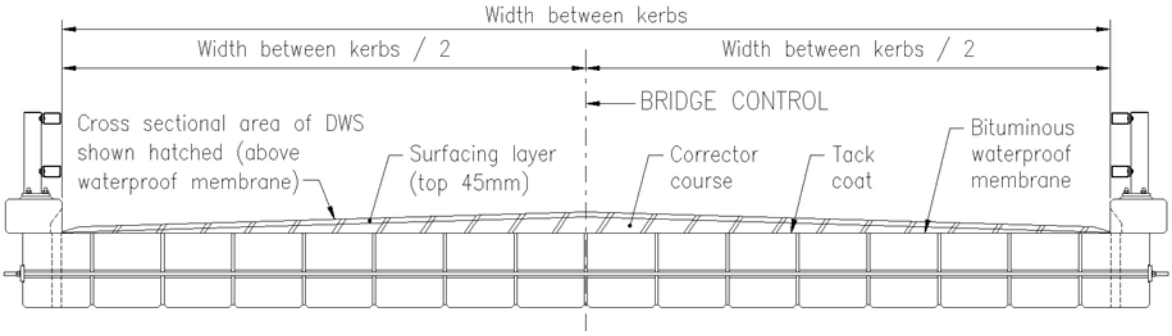
Dense graded asphalt is the most commonly used deck wearing surface on bridges, however open graded asphalt may also be used. For DWS estimate quantity calculations, the specific density of 2.4 tonnes/m^3 shall be used. The total mass shall be shown on the Typical Bridge Cross Section view on the General Arrangement drawings.

Quantities for bituminous waterproof membrane and the tack coat are calculated as the actual area of the bridge deck between kerbs, including the relieving slabs. Refer MRS84 *Deck Wearing Surface*, Clause 2.3.1-Bituminous Waterproof Membrane. The mass of bituminous waterproof membrane (10 mm deep for calculations) is excluded in the mass of DWS for all calculations.

The corrector course is calculated as the volume of DWS above the bituminous waterproof membrane and below the surfacing layer. Refer Figure 7.7-1 - Corrector Course and Surfacing Layer.

The surfacing layer is calculated using the area of deck, including the relieving slabs, x 45 mm (deck unit bridges) or 50 mm (RC deck bridges).

Figure 7.7-1 - Corrector Course and Surfacing Layer



The mass of DWS for a span is measured in tonnes and is calculated as follows:

Mass of DWS for a Deck Unit Span

2.4 x (nominal span length x cross sectional area of DWS at abutments and piers) - (2/3 deck unit length x width between kerbs x hog). Refer Figure 7.7-2 - Mass of DWS for Deck Units.

Refer the following example:

Span Length (nominal) = 14 m

Minimum depth of DWS at kerbs (not including membrane) = 0.045 m

Design hog at 100 days = 0.035 m

Depth of DWS only (excluding 10 mm of bituminous waterproof membrane) at kerbs at abutments and piers = 0.045 + 0.035 = 0.08 m

Width between kerbs = 9.22 m Crossfall = 3%

Depth of DWS at centreline at abutments and piers (rounded up to nearest 5 mm)

= 9.22 / 2 x 3% + 0.08 = 0.22 m

Cross sectional area of DWS at abuts and piers = 9.22 x 0.08 + 9.22 / 2 x 0.14

= 1.383 m^2

Mass of DWS for one span =

2.4 x (14 x 1.383 – 2/3 x 13.95 x 9.22 x 0.035) = 39.266 tonnes

Mass of Surfacing Layer =

2.4 x (14 x 9.22 x 0.045) = 13.941 tonnes

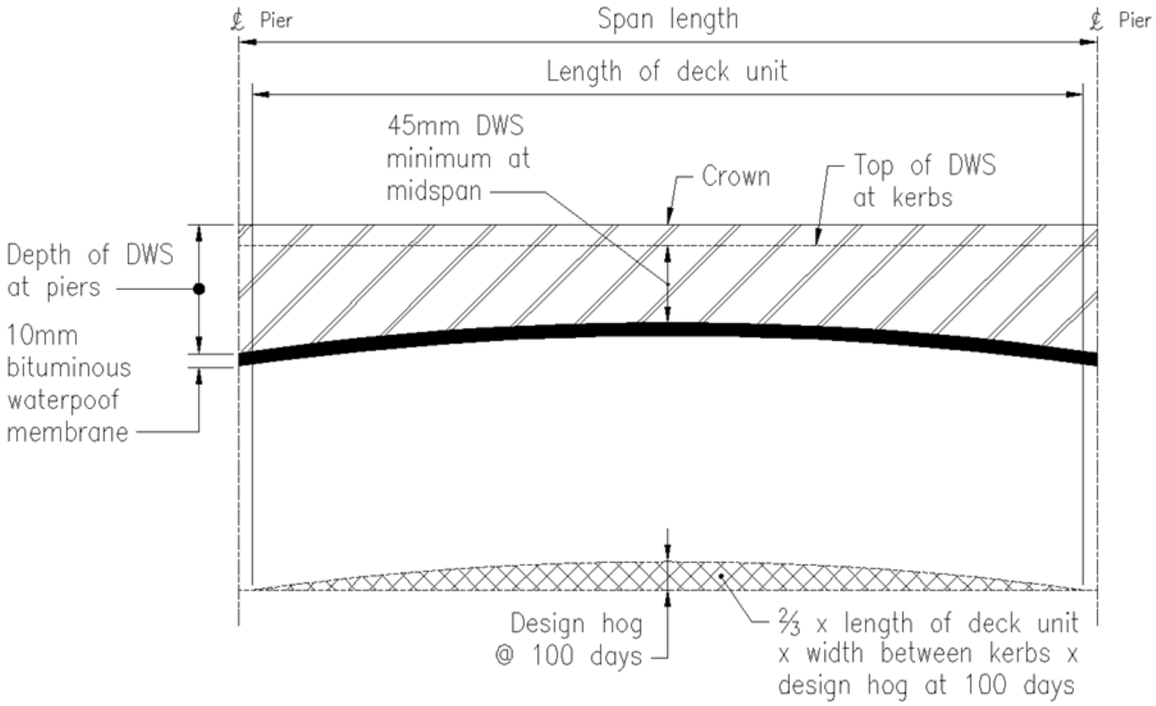
Round up to nearest 0.1 tonne = 14.0 tonnes

Mass of Corrector Course = 39.266 – 14

= 25.266 tonnes

Round up to nearest 0.1 tonne = 25.3 tonnes.

Figure 7.7-2 - Mass of DWS for deck units



Mass of DWS for Relieving Slabs

Mass of DWS for one relieving slab =

2.4 x length of relieving slab/cos (skew) x cross sectional area of DWS at abutments and piers

Using the previous example with a 15 degree skew the mass of dense graded asphalt DWS on a 3 m long relieving slab =

2.4 x 3 / cos (15) x 1.383 = 10.31 tonnes

Mass of DWS for RC Decks

Mass of DWS for one span =

2.4 x nominal span length x cross sectional area of DWS at abutments and piers

Adjustments

Masses are to be adjusted as required for bridges:

- on a VC
- with varying superelevation/crossfall.

Drafting and Design Presentation Standards
Volume 3: Structural Drafting Standards

Chapter 8: Bridge Widening

August 2019

Queensland Government

Chapter 8 Amendments

Revision register

Issue/Rev No.	Reference Section	Description of Revision	Authorised by	Date
1	-	First Issue	Manager (Structural Drafting)	Apr 2011
2	-	Document name change	Manager (Structural Drafting)	Nov 2011
3	All	General review and updates	Senior Designer	Aug 2019
	8.4	Additional information supplied for reasons bridge surveys are required. List of known bridge widening project issues.		
	8.10	New section - Historic Bridges		
	8.11	New section - Foundations		

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8 Bridge Widening

8.1 Glossary of terms

For a complete glossary of terms refer Chapter 1 *Introduction*.

8.2 Figures and examples shown in this volume

The figures and examples shown in this volume are for presentation purposes only and may contain some details that are now superseded. These details have been included for ease of reference, to illustrate typical solutions, and to show the required standard of drafting presentation. The details are not to be used without an engineering check and certification by a Structural Registered Professional Engineer Queensland (RPEQ) to confirm that the details are appropriate for the specific project in accordance with AS 5100 and the department's *Design Criteria for Bridges and Other Structures*.

8.3 Standard design details

Designs for the widening of bridges vary greatly depending on the types of existing structures and the width of the widening required.

The purpose of this chapter is to give some examples and procedures to follow as a guide only. Each case should be assessed on its own merits and appropriate drawings produced accordingly. For example, drawings for a bridge widening refer Appendix A - *Example Drawings*.

8.4 Bridge surveys

For bridges requiring widening, an accurate bridge survey is required so that "as constructed" details can be identified. Detailed design for the widened structure can then be prepared taking into account the layout of the existing structure. Typical requirements for bridge surveys are detailed in Section 8.7 *Survey Information for Bridge Widening*.

Bridge surveys are critical when designing a widening for many reasons including:

- identifying site details match drawings held by Transport and Main Roads (as constructed drawings are often not available for older projects)
- identifying the precise location, extension and size of transverse stressing bars, if applicable
- identifying the exact final hog of the existing deck units which is critical to accommodate during design of the adjacent units or girders, and
- identify any discrepancies in bridge settlement, vertical alignment and physical dimensions of the existing deck and substructure.

Project experience tells us that the most frequent issues encountered with widenings are:

- The correct position and alignment of transverse stressing bars.
- Location and proximity of existing foundations to the proposed new foundations especially where existing piles are raked.
- Condition state of existing transverse stressing bars. Occasionally transverse stressing bars may require coring to remove and replace.
- The existing deck may exhibit variations in vertical alignment and superelevation compared to the original design, which should be accommodated in the widening.

- DWS thickness may vary significantly from As Constructed drawings due to multiple resurfacing works over the life of the existing bridge.
- Where a bridge traffic barrier is to be replaced on the non-widened side the abutment wingwalls will require modification or extra footings required to accommodate impact loads and longer vertical transitions than the original structure.
- The location of existing reinforcement must be accommodated in the widening design and proposed dowel locations are to be designed accordingly to avoid clashes. Ground Penetrating Radar is to be stipulated on drawings to avoid clashes with existing reinforcement.
- Constructability of concrete pours are to be considered. Where the existing deck is under traffic and an infill pour is required consideration of traffic speed, proximity of traffic, and type of concrete for the infill pour is to be accommodated.
- Stage construction is to be documented appropriately on the drawings.
- Any proposed demolition works are to be detailed clearly. In some instances, hydro demolition may be an advantage.
- It is not wise to rely solely on notes such as “All dimensions to be verified on site” without undertaking a site survey, as this will often lead to significant construction variations.

8.5 Set out

Offset control lines

In addition to the procedure described below, it should be noted that occasionally the assumed Bridge Control Line for the project may not be the centre of the proposed structure or roadway. When this is the case, the set out shall be from that agreed Bridge Control.

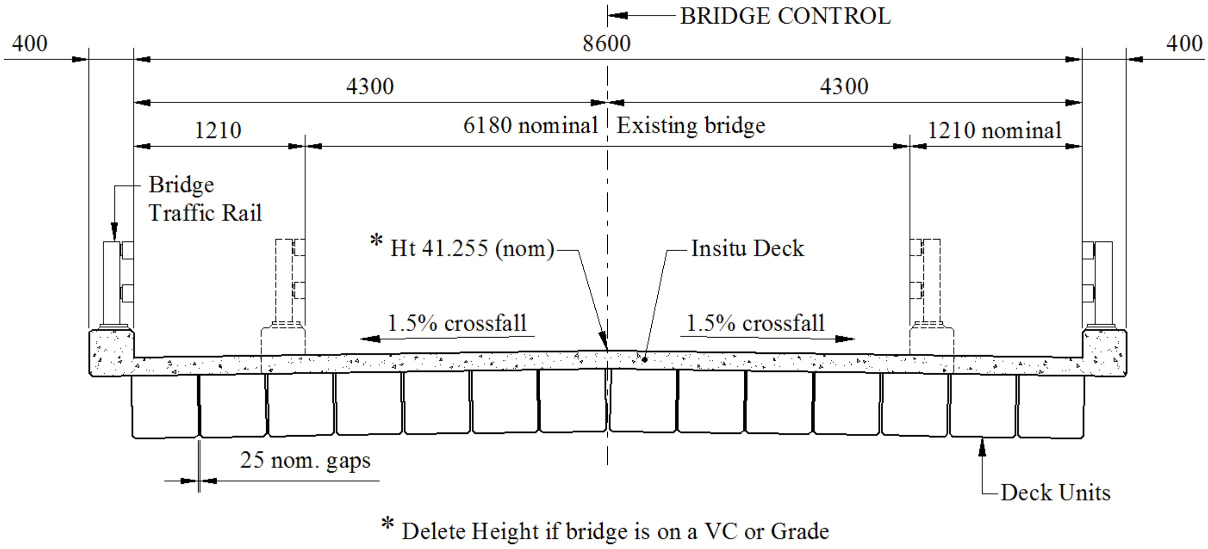
Bridges widened on both sides

Bridges widened on both sides should be set out from the centre of the widened bridge as follows:

- locate the centre of the bridge to be widened by reference to the existing bridge survey
- locate the centre of the widened bridge by reference to the additional widths required
- nominate this line on the Plan view of the General Arrangement as the Bridge Control Line
- in conjunction with the road alignment survey, if possible, give the co-ordinates of the Bridge Control Line on the Setting Out Diagram, and
- show all setting out dimensions from the Bridge Control Line on all drawings.

Refer Figure 8.5(a) - *Bridges widened on both sides*.

Figure 8.5(a) - Bridges widened on both sides



Note: It is particularly rare to widen a structure on both sides due to the increased cost of the works.

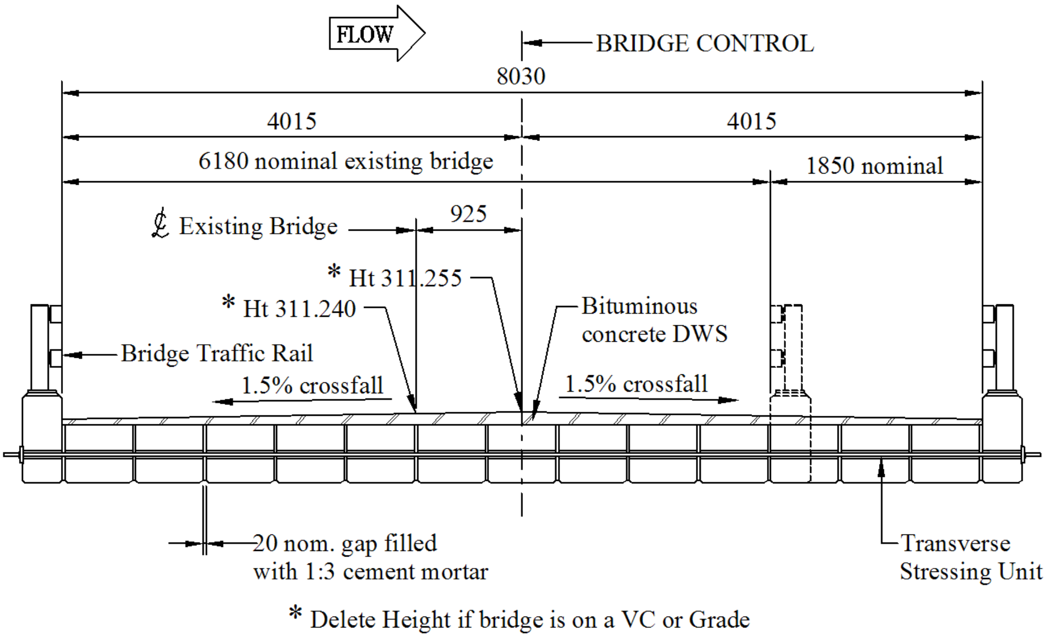
Bridges widened on one side

Bridges widened on one side only should be set out from the centre line of the widened bridge as follows:

- locate the centre of the bridge to be widened by reference to the existing bridge survey
- locate the centre of the widened bridge by adding a dimension of half the required widening to the location of the existing bridge centreline
- nominate this line on the Plan view of the General Arrangement as the Bridge Control Line
- in conjunction with the road alignment survey, if possible, give co-ordinates of the Bridge Control Line on the Setting Out Diagram, and
- show all setting out dimensions from the Bridge Control Line on all drawings.

Refer Figure 8.5(b) - *Bridges widened on one side*.

Figure 8.5(b) - Bridges widened on one side



8.6 PSC deck unit issues

Stressing bar couplers

Stressing bar couplers are used to join transverse stressing bars in the existing structure to those in the widening.

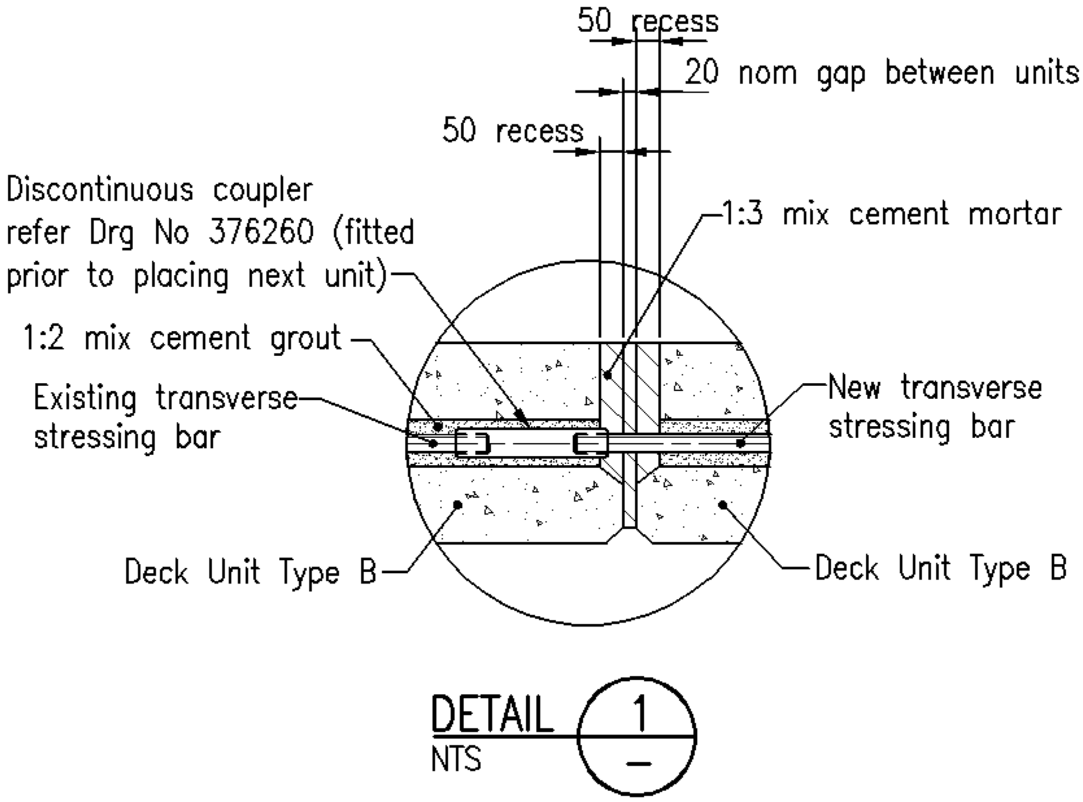
Most stressing bars to be extended will be “DSI” bar (32 mm diameter thread), “Macalloy” bars (imperial thread 11/8” diameter), and “VSL” bars (29 mm diameter coarse thread).

The type of stressing bar used in the existing structure is to be identified in the survey of the existing bridge so that a suitable coupler can be detailed on the drawings. Information sourced from existing bridge drawings is to be verified on site as substitute products may have been used.

The internal thread in all couplers is to be a minimum of 50 mm long in each end, with an unthreaded section in the centre of the coupler at least 10 mm, though it may need to be longer to suit the geometry. The discontinuous thread ensures that each stressing bar is screwed equal lengths into the coupler. For an example refer Appendix A - Example Drawings, Sheet 5.

Details of how the coupler is assembled shall be shown on the General Arrangement drawings. Typically the detail is a blow up from the Section Deck view. Refer Figure 8.6(a) - *Coupling detail*.

Figure 8.6(a) - Coupling detail



Note: threads are to suit both new and existing bars. Existing thread to be verified on site prior to design development for widening works).

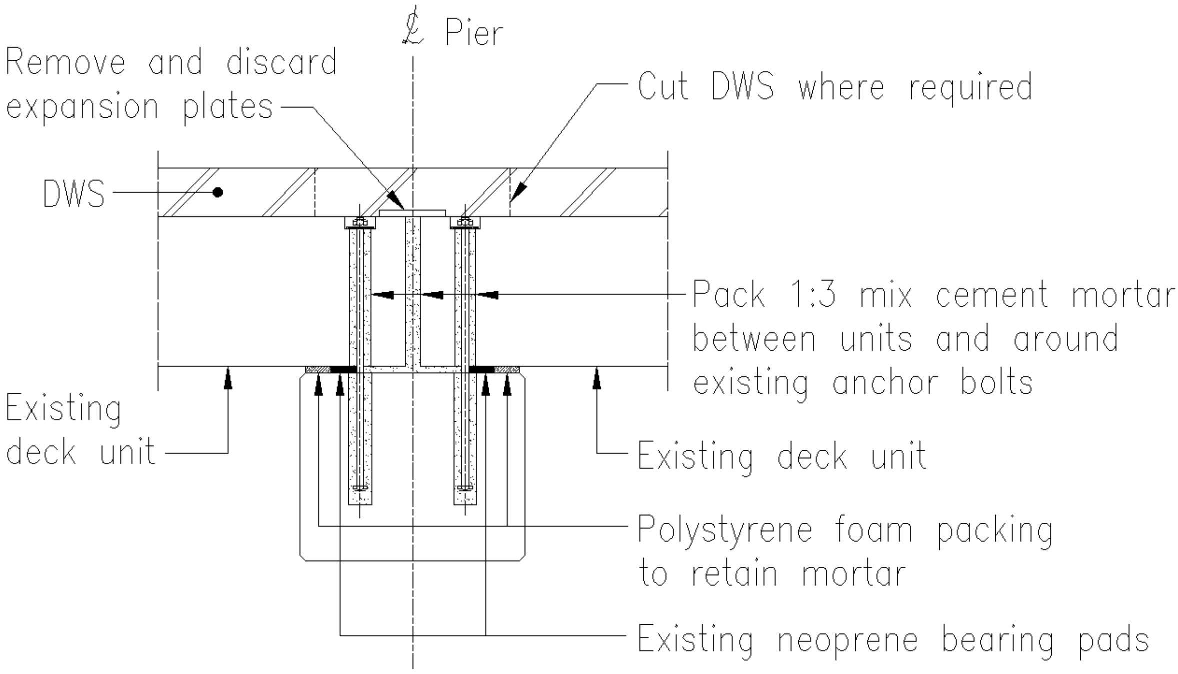
Recesses in new deck units

Recesses are provided in the new deck units over discontinuous couplers to provide access to enable the coupling of the transverse stressing bars. The recesses shall be large enough to fit a clenched fist through.

Articulation change

During the design of bridge widening the articulation may be changed. A typical detail of a conversion procedure from a deck expansion plate joint to a fixed joint is shown in Figure 8.6(b) - *Joint conversion at piers*. A similar detail would also apply to abutments.

Figure 8.6(b) - Joint conversion at piers



Conversion procedure at piers

When converting from an expansion joint to a fixed joint the following procedure may be adopted:

1. Remove all existing DWS.
2. Remove the deck expansion plates.
3. Remove the nuts and washers from all anchor bolts in the deck units on both sides of the piers. Up to 25% of the nuts may be left if they cannot be removed.
4. Pack polystyrene foam under the deck units to prevent cement mortar from escaping.
5. Pour 1:3 cement mortar into the 50 mm gap between the deck units (along the pier centreline) and around the holding down bolts. Pack mortar down to ensure that gap under the deck units is filled and the holding down bolt holes are completely filled.
6. Replace the washers and nuts on the holding down bolts.
7. Re-pave with DWS.
8. Rubberised bituminous filler and canite between the ends of the kerb units at the piers is to be removed and replaced with 1:3 cement mortar.

A similar procedure would apply to abutment conversions.

8.7 Survey information for bridge widening

Introduction

The following information is required to produce new bridge drawings of a widened structure:

- Figure 8.7(a) - *Survey information required for bridge widenings*
- Figure 8.7(b) - *Survey information required for widening of deck unit bridges*

- Figure 8.7(c) - *Survey information required for widening of girder bridges with a reinforced concrete deck*.

Requirements

1. The line of the bridge:
   a) the direction of Gazettal
   b) the distance of each kerb from the control line, defined in the survey data and linked to the proposed new alignments, see Figure 8.7(a) - *Survey information required for bridge widenings*.
2. The following features are to be located along the outside face of the kerbs:
   a) faces of the pier and abutment headstocks
   b) centreline of the pier headstocks, and
   c) centres of the bridge railing posts.
3. Dimensions shall be taken from a datum or reference points which should be clearly related to the concrete structure and running dimensions and bearings shall be given to features required. Preferably datum or reference points should be given in co-ordinates and related to a chainage where possible. In multi span bridges, details shall be supplied for each span.
4. Heights are required on the DWS or concrete deck at each kerb and along the centre of the roadway (if crowned). Heights should be provided at the abutments and piers with additional intermediate Heights being required along the bridge at approximately three metre centres.
5. The flow direction is to be indicated as shown in Figure 8.7(a) - *Survey information required for bridge widenings*.
6. Heights are also required where possible on the top of the pier and abutment headstocks. Location of Heights should be clearly defined, see Figure 8.7(b) - *Survey information required for widening of deck unit bridges* and Figure 8.7(c) - *Survey information required for widening of girder bridges with a reinforced concrete deck*.
7. Information on kerbs is required as follows:
   a) depth of the outside kerb units or cast insitu kerbs
   b) hog of the outer kerb units
   c) height of the transverse stressing bar above the soffit of the outside kerb units
   d) protrusion of the transverse stressing bar from its nut
   e) type of transverse stressing bar i.e. “Macalloy” bar (imperial 11/8” diameter thread), “DSI” bar (32 mm diameter thread), or “VSL” bar (29 mm diameter coarse thread)
   f) note if the thread is badly corroded or damaged
   g) height of kerb above the DWS or concrete deck
   h) depth of DWS at the kerbs at every mid span, abutment and pier, and
   i) location of cross girders on girder bridges.

8. Other dimensions as indicated on Figure 8.7(b) - *Survey information required for widening of deck unit bridges* and Figure 8.7(c) - *Survey information required for widening of girder bridges with a reinforced concrete deck*, to be supplied where possible.
9. Details of existing services and infrastructure. For example:
    a) overhead power and telephone lines
    b) fences
    c) road furniture, and
    d) services attached to the bridge.
10. Areas of the structure and abutment protection showing signs of deterioration or erosion should be defined and photographs supplied.
11. Condition of the DWS and expansion joints should be reported on and photographs supplied.
12. Other photographs of noteworthy features.
13. Note the existence of relieving slabs on the bridge (this is often unclear on the original bridge drawings).

Bridge widened on one side

Detailed information is required only on the widened side, although some dimensions will be necessary on the non-widened side to define the bearing of pier centre lines, abutments faces and transverse stressing bars.

If new rails are to be provided on the non-widened side, dimensions will be required to the abutment wingwalls and the centre of bridge railing posts.

Heights on ground at abutments and piers

Supply sufficient Heights so that the profile of the ground surface at the top and the toe of the existing abutment protection can be established. Provide Heights in the vicinity of the proposed abutment and pier extensions.

Provide water Heights of creeks and rivers and the date of the surveyed levels. If in tidal zone, high and low water should be registered together with the time and date of the surveyed Heights.

For railway overbridges

Bearing of the centre lines of all tracks and the chainage of the intersection of track centre lines.

Heights on both rails of all tracks are required at 5 m intervals for a distance of 50 m either side of the bridge.

Heights are required at the soffit of the girders or deck units, directly over the rails, and on both sides of bridge.

Existing horizontal clearances from the centreline of tracks to the faces of the piers and abutments should be shown on a detailed sketch.

For road overbridges

Heights at 5 m centres are required on the existing underpass roadway for a distance of 50 m either side of bridge. Levels are required on both sides of the pavement and at the centreline if the roadway is crowned.

Heights are required at the soffit of the girders or deck units over the roadway, on both sides of the bridge.

Existing horizontal clearances from the roadway to faces of the piers and abutments should be shown on a detailed sketch.

Figure 8.7(a) - Survey Information required for bridge widenings

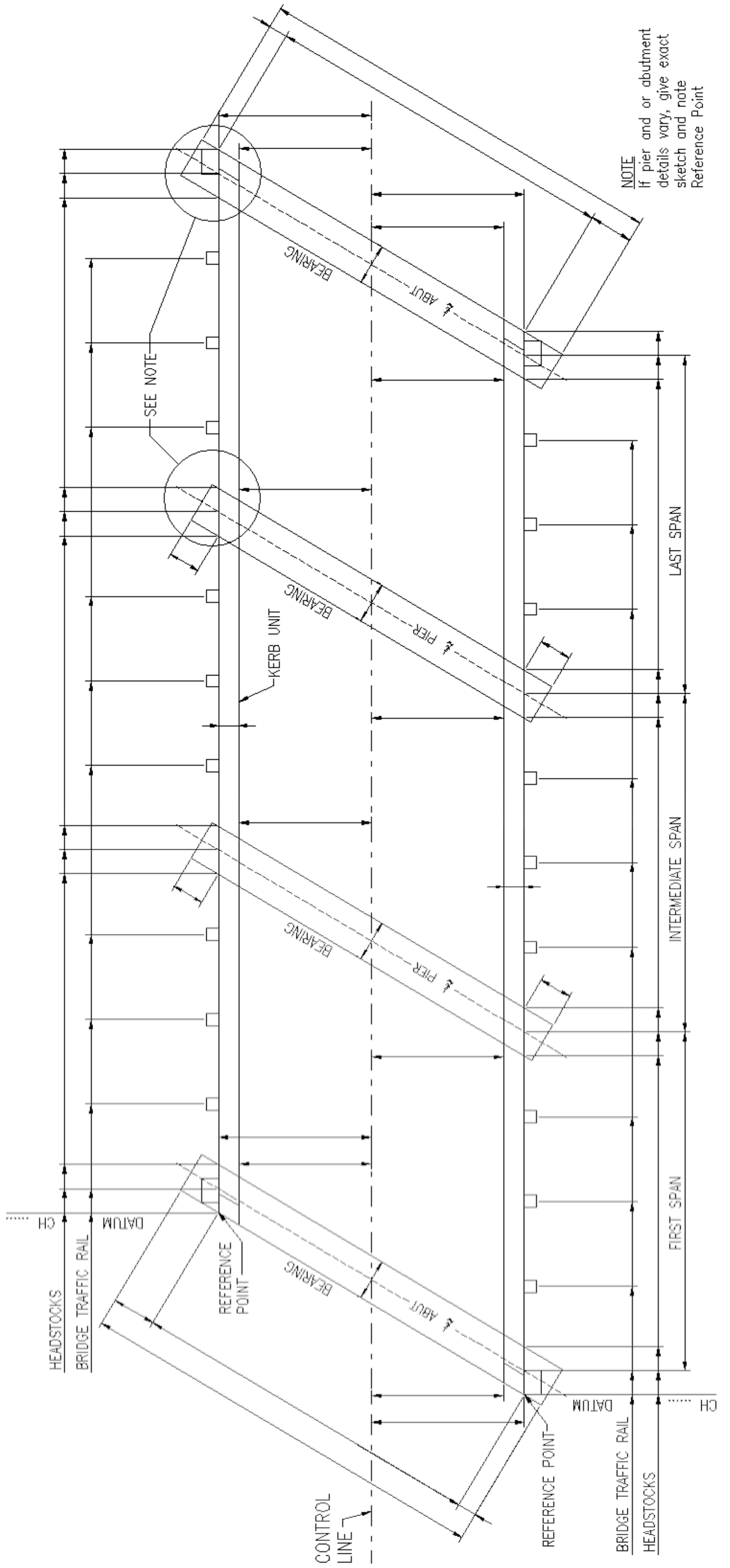


Figure 8.7(b) - Survey Information required for widening of deck unit bridges without a concrete deck

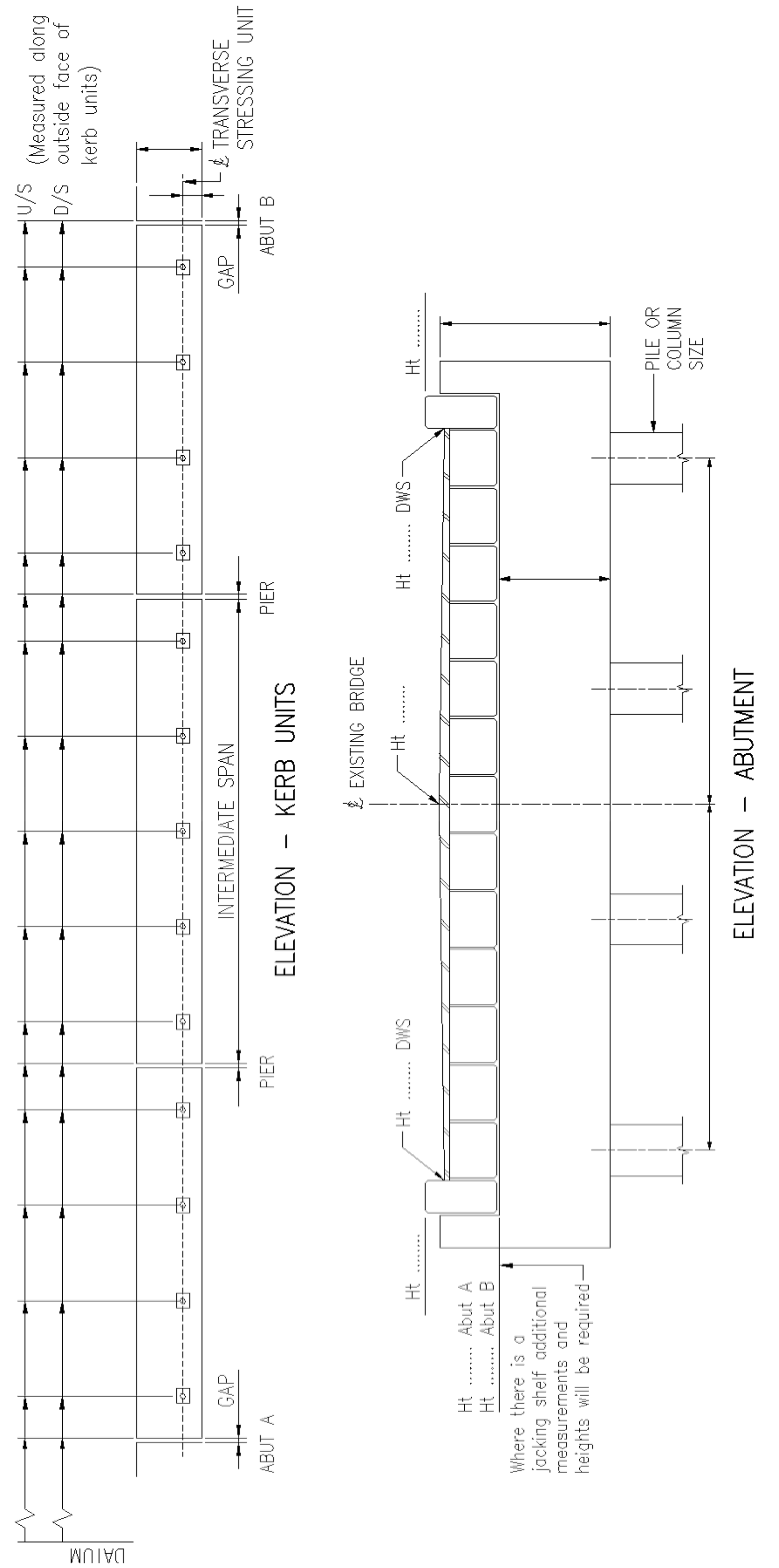
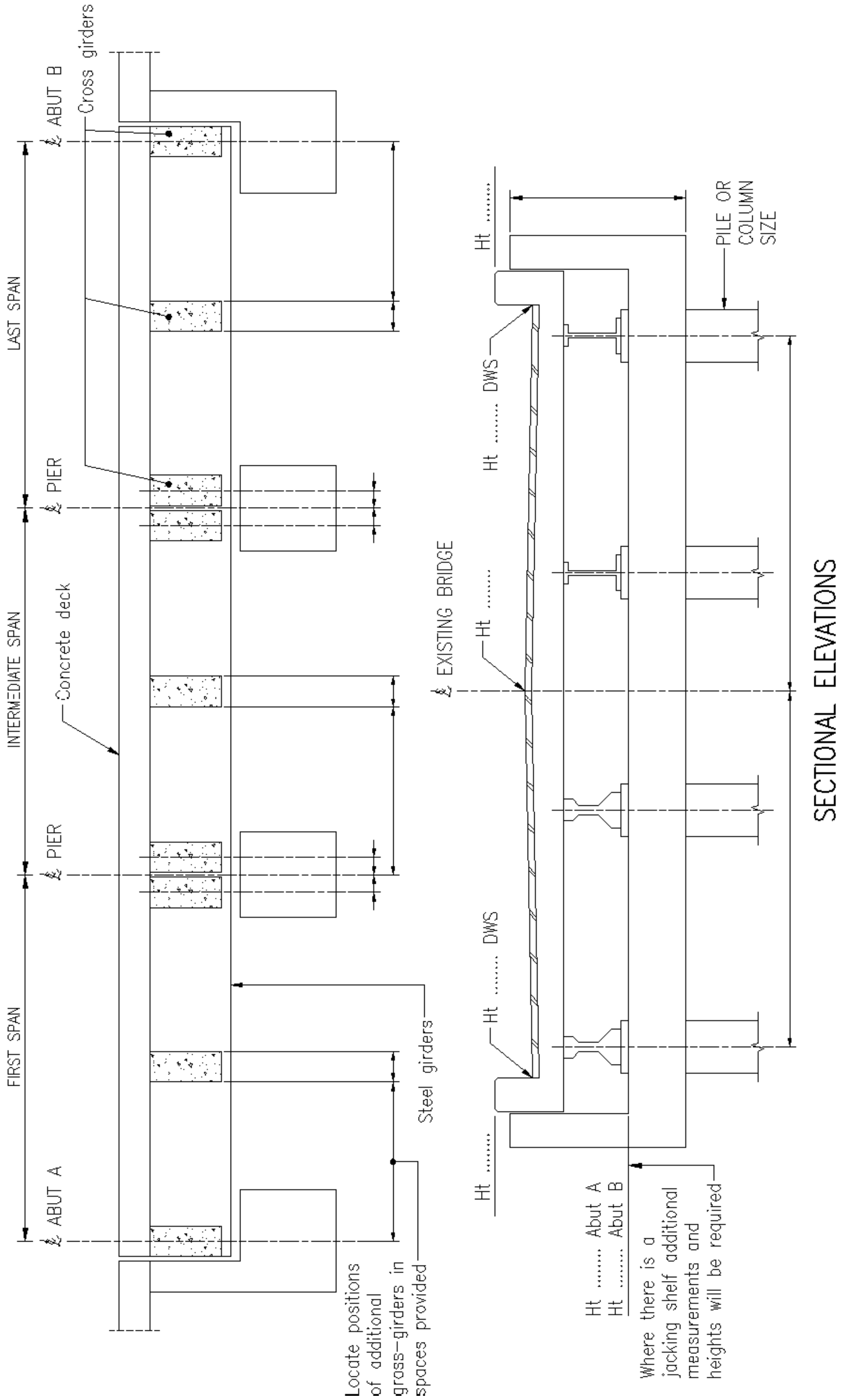


Figure 8.7(c) - Survey Information required for widening of girder bridges with a reinforced concrete deck



8.8 Survey format

Survey details are to be supplied in 12D format.

8.9 Survey accuracy

Because of the small tolerances involved in bridge construction, the bridge survey must be accurate to within 5 mm. The survey of the ground must be accurate to within 100 mm.

8.10 Demolished bridge artefacts

It is worth noting that in some cases existing bridges may be the second or third generation of existing structures for the particular site.

Details of the original bridge will often appear drafted on the General Arrangement plan and or elevation of the structure to be widened. Existing piles may be cut off below ground.

Further information, if required, may be available from Transport and Main Roads Plan Room or Structures Branch.

8.11 Foundations

Existing bridge foundations must be considered in the designed widening so that the new foundations do not clash with or impede the existing bridge foundations.

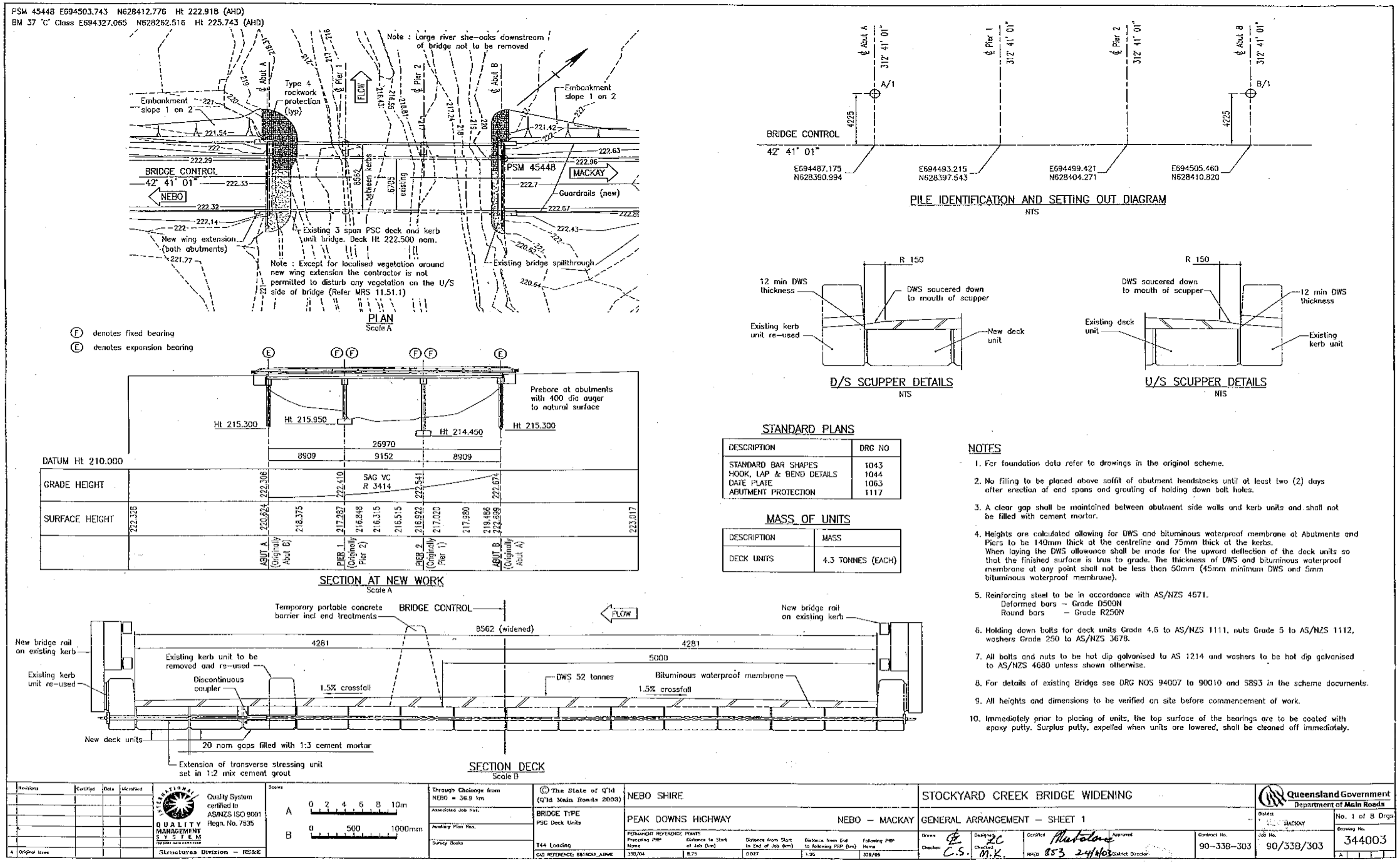
Existing timber piles also present a problem with new piles when they are in direct clash.

New foundations in close proximity to existing foundations may not only reduce the existing foundation capacities but in extreme cases have caused uplift of existing foundations and structures during driving.

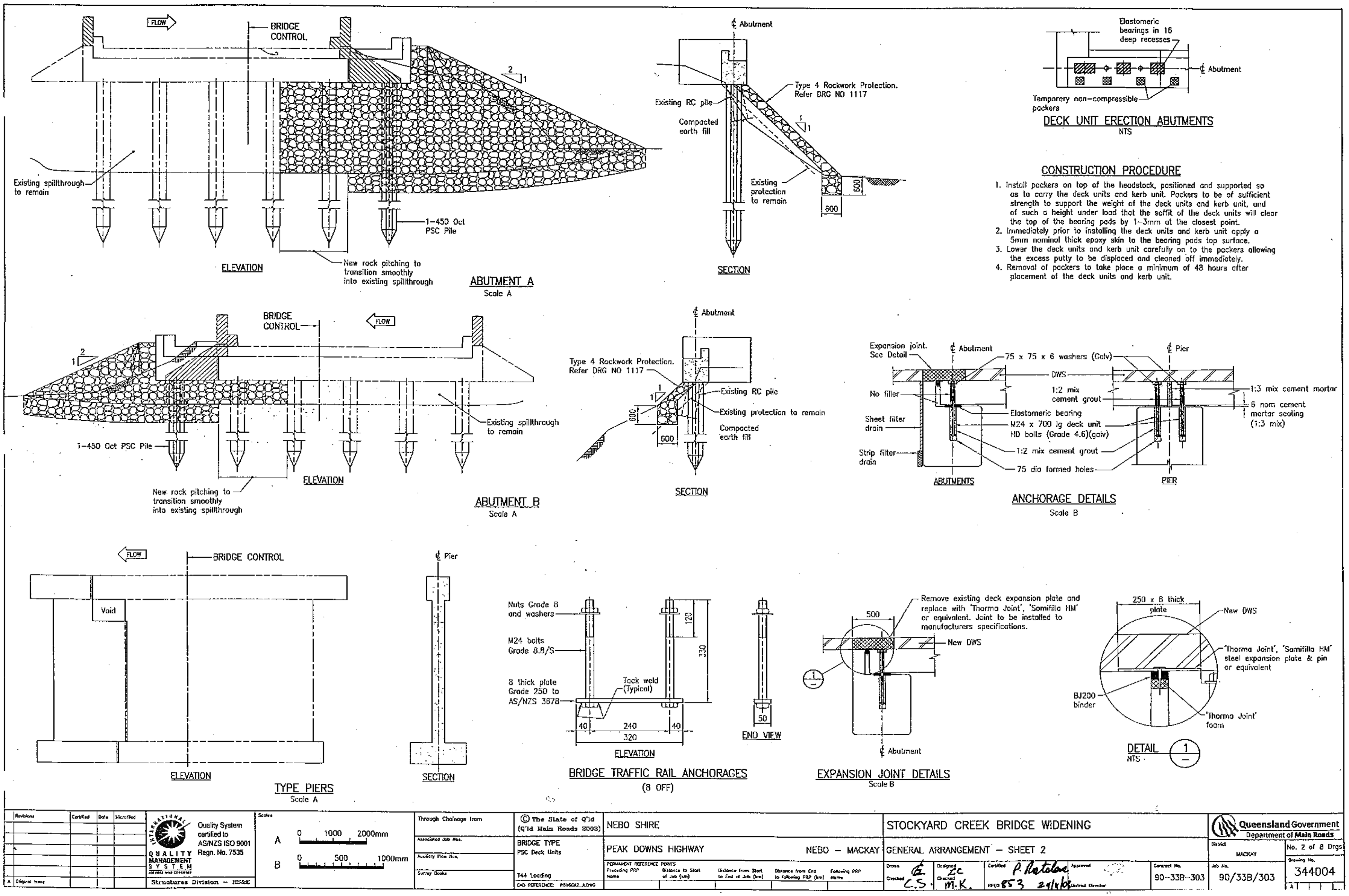
External piles may be raked on the existing structure. Raked piles should be identified during the detailing of the widening and appropriate allowance made to avoid them. This will often result in multiple rows of piles on the extension to avoid the existing raked piles.

Appendix A – Example drawings

Example drawings – Sheet 1

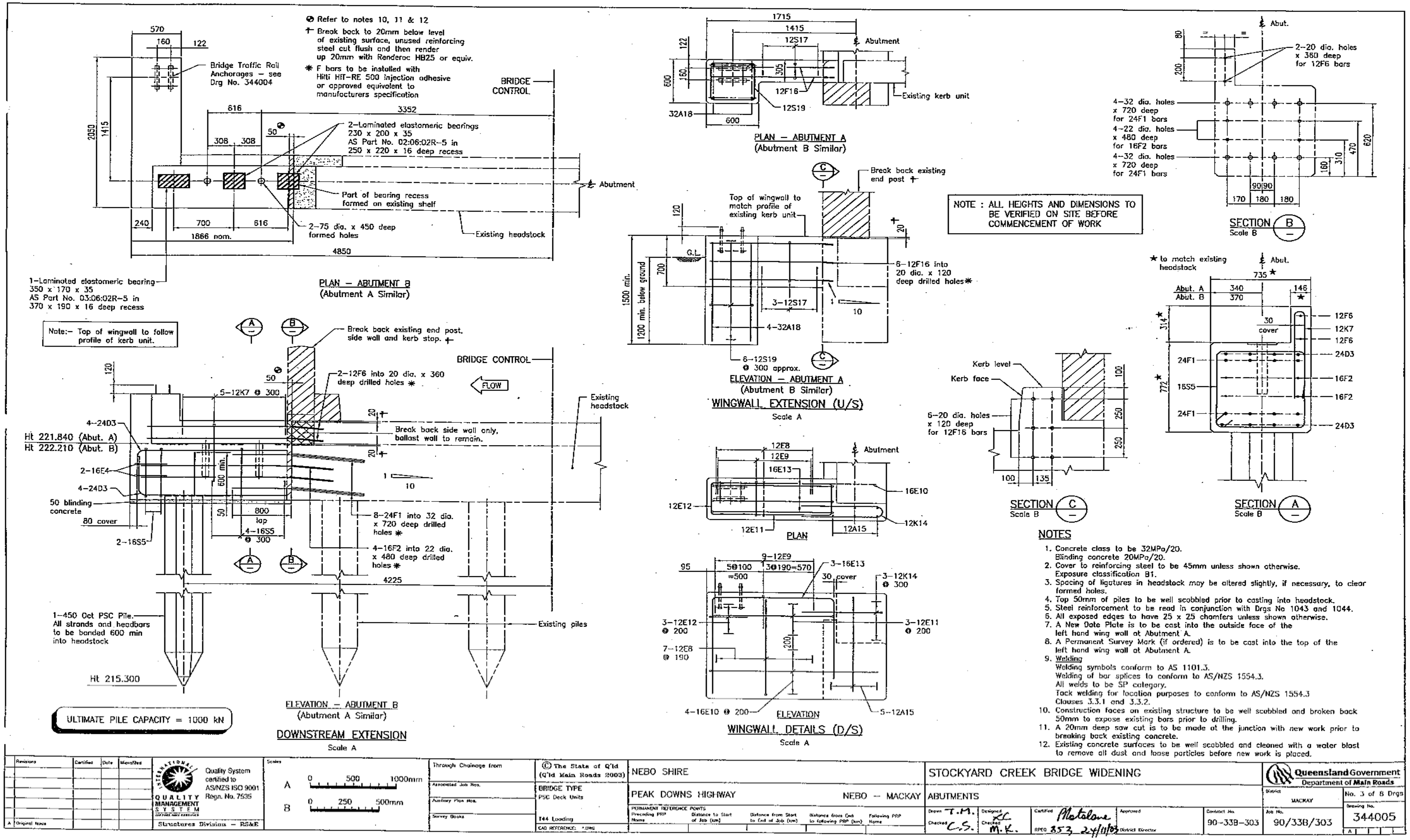


Example drawings – Sheet 2

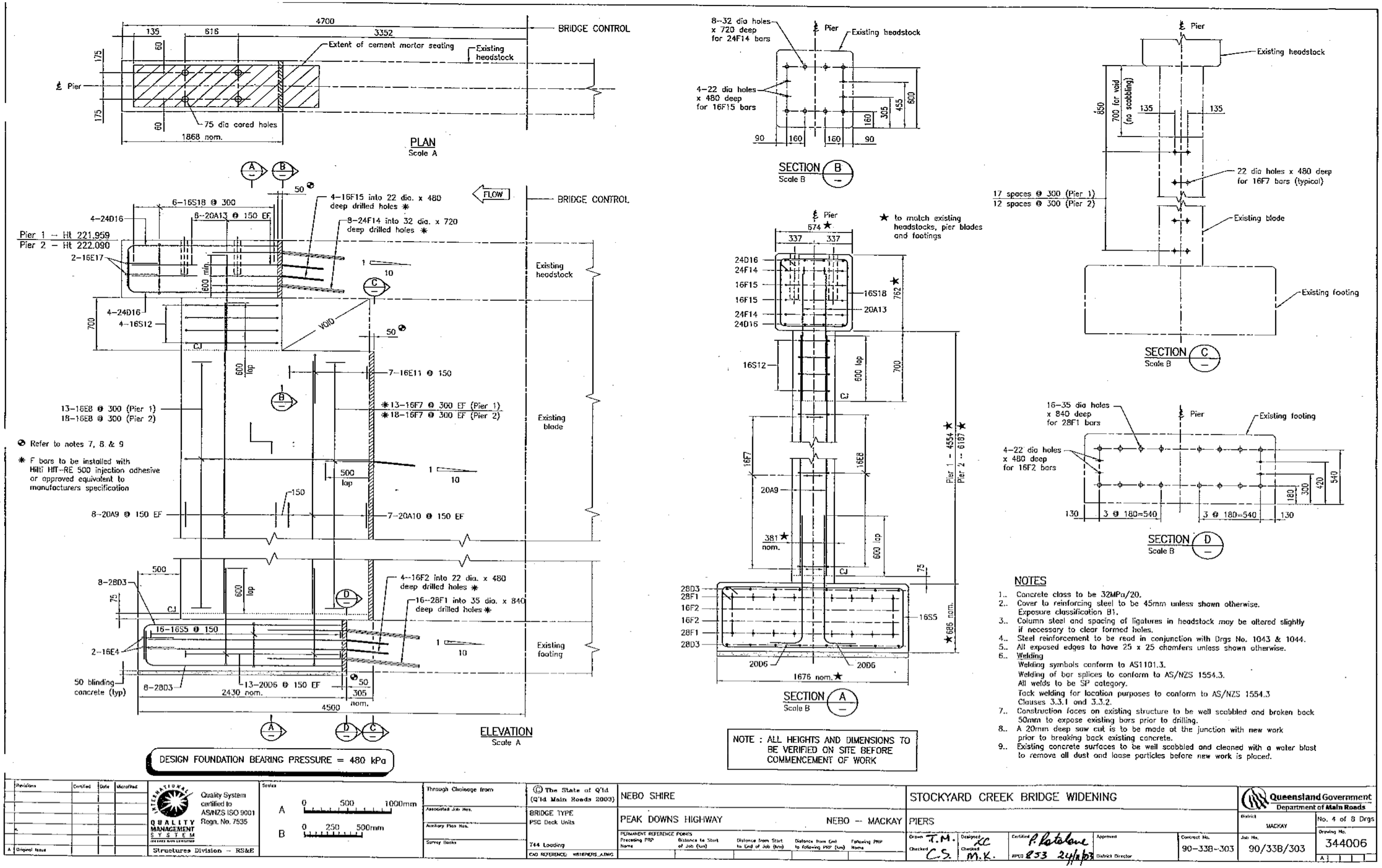


Example drawings – Sheet 3

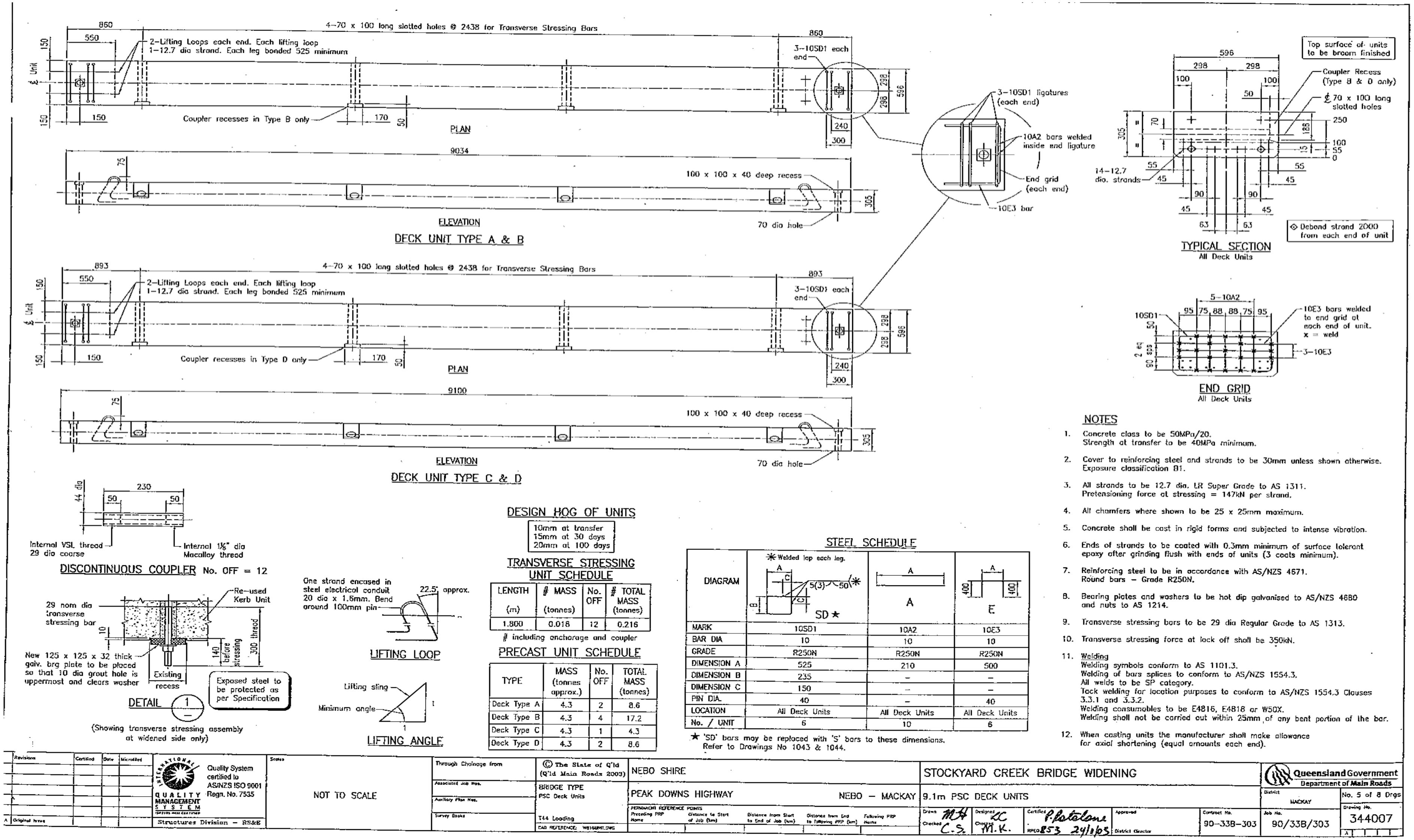
(Note: The example shown is for 1:2 sloped Bridge Traffic Barriers – extra posts are required for 1:10 slope Bridge Traffic Barriers).



Example drawings – Sheet 4



Example drawings – Sheet 5



Drafting and Design Presentation Standards
Volume 3: Structural Drafting Standards

Chapter 9: Bridge Deck Types

October 2017

Queensland Government

Feedback: Please send your feedback regarding this document to: tmr.techdocs@tmr.qld.gov.au

Chapter 9 Amendments

Revision register

Issue/Rev No.	Reference Section	Description of Revision	Authorised by	Date
1	-	First Issue	Manager (Structural Drafting)	Apr 2011
2	-	Document name change	Manager (Structural Drafting)	Nov 2011
3	9.3 9.5 9.10	Extra “constraints” to deck types added Kerb dimensions updated to match SD2045 Width of footways defined for where traffic barriers are not present	Team Leader (Structural Drafting)	Sep 2017

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9 Bridge Deck Types

9.1 Glossary of terms

For a complete glossary of terms refer Chapter 1 - *Introduction*.

9.2 Figures and examples shown in this volume

The figures and examples shown in this volume are for presentation purposes only, and may contain some details that are now superseded. These details have been included for ease of reference, to illustrate typical solutions, and to show the required standard of drafting presentation. The details are not to be used without an engineering check and certification by a Structural RPEQ to confirm that the details are appropriate for the specific project.

9.3 General

This chapter clarifies the bridge deck profiles most commonly designed by Transport and Main Roads.

Bridges are designed to a given set of design criteria which varies for any given project. Many constraints are taken into consideration and contribute to the type of bridge superstructure designed. These may include, but are not limited to:

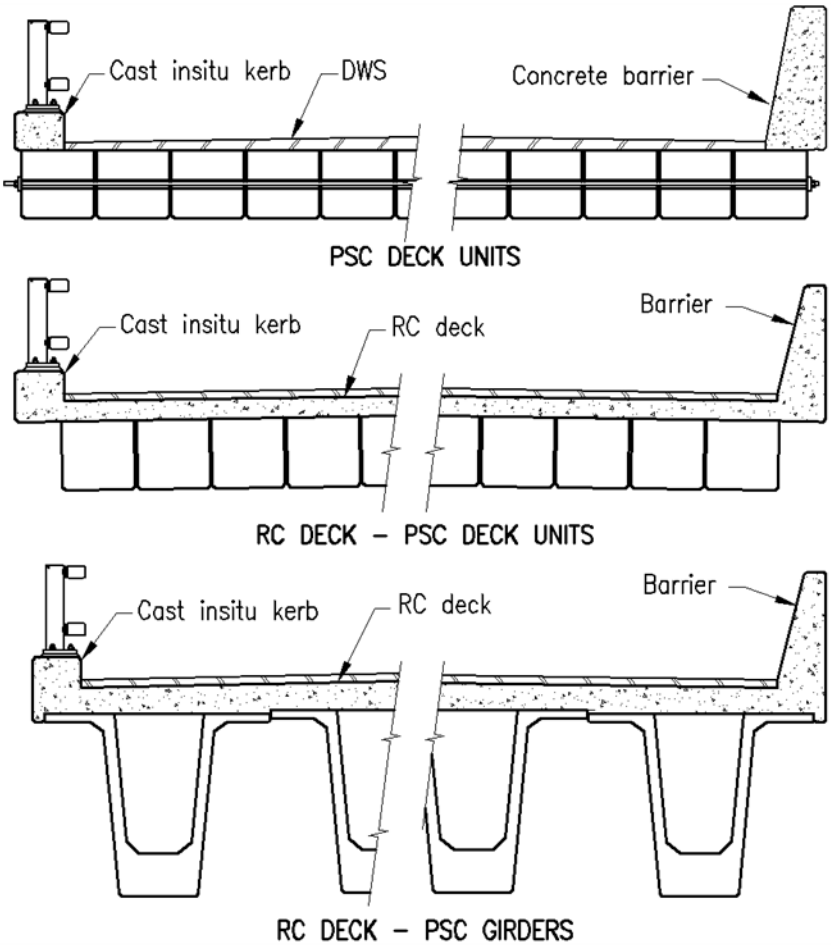
- bridge alignment
- vertical and horizontal geometry
- height above ground
- span lengths
- bridge over stream, road or railway
- footbridge / Shared user path / cycleway
- future bridge inspections and maintenance requirements
- geotechnical conditions
- ground conditions at the bridge site
- topographical features at the bridge site
- provisions for future widening
- services
- speed environment
- environmental requirements
- cultural heritage requirements
- availability of concrete to site
- ease of transport to site – physical length and tonnage may not be transportable on the road geometry
- urban vs rural environments, and
- local climatic and exposure conditions (for example, proximity to coast, high rainfall).

9.4 Deck types

The most common deck types used in bridge design fall into three main categories:

- PSC deck units with cast insitu kerbs or concrete barriers.
- PSC deck units with a reinforced concrete deck and kerbs or barriers.
- PSC or steel girders with a reinforced concrete deck and kerbs or barriers.

Figure 9.4 – Typical Deck Cross Sections



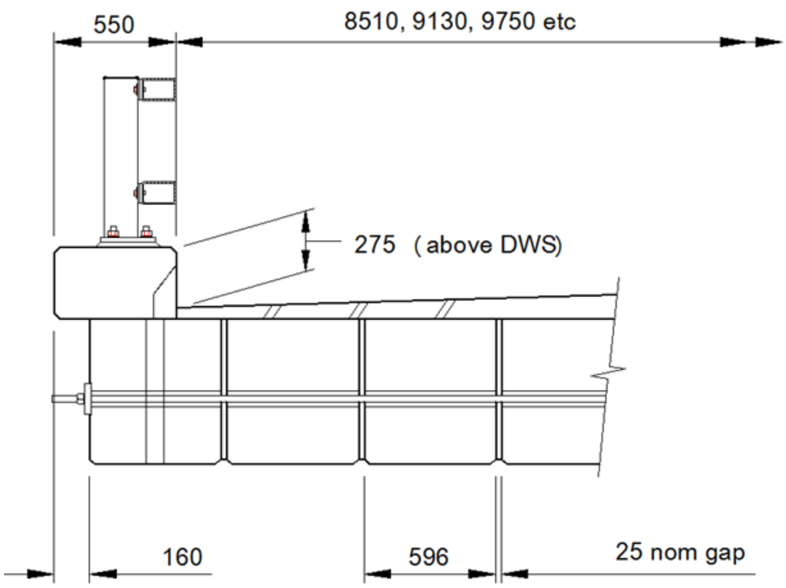
9.5 PSC deck units with cast insitu kerbs (Transversely Stressed)

Nominal widths between kerbs for this type of bridge are calculated using the following data:

- kerb width: 550 mm
- overhang: 160 mm
- deck unit width: 596 mm
- width between units: 25 mm (nominal).

Nominal widths between kerbs are therefore 8510, 9130, 9750 etc. depending on the number of deck units used. Refer Figure 9.5-1 - Cast Insitu Kerbs. For more extensive details refer Chapter 17 – *Cast Insitu Kerbs*, *Decks and Parapets* and Standard Drawing 2045 – *Standard Details of Cast Insitu Kerbs for Transversely Stressed PSC Deck Units.*

Figure 9.5 – Cast Insitu Kerbs



Gap between deck units (Transversely Stressed)

The standard gap between deck units as previously described is 25 mm nominal.

Tapered gaps may be necessary on bridges constructed on horizontal curves, or with a varying width between kerbs. In this instance, the average width of the gap over the length of the deck unit shall not exceed 30 mm, where the maximum width of gap is not greater than 40 mm at any point.

The Drafter shall check that the transverse stressing bar will fit through the deck unit stressing bar holes without touching the inside of any holes. The transverse stressing bar must not be bowed.

9.6 PSC deck units (with a reinforced concrete deck)

Reinforced concrete decks provide greater flexibility to accommodate defined geometric constraints such as roadway and footway widths and curved alignments. Reinforced concrete decks also allow for increased deck widths. For limitations on maximum deck widths refer to “Design criteria for bridges and other structures”.

Transverse stressing of the deck units is not required where a reinforced deck is used.

Some advantages of this type of construction are as follows:

- greater flexibility in laying out deck units for bridges on tight radius horizontal curves.
- generally, mortar is only required between the top 75 mm of the deck units. Overpass structures require mortar between the outer deck units only to strengthen them in case they are impacted by vehicular traffic
- the ability to provide for varying roadway cross sectional profiles over the length of the bridge structure
- a smooth running surface due to the constant thickness of DWS, and
- greater durability than transversely stressed bridges.

The deck provides an impervious barrier to water seeping through the bridge structure. Refer Chapter 17 – *Cast Insitu Kerbs and Decks*.

9.7 Span lengths - PSC deck units

Standard deck unit lengths range from 10 m (9950 mm actual unit length) to 25 m (24950 mm) in 1 m increments. A number of Transport and Main Roads PSC Deck Units Standard Drawings are available for industry reference. RPEQ Certification responsibilities remain with the project designer. The series of Standard Drawings commences at SD2042 design assumptions and continues from SD2050 – 10 m PSC Deck Unit published January 2017.

A 9950 mm long unit results in a 10 m intermediate span due to 50 mm longitudinal gaps between units at the piers. Standard unit lengths are to be used as the preferred option, this is for economy and consistency. Only in extenuating circumstances shall non-standard length units be considered for use.

Intermediate spans are the nominated span length, while end spans are slightly shorter due to the geometric configuration at the abutment headstocks. Refer Chapter 15 – *PSC Deck Units*.

9.8 PSC girders (with a reinforced concrete deck)

PSC Girders are generally utilised for spans ranging from 25 m – 35 m. Reinforced concrete decks are always used for PSC Girder projects.

In the future longer span lengths may be available soon for spans up to 46 m and girder masses up to 150 tonnes. Limitations will be present for casting yard locations, transport and handling and superstructure depths. The product must be determined appropriate for the Site and geometry.

The reinforced concrete deck may be constructed to any desired width conforming to the requirements of the roadway design. Refer Chapter 17 – *Cast Insitu Kerbs and Decks* and taking into account maximum widths stipulated in the Design Criteria for bridges and other structures. Bridge Jacking must also be taken into account when detailing deck widths as special considerations are required where the maximum no of 10 jacks per span end are exceeded. For example a longitudinal deck joint may be appropriate. Where possible it is desirable to have separate carriageways for each traffic direction to avoid exceedingly wide decks.

9.9 Span lengths - PSC girders

Deck spans on girder bridges can be set at any length within the span limitations of the girders but even metre spans are desirable.

For efficiency of design, girders of the same length should be used on the end spans as well as the intermediate spans. Refer Chapter 14 – *PSC Girders*.

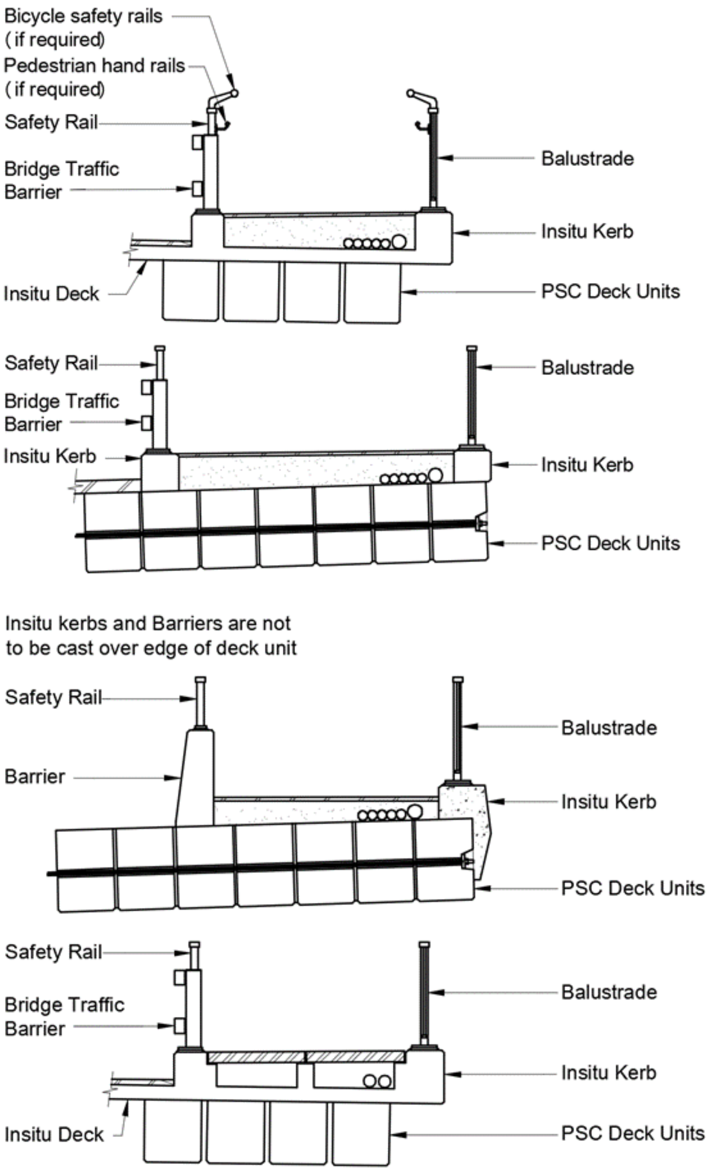
9.10 Bridge footways and bikeways

Width and construction details of footways built directly onto deck units are restricted to the modular widths of the deck units and gaps between them. There are fewer restrictions when the footway is built on a reinforced concrete deck.

For minimum design requirements regarding the height of barriers refer Chapter 19 – *Bridge Barriers* and Chapter 4.9 of the *Design Criteria for Bridges and Other Structures*. These requirements are a combination of AS 5100 *Bridge Design*, the Transport and Main Roads *Road Planning and Design Manual* (RPDM), and Austroads Part 14: *Bicycles*. The nominated width of a footway / bikeway is the minimum clear distance between the inside faces of handrails / safety rails / barriers. Where a barrier is not installed between the carriageway and the footpath the nominated width of the footpath + 450 mm is to be provided. This is to provide some clear distance for vehicles overhanging the kerb and to provide a potential barrier installation opportunity in the future. Refer to Chapter 7.10.2 of the RPDM for further information.

Refer to "Providing for Bicycles at Structures" – Chapter 5, Section 5.5.5 of the RPDM.

Figure 9.10 – Footways and Bikeways



Drafting and Design Presentation Standards
Volume 3: Structural Drafting Standards

Chapter 10: Bridge Geometry

February 2016

Queensland Government

Feedback: Please send your feedback regarding this document to: tmr.techdocs@tmr.qld.gov.au

Chapter 10 Amendments

Revision register

Issue/Rev No.	Reference Section	Description of Revision	Authorised by	Date
1	-	First Issue	Manager (Structural Drafting)	Apr 2011
2	-	Document name change	Manager (Structural Drafting)	Nov 2011
	10.10	Add section Road Design Considerations with Respect to Low-Level Frequently Flooded Bridges		
	10.11	Edit section Road Design Considerations with Respect to Rarely Flooded Bridges		
3	10.9	Reference to section 7.7.3 added for ease of use.	Team Leader (Structural Drafting)	Feb 2016
	10.10	Grammatical changes. Recommend skew to 30° to suit published standards.		
	10.12	New section - Summary of geometric layout.		
	10.13	Section number changed from 10.12 to 10.13. Outdated reference to Road Planning Updates removed		

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10 Bridge Geometry

10.1 Glossary of terms

For a complete glossary of terms refer Chapter 1 - *Introduction*.

10.2 Figures and examples shown in this volume

The figures and examples shown in this volume are for presentation purposes only, and may contain some details that are now superseded. These details have been included for ease of reference, to illustrate typical solutions, and to show the required standard of drafting presentation. The details are not to be used without an engineering check and certification by a Structural RPEQ to confirm that the details are appropriate for the specific project.

10.3 General

Bridge geometry can be divided into two broad areas, horizontal alignment and vertical alignment.

Horizontal Alignment

Layout of the bridge as viewed in plan. It provides a corridor or laneway that covers the full pavement width of the road.

Vertical Alignment

Profile of the bridge as viewed in elevation. It conforms to the grading and the cross sectional profile of the road.

10.4 Orientation of bridge control to horizontal alignment

The Bridge Control line is the principal line of reference used throughout bridge drawings. The procedure for fitting a bridge to a horizontal curve should consider how best to orientate the Bridge Control to the Road Control.

This is achieved by applying the following guidelines:

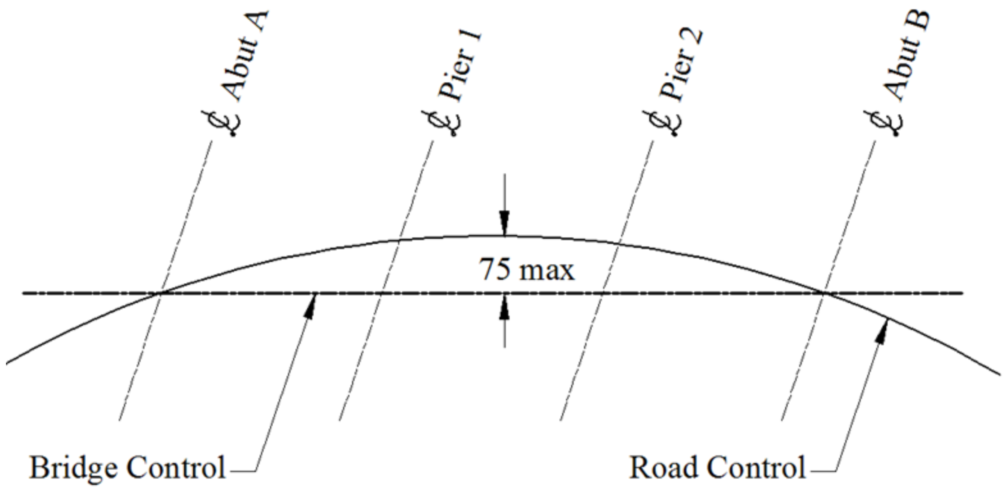
STEP 1 - Consider if it is possible to locate the bridge on a straight line, even though the Road Control is curved. This approach simplifies the laying out of the bridge

The limiting factor in being able to apply this approach is the maximum permissible offset from the straight Bridge Control to the curved Road Control which is 75 mm.

There are two ways of applying this 75 mm offset and they are shown in Figure 10.4-1 - Bridge Offset 75 mm Maximum and Figure 10.4-2 - Bridge Offset 150 mm Maximum.

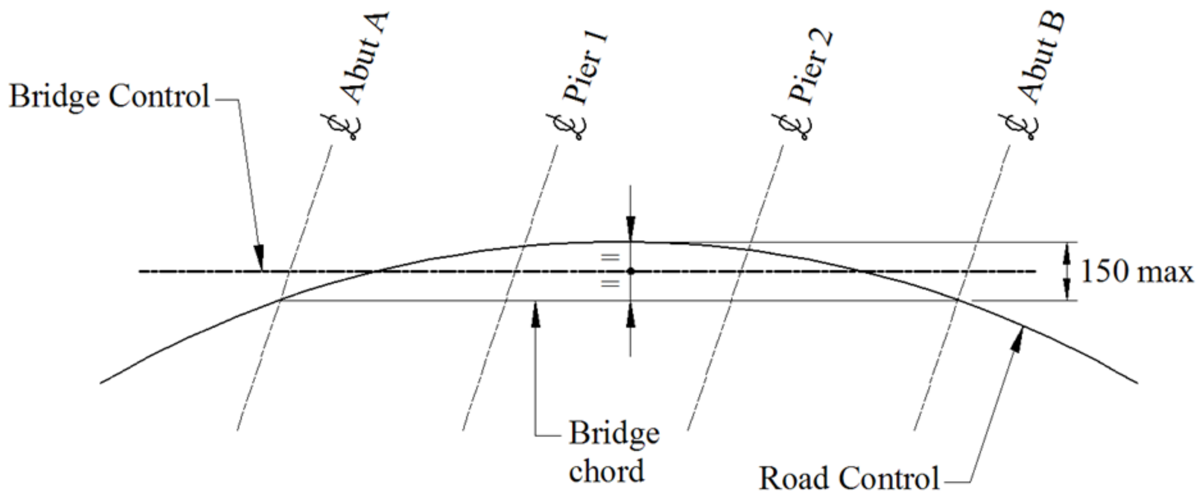
Figure 10.4-1 - Bridge Offset 75 mm Maximum

Bridge offset is less than or equals 75 mm



Bridge offset from the chord to the Road Control is greater than 75 mm but less than 150 mm

Figure 10.4-2 - Bridge Offset 150 mm Maximum



STEP 2 - If the combination of small radius curve and length of bridge makes it impossible to maintain a straight bridge alignment, then it is necessary to locate the bridge around the curve with each span set out as a parallelogram. Refer Figure 10.4-3 - Span Offset 75 mm Maximum and Figure 10.4-4 - Span Offset 150 mm Maximum.

Figure 10.4-3 - Span Offset 75 mm Maximum

Bridge offset is greater than 150 mm and span offset is less than 75 mm

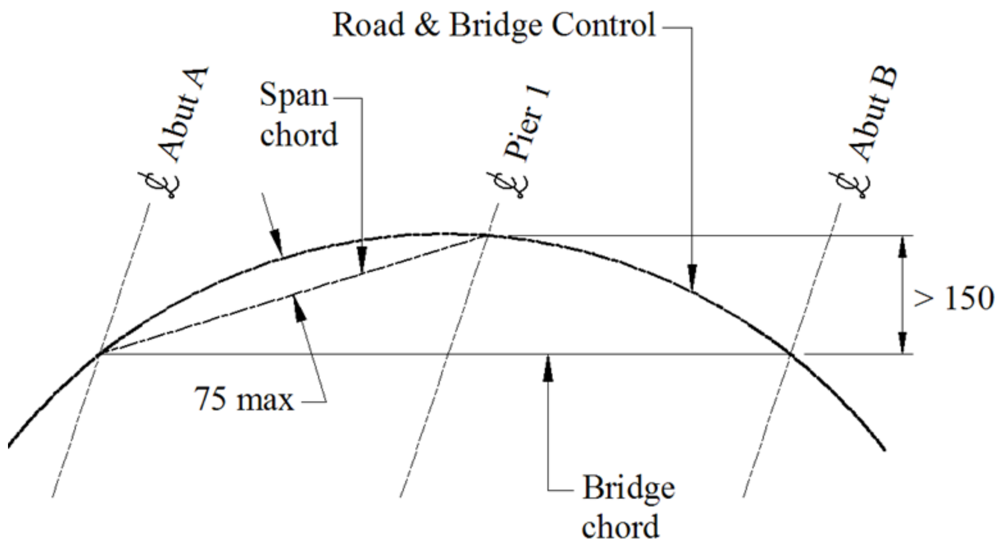
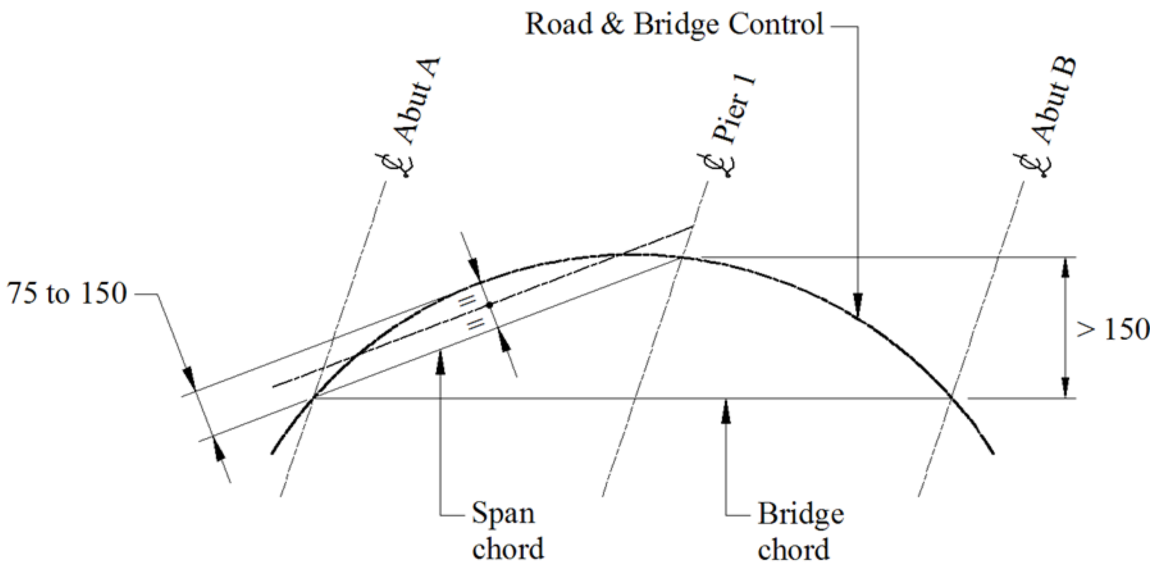


Figure 10.4-4 - Span Offset 150 mm Maximum

If the span offset from the span chord to Road Control is greater than 75 mm and less than 150 mm



10.5 PSC deck units on small radius curves

General setting out

The general setting out of deck unit bridges on curves has been covered in Section 10.4 – *Orientation of Bridge Control to Horizontal Alignment*. This section deals with deck unit bridges around small radius curves where a combination of factors such as the amount of skew, tightness of curve, or length of bridge precludes the use of simple parallelograms.

Special geometry required for bridges around small radius curves is dependent on several criteria, but basically a bridge can be set out in a series of parallelograms from the chords until the gaps between the units exceed 30 mm in width.

Every endeavour should be made to use parallelograms, but in the event of that system not working then the following system should be used.

When looking at a curved bridge, it will be noticed that, if parallelograms where used, the bridge would increase in width in a particular direction depending on the orientation of the curve and direction of the skew. Therefore the geometric calculations must commence from the narrowest end.

After setting the span lengths along the Road Control, the commencing span is set up as a parallelogram. For the next span, two parallel lines are set either side of the chord for that span, representing the inside face of the cast insitu kerb or the outer edge of the outer deck unit. These lines are then intersected by an arc (with a radius equal to the span length) centred at the intersection of the pier centreline and the edge line for the preceding spans. The connection of these points creates the centreline of the next pier. Figure 10.5-1 - PSC Deck Unit Bridges on Small Radius Curves and the procedure explained below assists with the previous explanation.

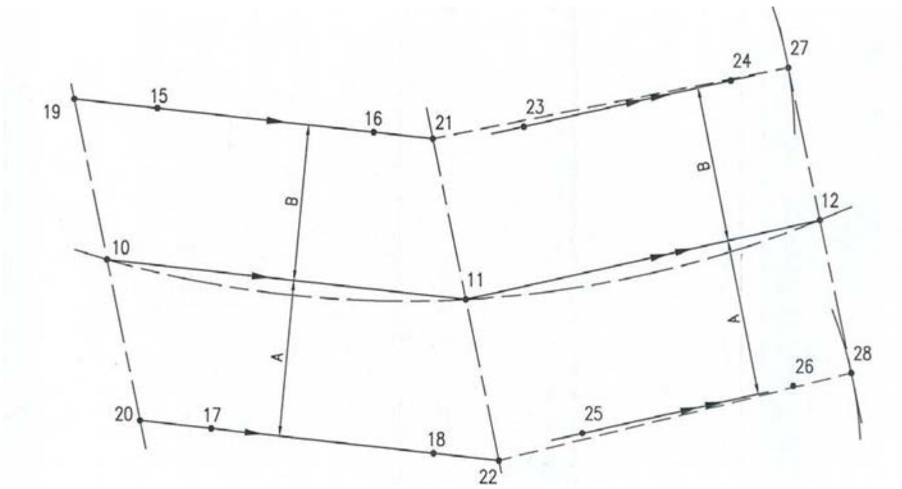
It will be noted that this pier centreline is no longer parallel to the previous pier or abutment centreline as the skew is slightly increased. Due to this effect the commencing skew angle must allow the designed bridge skew to be correct (±1º) at the heaviest flow section of the waterway. The same procedure is then repeated for each successive span.

Procedure

Refer Figure 10.5-1 - PSC Deck Unit Bridges on Small Radius Curves.

- set up both the horizontal alignment and vertical alignment
- locate the abutment and pier positions along the alignment (points 10 to 12)
- at the commencement end, set up parallel lines, either side of the chord, representing the bridge edge (inside face of the cast insitu kerb or the outer edge of the outer deck unit) (points 15 to 18)
- find the intersection of these lines with the centrelines of the abutments and piers (points 19 to 22)
- set up parallel lines in the second span to the same width as before (points 23 to 26)
- intersect these lines with arcs (with a radius equal to the span length) centred at points on the pier (points 21 and 22)
- join these points (27 and 28). Thus determining the bearing of the next pier
- repeat steps five, six and seven for the remainder of the bridge.

Figure 10.5-1 - PSC Deck Unit Bridges on Small Radius Curves



10.6 Layout of reinforced concrete deck bridges

PSC deck unit bridges

As skew angles increase, span lengths increase, and the number of spans increase, it becomes increasingly difficult to achieve a layout which accommodates the use of transverse stressing bars in deck unit bridges on a horizontal curve. When slotted holes longer than 100 mm x 70 mm are required for the passage of stressing bars due to saw toothing of the deck units, the option of using a reinforced concrete deck on deck unit design should be investigated.

The advantage of this system is that there is no requirement for allowance of stressing bars, no mortar between the deck units, and the layout of the deck units is not tied to the line of each span (to create the line of the kerb).

The maximum overhang from the outside of the outer deck unit to the outside face of the kerb should be approximately 500 mm. Refer Chapter 17 – *Cast Insitu Kerbs and Decks*, Section 17.6 – *Deck Overhang*.

Girder bridges (Super T-girders)

When detailing a reinforced concrete deck bridge on a horizontal curve, first preference should be given to locating girders parallel in each span. This will simplify detailing and subsequent construction of the cross girders and the PSC girders.

Care should be exercised in locating the intersection of girder centre lines and abutment and pier centre lines in order that:

- A maximum cantilever of 1.25 m from centre line of girder to outside face of the girder flange is maintained. Refer Chapter 14 – *Prestressed Concrete Girders,* Section 14.5 – *Girder Profiles*.
- If deck drainage is required, enough width must be provided in the outer most girder flange to fit scuppers and a drainage pipe.
- When factors of skew, span length and tightness of horizontal curve make the above parameters unattainable, then girders should be splayed, i.e. spacing of girders would vary from one end of span to the other end.

- Maintain constant length of girders where possible.

10.7 Encroachment of wing tip into traffic lane

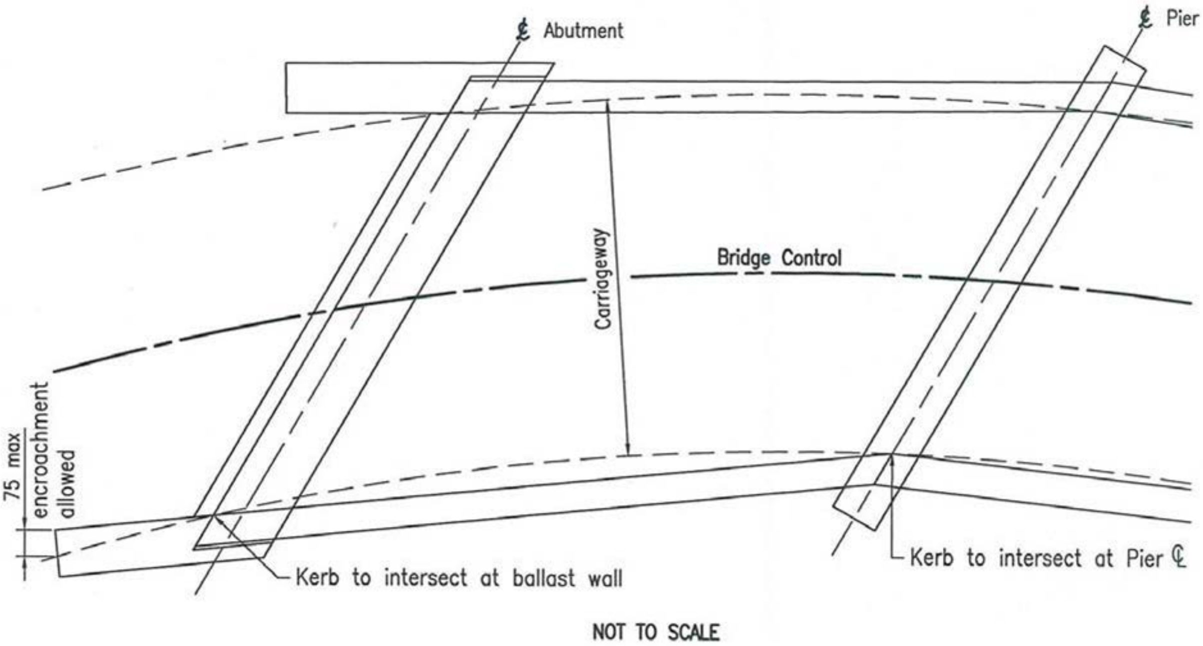
PSC deck unit bridges – without a reinforced concrete deck

On small radius curves and when spans are located around the curve, a check should be made to ensure that the end of the wing walls, which usually assume the line of the kerbs on the adjacent span, do not project more than 75 mm into the traffic lane.

If this is the case, the wingwalls are to be set parallel to a chord line running from the start of the abutment wing (at the ballast wall) to the end of the wingwall.

It should be noted that the bridge traffic rails will need to be kinked at the abutments and piers to accommodate this change. Refer Figure 10.7-1-Wing Encroachment.

Figure 10.7-1 - Wing Encroachment



10.8 Vertical alignment

Vertical Curves

Vertical curves come in two forms:

- Crest VC - the grade decreases in the direction of progressive chainage.
  Refer Figure 10.8-1 – Crest VC Details.

- Sag VC - the grade increases in the direction of progressive chainage.

Refer Figure 10.8 – Sag VC Details.

It is important to note that vertical curves as applied to TMR vertical geometry are parabolic curves and not pure circular curves. The fact that vertical curves are denoted on working drawings as having a particular radius, can create some confusion to designers. It should be noted that, in fact, a radius calculated for a vertical curve is only a nominal radius which applies at that part of the parabola which very closely resembles a pure circular curve.

Vertical Alignment

With regard to positioning a bridge in a longitudinal vertical plane, it can be accepted that the bridge will follow the vertical alignment of the Road Control. This may result in the bridge being on a straight or curved grade, or in some cases a combination of both.

Figure 10.8-1 – Crest VC Details

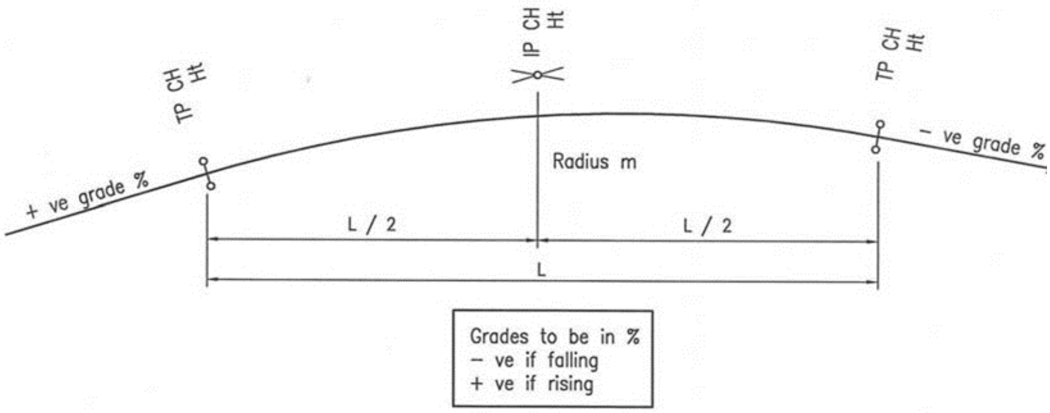
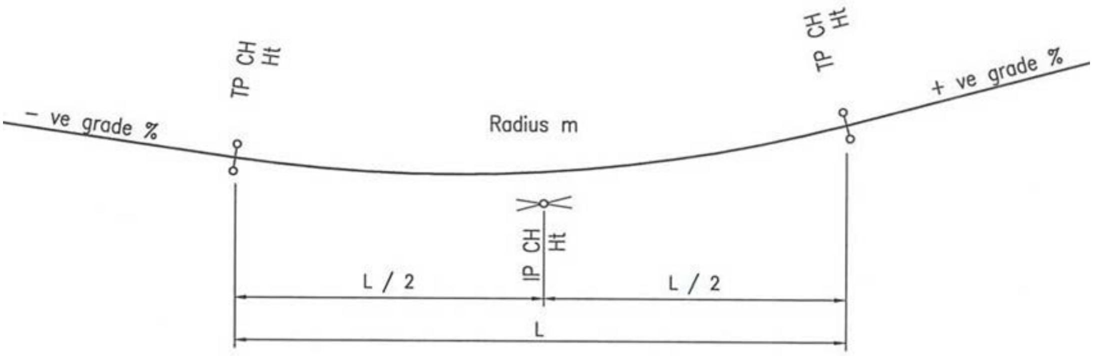


Figure 10.8-2 – Sag VC Details



10.9 Bridge crossfall

The crossfall / superelevation and alignment of a bridge is usually provided by a road designer. It should comply with *Road Planning and Design Manual*, Table 7.16 (in section 7.7.3) as duplicated in Table 10.9-1 - Typical Pavement Crossfalls.

Table 10.9-1 - Typical Pavement Crossfalls

Road Surface	Traffic Lane (%)	Shoulder (%)
Cement Concrete	2.0-3.0	2.0-4.0
Asphalt Concrete	2.5-3.0	2.5-4.0
Sprayed Seal	3.0-4.0	3.0-4.0
Unsealed	3.5-4.0	4.0-5.0
Within Floodway's	1.0-2.0	1.0-2.0

There are many controls in urban areas which force departures from the above values. For further explanation refer to the *TMR Road Planning and Design Manual*, 7.7.3 – *Road Crossfall*.

There may be good reasons why there is a deviation from the values, such as the following example:

- The bridge surface of a widened bridge may also need to be flatter than the TMR *Road Planning and Design Manual* specifies to reduce the amount of dead load caused by the additional DWS. Older bridges were not designed to carry the same loads that modern bridges are.

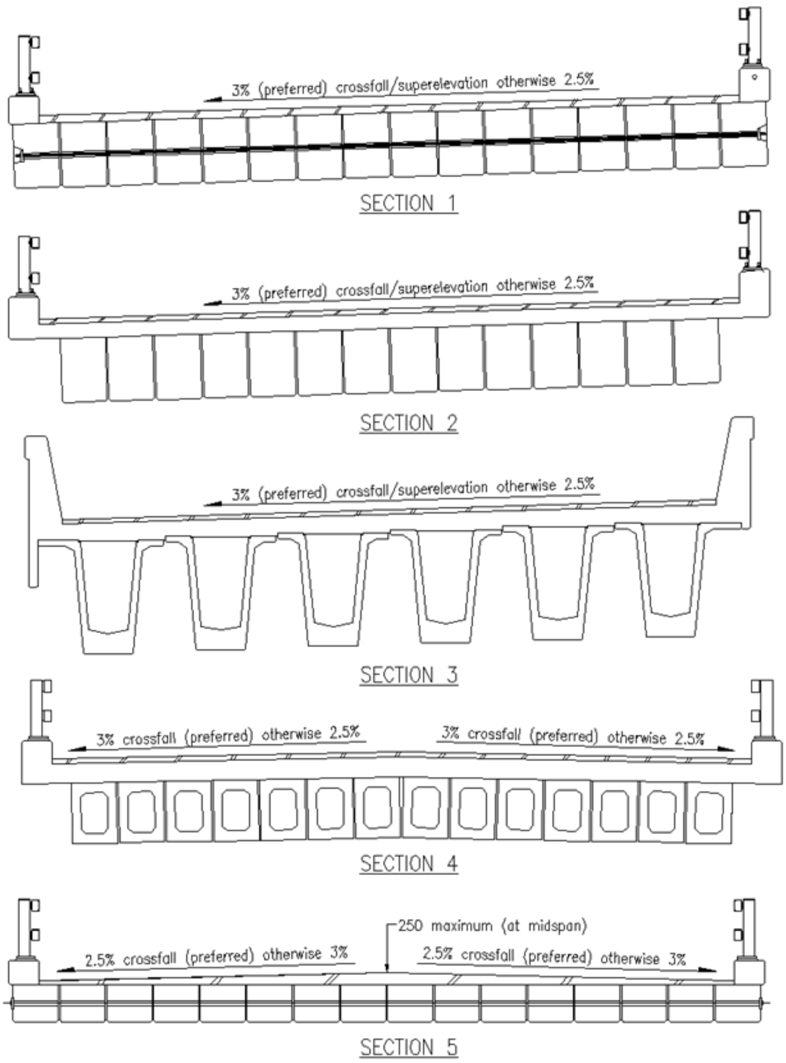
The maximum crossfall for a footpath is 2.5%, though two per cent is preferred.

Three per cent is the preferred bridge crossfall so that water runs off the road surface as quickly as possible. Refer to Sections 1 to 4 in Figure 10.9-2 - Bridge Crossfall / Superelevation.

Three per cent crossfall suits bridges where the DWS is a constant thickness, for example, bridges with a deck or bridges that are superelevated.

2.5% is the preferred crossfall for bridges with a crown and without a deck. Refer to Section 5 in Figure 10.9-2 - Bridge Crossfall / Superelevation. 2.5% crossfall is used to reduce the depth of DWS at the crown. This will reduce dead load and rutting in the road surface. The depth of DWS must not exceed 250 mm anywhere along the span. For very wide bridges a deck may be needed to prevent the DWS being too deep. Refer to Section 4 in Figure 10.9-2 - Bridge Crossfall / Superelevation.

Figure 10.9-2 - Bridge Crossfall / Superelevation



Deck wearing surface

On deck unit bridges the thickness of DWS is varied to achieve the nominated profile of the road and to account for the hog of the deck units.

On bridges with a reinforced concrete deck, the DWS is a constant thickness because the deck accounts for the hog of the deck units and any changes in crossfall / superelevation. Refer Chapter 7 – *Deck Wearing Surface*.

10.10 Road design considerations with respect to low-level frequently flooded bridges

For the purpose of this document, a bridge is considered to be low-level and frequently flooded when its superstructure may be partially or fully submerged by a flood smaller in magnitude than a 20 year average recurrence interval (ARI).

When planning a road alignment, the road designer should work closely with hydraulic and structural engineers to determine the best design. Every bridge shall be accessed individually, however the following general guidelines may assist in reducing construction costs and simplify the design, drafting, and construction of a bridge:

Crossfall/Superelevation:

- The bridge deck should be designed with a two way crossfall. There are advantages and disadvantages when the deck is superelevated (see below), and therefore a two way crossfall is the best compromise.
- A superelevated deck falling to the upstream side will tend to be covered in debris and silt after the flood water subsides. It will however, be safer to drive on, as there is less chance of the vehicle being pushed downstream by the force of the water.
- A superelevated deck falling to the downstream side may trap debris underneath the deck. It will also be subjected to greater uplift forces. The deck however, should be relatively clean after the flood water subsides.
- Constant crossfall / superelevation is preferred.
- Varying crossfall / superelevation can be accommodated but should be avoided.

Vertical alignment:

- The deck should be level so that the deck acts as a weir when flood water over-tops it. If the bridge is on a grade or a VC, the flood water will be directed to the low end of the bridge. This may drastically alter the pattern and turbulence of flow and lead to scour and erosion problems at the low end of the bridge.
- Additionally, the deck should be level so that motorists crossing a flooded bridge do not encounter an unexpected increase in water depth.
- If extenuating circumstances prevent a level bridge, a small constant grade is preferred.
- Generally a VC is not preferred on bridge, however sometimes they can assist with draining the deck when stormwater is not allowed to drain directly from the bridge deck into the stream. This is achieved by putting the crest of the VC near the middle of the bridge, and draining the water towards each abutment. Doing this may mean that a drainage system is not required.
- A combination of any of the above can be accommodated but should be avoided.

Horizontal alignment and skew:

- Where possible, the alignment should be designed to minimise the length and skew of the bridge. This may be achieved by traversing the watercourse as square as possible to the direction of the flood flow. A bridge on a HC, or a bridge not square to the flow, may direct water towards the downstream abutment. This may drastically alter the pattern and turbulence of flow and lead to scour and erosion problems around this embankment.
- A bridge crossing a stream is usually skewed so that the abutments and piers are parallel to the flood-water flow.
- Skews should be minimised where possible to be 30° or less to simplify girder and unit design. (published PSC Deck Units are limited to 30°)
- Varying skew can be accommodated to suit horizontal curves but should be avoided where possible.

10.11 Road design considerations with respect to rarely flooded bridges

For the purpose of this document, a bridge is considered to be rarely flooded when its superstructure is not submerged by a flood smaller in magnitude than a 20 year average recurrence interval (ARI).

When planning a road alignment, the road designer should work closely with hydraulic and structural engineers to determine the best design. Every bridge shall be assessed individually, however the following general guidelines may assist in reducing construction costs and simplify the design, drafting, and construction of a bridge:

Crossfall / Superelevation:

- Constant crossfall / superelevation is preferred.
- Varying crossfall / superelevation can be accommodated but should be avoided.

Vertical alignment:

- A bridge with a level deck is the easiest to draw, however a bridge on a slight grade improves the drainage of the bridge deck. Therefore, all bridges should be on a minimum grade of 0.3% if this can be easily accommodated by the approach road works at both ends of the bridge.
- Generally a VC is not preferred on bridge, however sometimes a VC can assist with draining the deck when stormwater is not allowed to drain directly from the bridge deck into the stream. This is achieved by putting the crest of the VC near the middle of the bridge, and draining the water towards each abutment. Doing this may mean that a drainage system is not required.
- A combination of any of the above can be accommodated but should be avoided.

Horizontal alignment and skew:

- The bridge should be straight and aligned as square as possible to the direction of the flood-water flow. This will reduce skew and length of the bridge.
- A HC is the next preferred option.
- A combination of any of these can be accommodated but should be avoided.
- A bridge crossing a stream is usually skewed so that the abutments and piers are parallel to the flood-water flow.

- If the bridge needs to be skewed, try and limit it to 30° to suit standard precast beams
- Varying skew can be accommodated but should be avoided.

10.12 Summary of alignment design and bridge layout aims

Road alignment design should consider the impacts of the alignment on the bridge structures. The combined effects of horizontal curve / vertical curve / skew / grade / superelevation can complicate the geometric layout of a structure significantly especially when considering bearing and unit / girder geometry and placement – where possible design alignments should seek to eliminate at least one or two or if practical most of these of these alignment features.

The desired outcomes of an optimised alignment and bridge layout are:

- First pass when deciding on the bridge layout is to attempt to use a straight bridge for a curved design alignment, the constraints being no part of the bridge kerbs and wings is to deviate from curved alignment by more than 75 mm
- Simplify the design alignment where available to reduce skew, horizontal and vertical curves, superelevation and grade
- Skews on structures at 30° or less – this allows use of TMR standard drawings as a basis for RPEQ certified project specific PSC unit drawings
- Minimised curves allowing the use of transverse stressing units which may negate the need for cast insitu decks (span lengths or durability may mandate cast insitu deck)
- For curved bridges a cast insitu deck may be required to overcome fitment issues with transverse stressing bars – designer to check using a layout diagram
- Rationalisation of precast products such as deck units (length and skew)
  - Attempt to use average skew across neighbouring spans to minimise variation in girders / units on multiple span bridges with curves (for example, a 6 span bridge may utilise 3 distinct skews averaged across spans 1&2, 3&4, 5&6 to reduce unit variations)
  - Use standard length units to match published standard drawings
  - Rationalise unit lengths around curves where practical (geometry may require units to be fanned so that gaps increase to accommodate same length units)
- Overhang of cast insitu deck on curved decks to be managed to meet identified design limitations (for example, 500 max 100 min overhang – design engineer to inform)
- Vertical geometry needs to be assessed for effects on girder and unit ends. Ends of precast products need to be calculated to be vertical when placed on the grade (sloped when cast). (Nominal end clearance of 50 mm is required between girders / units / ballast walls at abutments and piers – it is recommended the designer draft a scaled elevation of the superstructure and substructure to ensure clearance is achieved)
- Consideration of the location of the top and bottom faces of units on grade / crossfall / superelevation needs to be addressed to ensure correct placement of formed holes and adequate clearances to end walls and ballast walls at the abutments. It is recommended a layout drawing be drafted to validate formed hole locations and clearances, unit lengths, stressing bar fitment etc. For complex geometry a 3d drawing may be required.

10.13 Bridge width

For minimum design requirements regarding bridge widths, refer TMR *Bridge Design Criteria for Bridges and other Structures*. These requirements override AS 5100 - *Bridge Design* and the TMR *Road Planning and Design Manual*.

Drafting and Design Presentation Standards
Volume 3: Structural Drafting Standards

Chapter 11: General Arrangement Drawings

December 2020

Queensland Government

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Chapter 11 Amendments

Revision register

Issue/Rev No.	Reference Section	Description of Revision	Authorised by	Date
1	-	First Issue	Manager (Structural Drafting)	Apr 2011
2	-	Document name change	Manager (Structural Drafting)	Nov 2011
	11.7	Threaded rod option added		
3	-	General Revisions Updated Appendix sample drawings	Senior Designer	Dec 2020

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11 General Arrangement Drawings

11.1 Glossary of terms

For a complete glossary of terms refer Chapter 1 *Introduction*.

General Arrangement drawings are informally referred to as GA's as they will be in this chapter. On all drawings they are to be referred to with the full description and shall not be abbreviated.

11.2 Figures and examples shown in this volume

The figures and examples shown in this volume are for presentation purposes only, and may contain some details that are now superseded. These details have been included for ease of reference, to illustrate typical solutions, and to show the required standard of drafting presentation, as such, details are shown for PSC Deck Units and PSC Girders. The supplied details are not to be used without an engineering check and certification by a Structural RPEQ to confirm that the details are appropriate for the specific project.

11.3 Consistency in presentation

As stated in Chapter 1 – *Introduction*, the purpose of this volume is to standardise the presentation of structural drawings, particularly departmental bridges, to achieve uniformity in appearance and detail for structural drawings.

This is important, particularly when drafting GA drawings, which can be drawn so that similar information is displayed consistently. For example:

- plan and elevation on the first sheet (multiple first sheets if the bridge is too long to fit on one drawing)
- bench mark / permanent survey mark information is always shown in the top left-hand corner of the first GA drawing along with a legend regarding foundation bore holes
- the catchment area is to be shown at the bottom right-hand side of the Plan view, and
- the notes are to be shown at the bottom right-hand side of the drawing.

11.4 Types of GA drawings

GA drawings give an overall representation, at various phases of the project, of the bridge to be constructed. These phases are:

- concept design (15% complete)
- preliminary design (50% complete), and
- detailed design (85% / 100% complete)

The level of detail provided at each phase will increase as the project progresses from concept through to detailed design.

11.5 Concept design GA drawings

The information available at the concept stage of the project can be limited. These drawings are used to provide different options that may be appropriate for the particular site and road design.

The following views shall be provided:

- plan
- elevation
- section deck
- horizontal curve alignment (if available)
- vertical curve alignment (if available)
- concept drawing stamp (with issue date), and
- title block (if various options are provided each drawing is to be clearly marked with the appropriate option, for example Option A, Option B etc.).

Each of these views shall provide all information available at that time.

Generally, there will be one drawing, however depending on the overall length of the bridge there may be multiple drawings. Concept GA drawings are usually used to indicate the anticipated type of structure for the Region's Business Case.

Refer Appendix A - Example Concept GA Drawings.

The following sections will explain each view in detail and look at some of the aspects to be addressed:

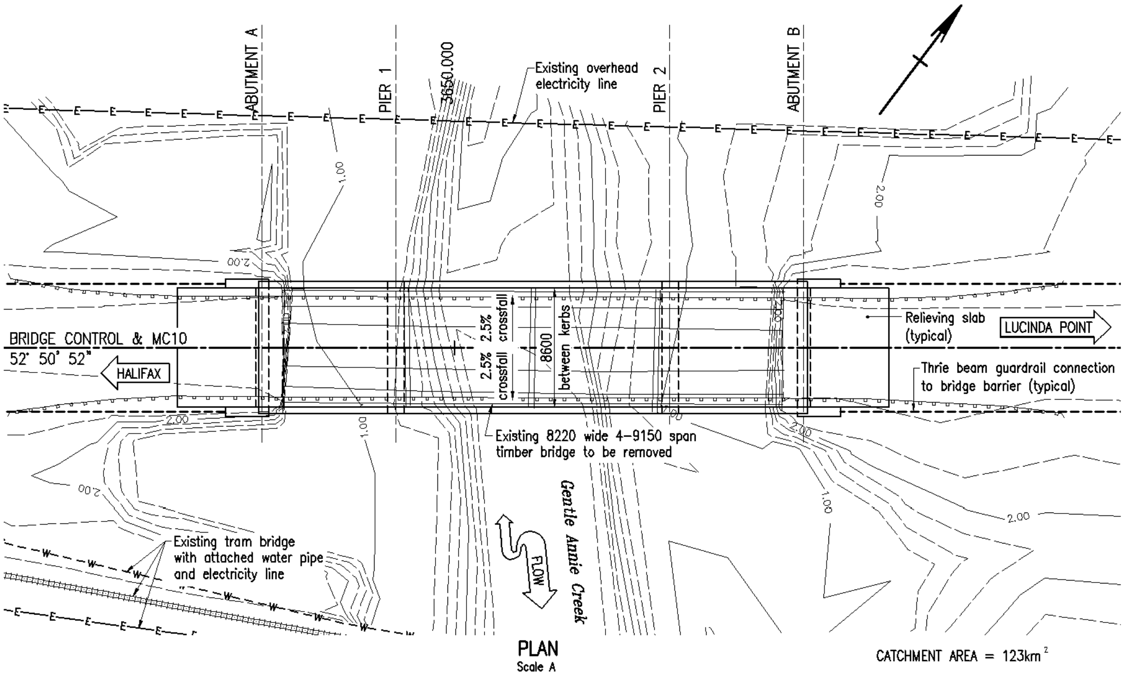
Plan

- Outline of the structure
- Waterway name
- Crossfall or superelevation
- Width between kerbs
- Major towns (in each direction)
- Contours of the existing surface, at 0.25 m intervals with Heights marked at 1 m intervals
- Property boundaries and fences
- Public utilities and services, labelling any services to be relocated, including if it is in or out of the contract
- Abutments and Pier(s) centrelines
- Relieving slabs
- Approach and departure guardrail / extruded concrete barriers
- Stream flow, including tidal stream flow when appropriate
- North point
- Road control line and chainages
- The Road Control is to be shown on the left hand side of the Plan view along with the Bridge Control. The horizontal alignment, bearing or radius, shall also be shown.

- Existing structures, to be shown in a dashed line, and with details such as span lengths, bridge width and composition and existing nominal deck Height. This is important particularly when a new bridge is being built on or near the same alignment as the existing bridge. Ensure the new piles are well clear of the existing piles taking into account any rake on new or existing piles and the maximum theoretical out of position tolerance or existing 'As Constructed' information.

Refer Figure 11.5(a) - Concept GA Drawing - Plan.

Figure 11.5(a) - Concept GA Drawing - Plan



Elevation

- Outline of the structure
- Individual span lengths and overall length of the structure between abutments
- Excavation to clear waterway
- Minimum vertical clearances for overpass bridges
- Existing surface cross section taken along the Control Line
- Existing structures
- Datum Height
- Table of grade Heights and vertical alignment details. Heights shall be shown at abutments and piers.
- Table of surface Heights. Show Heights at major changes in grade and at abutments and piers centrelines.
- Table of chainages. Show chainages for each surface Height and at abutment and pier centrelines, and
- Hydraulic information including flood velocities and flood immunity Heights.

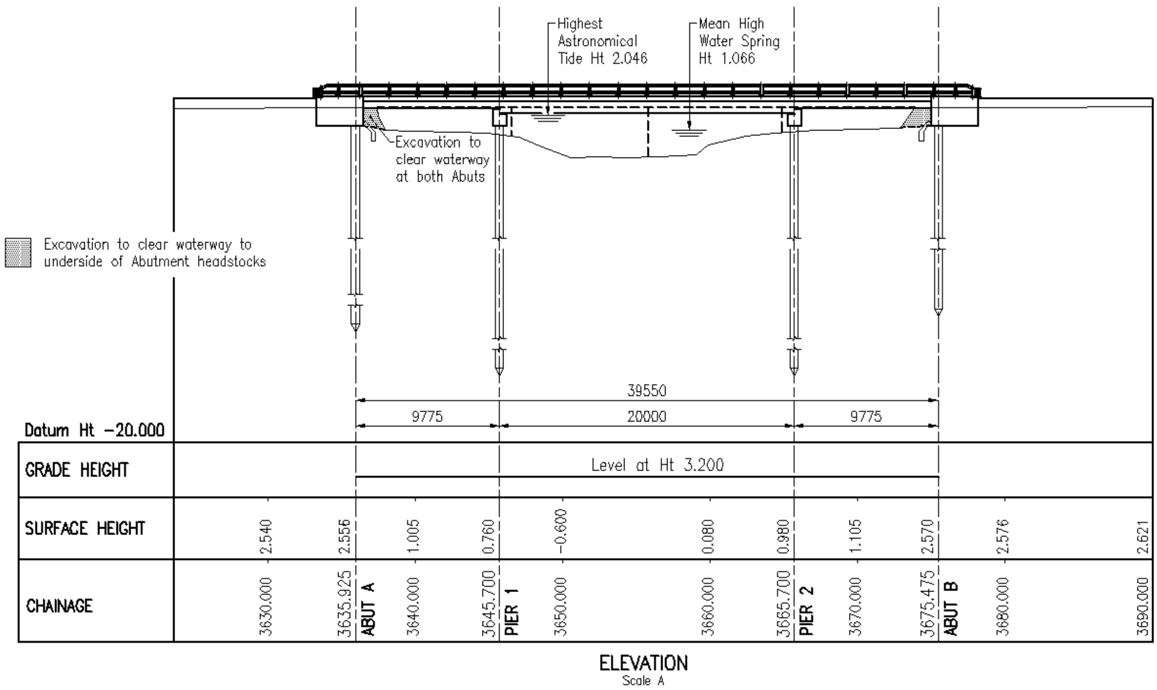
To obtain the relevant permits, the following additional hydraulic information shall be shown when the bridge spans a navigable waterway:

- Mean high water spring – The long term average of the Heights of two successive high waters during those periods of 24 hours (approximately once a fortnight) when the range of tide is greatest, at full and new moon.
- Mean low water spring – The long term average of the Heights of two successive low waters during those periods of 24 hours (approximately once a fortnight) when the range of tide is lowest, at full and new moon.
- Highest astronomical tide – The highest level that can be predicted to occur under average meteorological conditions and any combination of astronomical conditions. This level will not be reached every year. Storm surges may cause considerably higher levels to occur.
- The clear span between abutments and piers.
- The clearance between the Highest Astronomical Tide and the underside of the deck units / girders.

The Elevation view can become complex on skewed bridges. The view may be replaced with a Sectional Elevation where there are no specific advantages to a projected elevation. Where available, the plan and elevation may also be supplemented (not replaced) by a 3D view, to assist in visualising complex bridge features.

Refer Figure 11.5(b) - Concept GA Drawing - Elevation.

Figure 11.5(b) - Concept GA Drawing - Elevation



Section deck

The section deck is a typical cross section taken through the bridge superstructure. Components that may be shown include, but are not limited to:

- Bridge control
- Deck units / girders, nominal gaps between the deck units / girders
- Transverse stressing units
- Reinforced Concrete (RC) deck
- Grade Height
- Deck Wearing Surface (DWS) and bituminous waterproof membrane
- Crossfall or superelevation
- Width between kerbs (overall width and dimensions to the Bridge Control)
- Width of footways
- Flow arrow
- Scuppers and drainage
- Barriers, and
- Jacking points for girder bridges.

Refer Figure 11.5(c) - Concept GA Drawing - Typical Section Deck and Figure 11.5(d) - Concept GA Drawing - Typical Section Girders.

Figure 11.5(c) - Concept GA Drawing - Typical section deck units

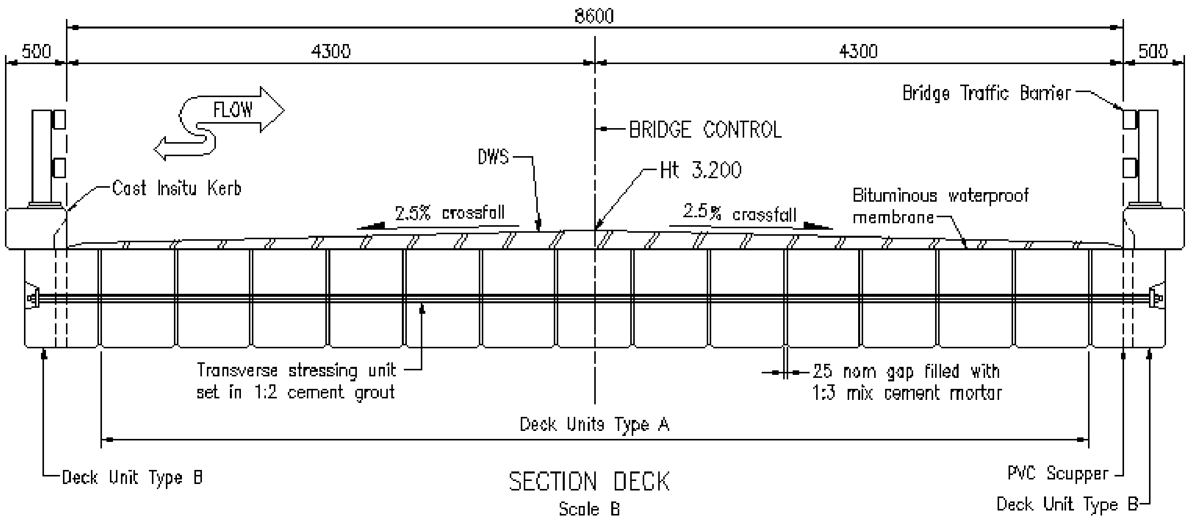
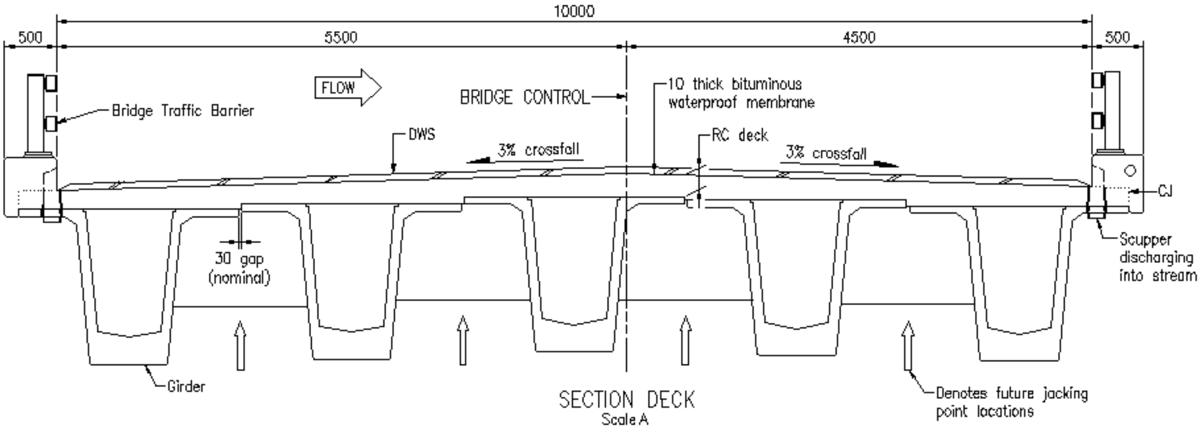


Figure 11.5(d) - Concept GA Drawing - Typical section girders



Stability of PSC girders and deck units

The following text shall be shown on the GA drawing besides the section deck detail 'THE CONTRACTOR SHALL SUBMIT A CONSTRUCTION PROCEDURE TO THE SUPERINTENDENT WITH REGARD TO ENSURING THE STABILITY OF PSC GIRDERS DURING CONSTRUCTION'

Drilling of holes into deck units and girders

The following text shall be shown on the GA drawing besides the section deck detail 'DRILLING INTO THE DECK UNITS (or PSC GIRDERS) IS NOT PERMITTED. ALL FERRULES / ATTACHMENTS MUST BE CAST-IN'

Alignment details

All bridge scheme drawings shall contain adequate alignment information to define the bridge site alignment independently of road design or survey drawings.

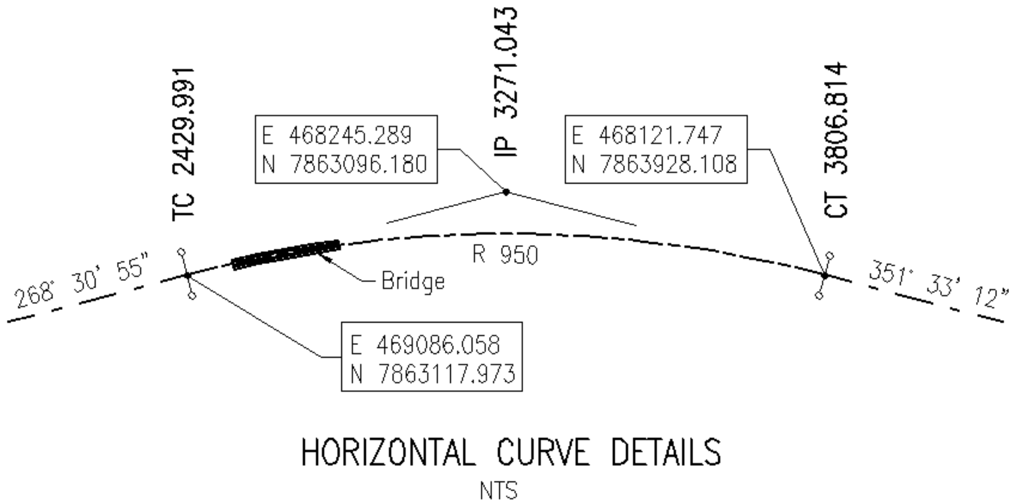
The horizontal and vertical curve details illustrate possible implications on the structure, for example a horizontal curve within 200 m of the bridge may have implications on the superelevation of the structure or possible implications on the width of the structure.

Horizontal curve alignments

Where a bridge is on a horizontal curve the following information is to be shown on a Horizontal Curve detail, Refer Figure 11.5(e) - Horizontal Curves:

- bearings before and after the curve
- radius of the curve
- tangent points (including chainage and co-ordinates)
- intersection points (including chainage and co-ordinates)
- location of the bridge in relation to the curve, and
- any other curve that may have an impact on the structure (within approximately 200 m of the abutments).

Figure 11.5(e) - Horizontal curve detail

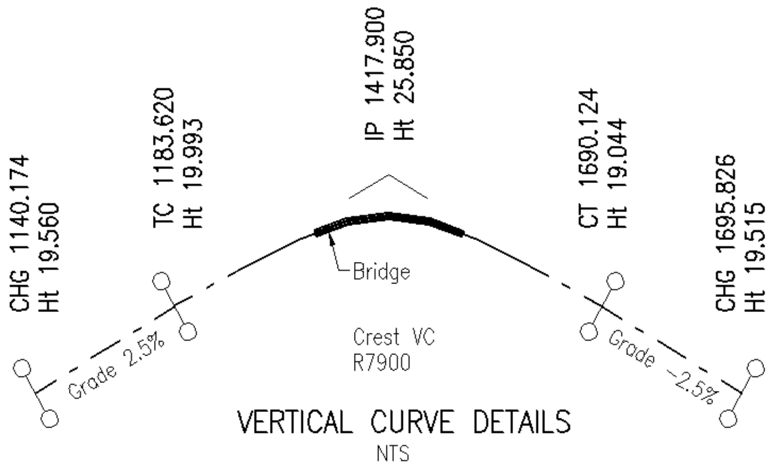


Vertical curve alignment

Where a bridge is on a vertical curve the following information is to be shown on a Vertical Curve detail, Refer Figure 11.5(f) - Vertical Curve Details:

- grade before and after the curve
- radius of the curve and direction of the curve (sag or crest)
- tangent points (including chainage and Heights)
- intersection points (including chainage and Heights)
- location of the bridge in relation to the curve, and
- any other curve that may have an impact on the structure (within approximately 200 m of the abutments).

Figure 11.5(f) - Vertical curve detail



11.6 Preliminary design GA drawings

At the preliminary design phase more information becomes available, which may include final horizontal and vertical alignments, preliminary geotechnical data, hydraulic design etc.

The span length of the bridge will be fixed, as will the width between kerbs. Bridge Fixing is when the design team, hydraulics team, Transport and Main Road's structures and the region, sign off on the length, width, vertical alignment and type of bridge.

More detailed GA drawings can now be prepared. The concept drawings, if available, can be updated with the current information. Views included on the Preliminary GA include, but are not limited to:

- Outline of the abutment spillthroughs and the embankment slopes. Also note if the new embankments intrude into the traffic lanes of the existing road. When they do, solutions including stage construction of the new bridge, temporary retaining walls for the embankments, or side tracking of the bridgeworks, shall be shown.
- Preliminary drawing stamp (with issue date).
- Type Abutments and Piers showing the anticipated structure (this is only required when a preliminary cost estimate is requested by the client). The Type Abutments and Piers views show the type of substructure that the estimate is based on. For example, if the estimate includes driven piles then the views should indicate driven piles because this type of substructure is substantially less expensive than cast in place piles. For drawing requirements refer Section 11.7 – *Detailed Design GA Drawings*.

A table showing the co-ordinates of the proposed bore hole locations may be required (if bore holes have not already been drilled). Refer to the *Geotechnical Design Standard - Minimum Requirements* for an explanation of the number and position of bore holes required at each abutment and pier. The proposed bore holes shall be shown in the Plan view. The co-ordinates shall be rounded to the nearest 0.1 m. The Preliminary Design GA drawing/s may be used with a fixing letter for review and agreement with key stakeholders on the bridge location, spans etc. Once agreement is reached the Preliminary Design GA may be used to inform geotechnical investigations

Refer Appendix B - Example Prelim Design GA Drawings.

11.7 Detailed design GA drawings

At the detailed design phase, all necessary information should be available to draft the final GA drawings for the project. Refer Appendix C - Example Detailed Design GA Drawings.

The Preliminary Design GA drawings can be updated with all final information to create the Detailed Design GA drawings. In addition to views on the Preliminary Design GA drawings, other views shall be added. These may include, but are not limited to:

- note 'Embankments to be in place prior to pile driving. Prebore with …. dia auger to natural surface Height' to be placed in a box on the left hand side of Abutment A
- deck unit anchorage details
- deck unit construction sequence
- pile identification and setting out diagram
- deck unit or girder layout diagram (unless shown on unit or girder drawings)
- type abutments and piers
- limits of HLP vehicle diagram
- table of Standard drawings

- pier design flood force data, including flood velocities and immunity Heights
- notes
- staged construction diagrams and erection procedures, and
- actual borehole locations.

The following sections will explain each view in detail and look at some of the aspects to be addressed.

Plan

All text is to be clear and concise when read at A3 drawing size. If text is placed over features of the drawing, for example contour lines, embankment lines, hatched areas etc., these features are to be blocked out. (In AutoCAD this is referred to as a wipeout or textmask).

It is not necessary to show abutment and pier chainages in this view, but the Plan view must be aligned vertically above the Elevation view below.

In addition to the features previously listed for concept and preliminary GA, additional features may include, but are not limited to:

- Two Bench Marks or Permanent Survey Marks shall be shown in the top left-hand corner along with the type of survey mark, its co-ordinates, Height and Height datum, for example PSM 166915, Star Picket, E274125.225, N2329910.650, Ht 3.970 AHD.
- Existing fences and property boundaries. Note any conflict that bridge components, such as embankment spillthroughs, may have on property boundaries.
- Catchment area in the bottom right-hand side of the Plan view.
- All services such as electricity cables above or below ground, water mains, telecommunication cables etc. Particular reference shall be made for any service that may have an impact on the construction of the bridge. Clearly nominate the services and how they are treated, for example de-energised, relocated etc.
- Actual (not proposed) bore hole locations as detailed in the Geotechnical Report.
- Define excavation to clear waterway by hatching. For maintenance and inspection requirements a minimum clearance of 1200 mm is required between underside of deck units / girders and the ground surface at the abutments. The resulting embankment slopes from the excavated area up to the natural surface shall be a maximum gradient of 1 on 2. Refer Chapter 13 – Provision for Bridge Jacking, Inspection and Maintenance, Section 13.7 - Abutment Protection.

Elevation

The elevation gives details of Grade Heights, Surface Heights and Chainages along the Road Control. If this view is shown along any other alignment the line of section is to be clearly noted.

In addition to the features previously listed for Concept and Preliminary GA, additional features may include, but are not limited to:

- Services above or below the natural surface.
- Heights to PSC pile tips, toe of steel liners, toe of cast in place piles, soffit of pilecaps and footings.

- Preboring requirements. Show a boxed note describing the location, size of auger and give a Height at the toe of prebore. Generally, the diameter of the auger is 50 mm less than the nominated size of the PSC pile.
- Maximum reported flood Height and date.
- Recent water Height and date.
- Articulation of the bridge. Fixed bearing, continuous joint or expansion bearing shall be shown at the centreline of the abutments and piers along with an explanation of the symbols used as shown below (placed on the left of the view):

  F denotes Fixed Bearing

  E denotes Expansion Bearing

  C denotes Continuous Joint.

Section deck

In addition to the detail previously mentioned regarding Concept and Preliminary Design GA drawings, show the mass of DWS and the conduit details (if required).

Anchorage details

For Deck Unit bridges anchorage details at abutments and piers shall be shown on the GA drawings. For girder bridges these details are typically shown on the Miscellaneous Details drawing. Refer to Chapter 14 – *Prestressed Concrete Girders*, for further information.

Anchorage details show the assembly details at abutments and piers. Features may include, but are not limited to:

- Abutment and pier headstocks, deck units, girders, relieving slabs, RC deck, DWS etc.
- Detail of the anchorage system used, for example, dowels, threaded rod or holding down bolts on deck unit bridges or restraint mechanism on girder bridges.
- Additional corrosion protection details for holding down bolts.
- Provision for future jacking.
- Positioning of jacks for future bridge maintenance.
- Limits of mortar seating and its nominal thickness.
- Bearings and recesses for bearings. Note that when deck units/girders are supported by bearings at fixed abutment joints, an approved small movement joint shall be provided in the DWS. Refer Chapter 17 – *Cast Insitu Kerbs and Decks*, Appendix A - Deck Design Sketches – Sheet 2.
- Areas to be grouted, or left clear of grout.
- Expansion joints, and
- Compressible filler.

Refer Figure 11.7(a) - Deck Unit Anchorage Detail - No Provision for Jacking and Figure 11.7(b) - Deck Unit Anchorage Detail - Provision for Jacking.

Figure 11.7(a) - Deck unit anchorage detail - No provision for jacking

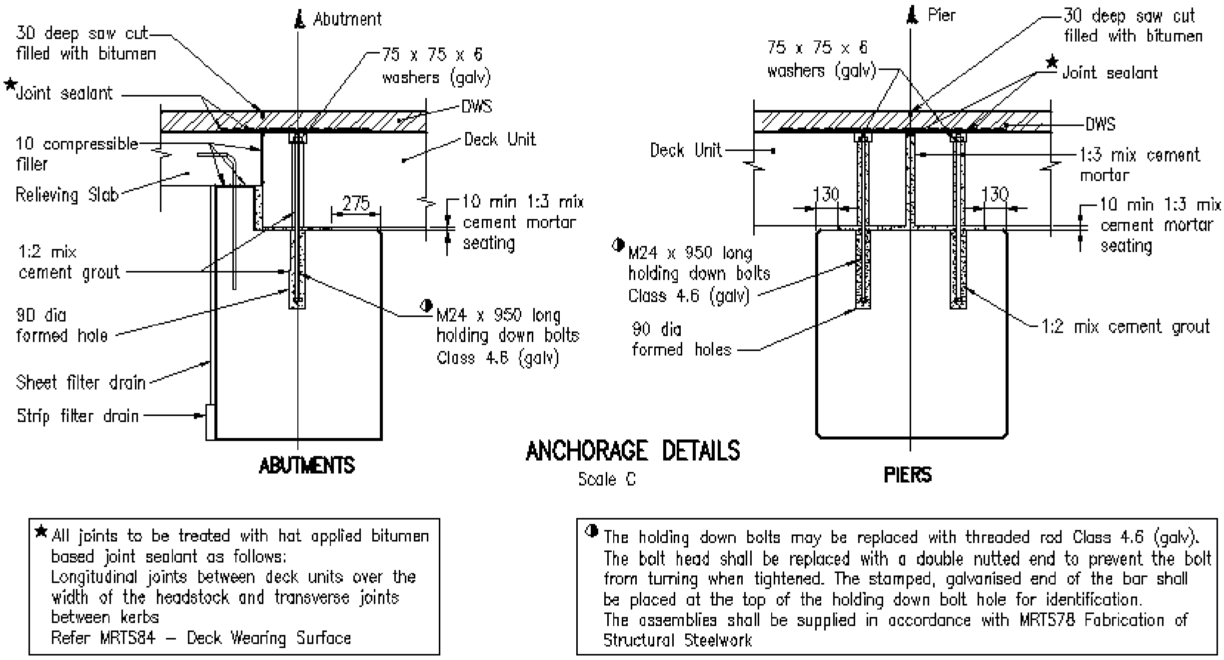
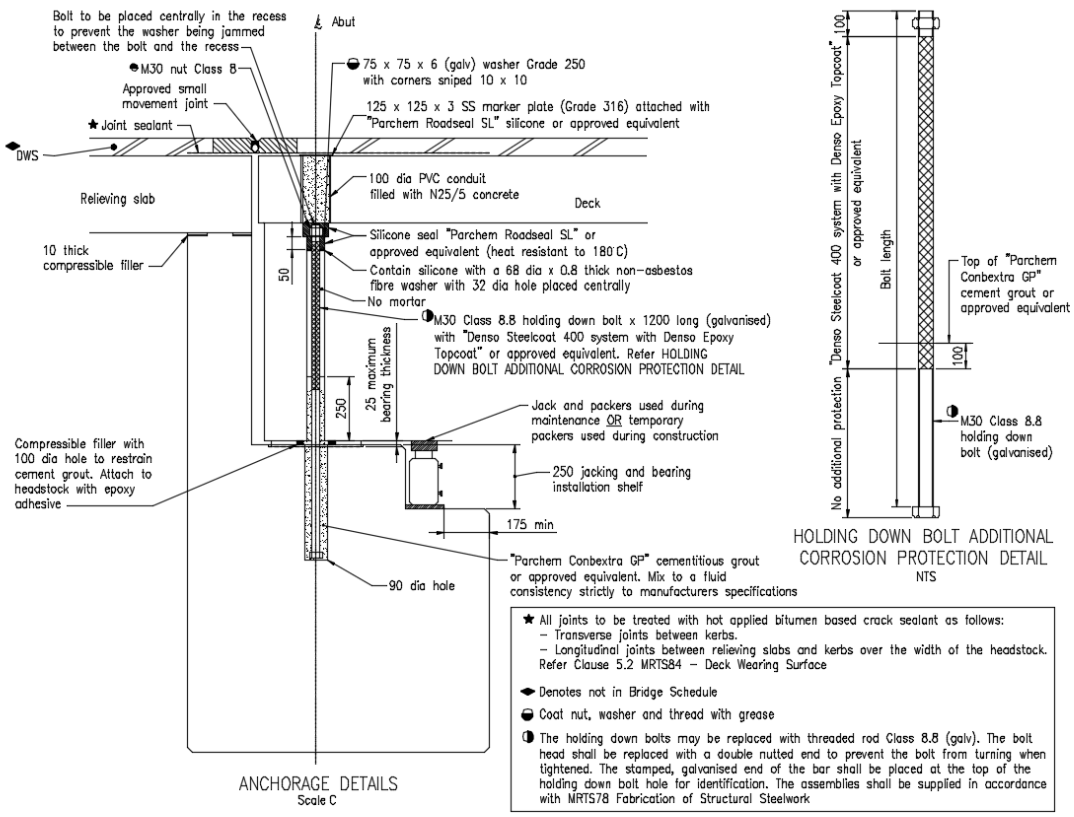


Figure 11.7(b) - Deck unit anchorage detail - Provision for jacking



Deck unit erection construction sequence

When precast deck units are erected on elastomeric bearings, the erection procedure notes and appropriate diagram are shown. Refer Chapter 13 – *Provision for Bridge Jacking Inspection and Maintenance*, Section 13.5 – *Deck Unit Erection Construction Sequence*.

Pile identification and setting out diagram

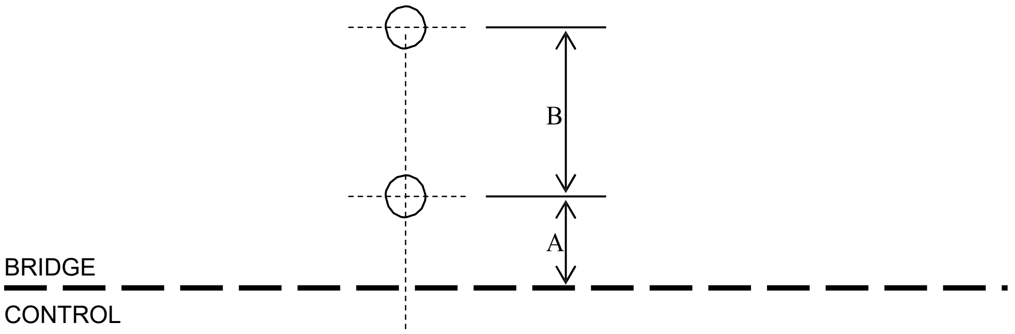
The pile identification and setting out of the piles shall be shown on the GA drawings. The Pile Identification and Setting out Diagram is generally not drawn to scale, but it shall have reasonable proportions and shall show the following details:

- bridge control and its bearing, or the radius of the horizontal curve
- the centreline of the pile group at abutment and piers shall be defined by a bearing and the intersection with the Bridge Control line shall be identified by a co-ordinate
- pile identification number for each individual pile
- dimensions to locate each pile
- relationship of footings to Bridge Control and abutment and pier centrelines, and
- relationship of stage construction to Bridge Control.

All piles shall be identified by a Pile Identification Number shown adjacent to the pile it represents. The format of the number is @/# where:

- @ = an alphanumeric character or number that represents the element of the bridge, for example A for Abutment A, B for Abutment B and one for Pier one
- # = a sequential number given to each pile counting from the left-hand side of the bridge.

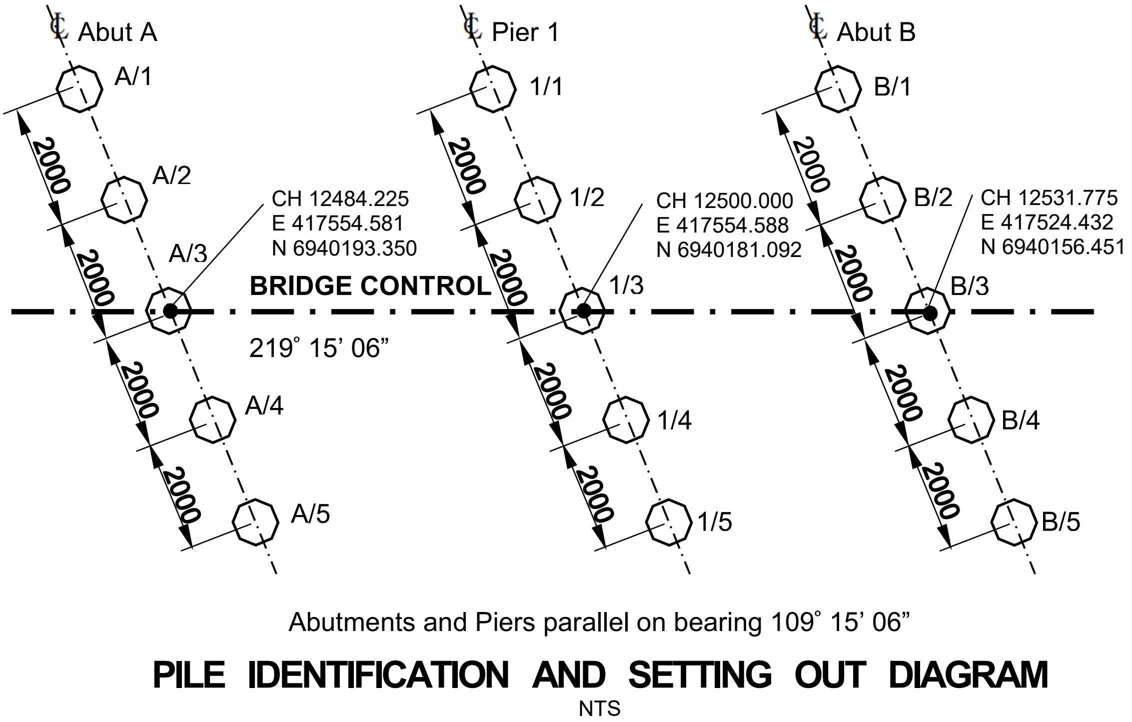
The spacing of the first pile from the Bridge Control along the centreline of the group of piles shall be dimensioned from the Bridge Control line, Dimension A. The spacing of each subsequent pile along the centreline of the group of piles shall be dimensioned from the previous pile, Dimension B.



Where raked piles are used, a note shall be added to the drawing stating that the location shown is at the underside of the headstock / pilecap into which the pile is bonded. Raked piles are also to have the slope of the rake noted together with an arrow showing the direction of the rake.

Refer Figure 11.7(c) - Pile identification and setting out diagram.

Figure 11.7(c) - Pile identification and setting out diagram



Deck unit or girder layout diagram

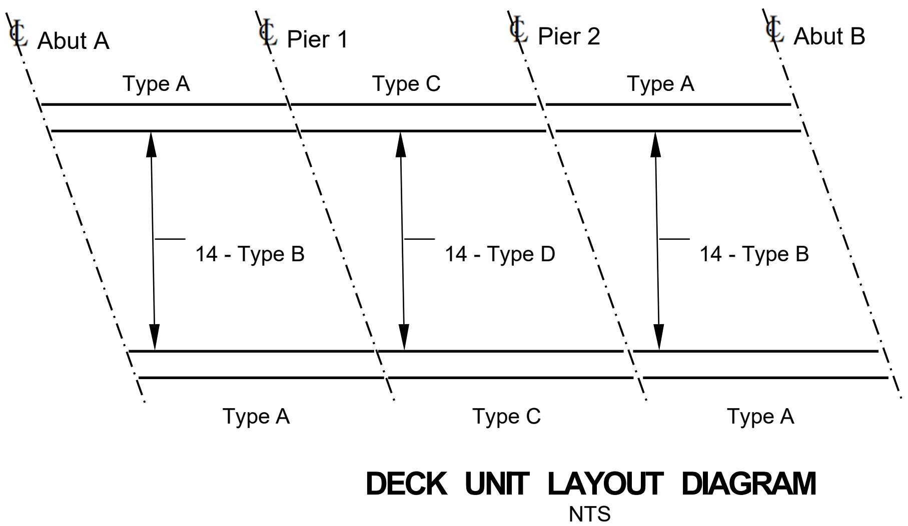
The Layout Diagram is generally not drawn to scale, but it shall have reasonable proportions.

Layout Diagrams may be shown either as part of the GA drawings or as part of the unit or girder drawings. Type names such as A/B/C and so on shall be consistent with the naming conventions used in the unit or girder drawings elevation and plan views.

For a simple layout where each span has the same deck unit or girder types, they can be identified on the Section Deck. Refer Figure 11.5(c) - Concept GA Drawing - Typical section deck units.

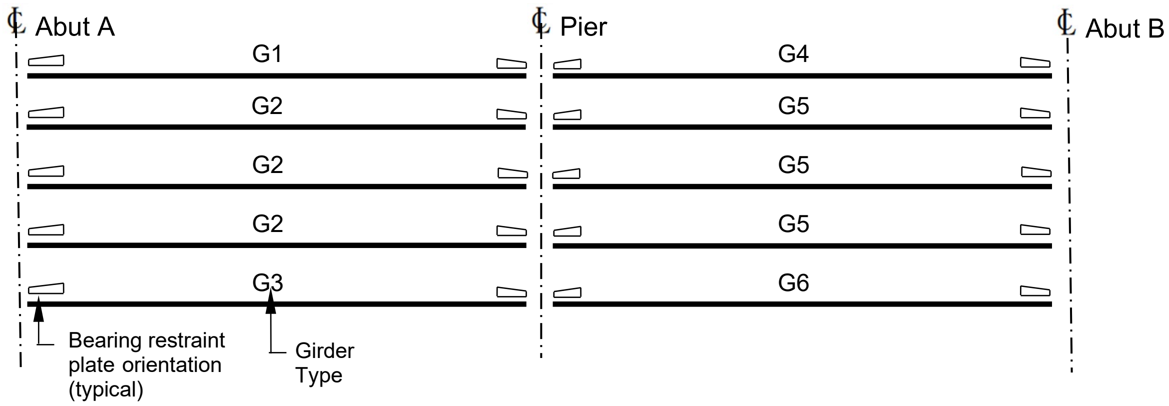
When deck unit types vary from span to span, due to expansion joints, continuous deck joints and so on, a pictorial plan view of all bridge spans shall be shown with the deck unit types clearly identified. Refer Figure 11.7-4 - Deck unit layout diagram.

Figure 11.7(d) - Deck unit layout diagram



For girder bridges these details are shown on the Miscellaneous Details drawing when the diagram is used to layout steelwork (bearing restraint plates) as well as the girders. Refer Figure 11.7(e) - Girder layout diagram.

Figure 11.7(e) - Girder layout diagram



LAYOUT DIAGRAM FOR GIRDERS AND BEARING RESTRAINT PLATES

NTS

Note: Bearing restraint plates are tapered to ensure girders may be supported on level bearings. Depending on the grade of the bridge, the orientation of the restraint plates may change. Refer to girders chapter for further information.

Type abutments and piers

Type Abutments and Piers are to show the typical features for each substructure element. Where there is more than one type each unique type is to be shown. Refer Figure 11.7(f) - Type Piers and Figure 11.7(g) - Type Abutments for basic examples. These views give a pictorial view of each structure and shall show:

- Elevation and section (or end elevation as appropriate).
- Number, type and size of piles supporting each structure, or reference to a pile drawing.
- Outline of the headstock.
- A clear delineation between new work and the existing bridge, including broken back areas. No dimensions are required in this view but may be added where appropriate.
- Abutment Protection type, in accordance with the following Standard drawings. (Project specific design features are to be shown where applicable):
    a) Type 1 - Rock Spillthrough refer Transport and Main Road's Standard Drawing 2232 or 2233. If the protection conforms to a standard drawing only the toe wall dimensions need to be detailed. If the protection is non-standard, all off the non- standard details shall be detailed and all other details shall be referenced back to the standard drawing.
    b) Type 2 - Reinforced Concrete Over Spillthrough refer Transport and Main Road's Standard Drawing 2234 or 2235. If the protection conforms to a standard drawing only the toe wall dimensions need to be detailed. If the protection is non- standard, all off the non-standard details shall be detailed and all other details shall be referenced back to the standard drawing.

c) Type 4 - Rockwork Over Spillthrough refer Transport and Main Road's Standard Drawing 2236 or 2237. If the protection conforms to a standard drawing only the toe wall dimensions need to be detailed. If the protection is non- standard, all off the non-standard details shall be detailed and all other details shall be referenced back to the standard drawing.

d) Rock Masonry refer Transport and Main Road's Standard Drawing 2238. All rock masonry details shall be shown on the Type Abutments view. The standard drawing shows the details required. Refer Figure 11.7(h) - Type Abutments with Rock Masonry. (Note: Rock masonry is only recommended for bridge widenings of structures with existing rock masonry protection.)

e) Type 7 – Rock Filled Gabion Protection - Height up to 6 m refer Transport and Main Road's Standard Drawing 2241.

f) Type 8 - Rip Rap protection – Height up to 6 m refer Transport and Main Road's Standard Drawing 2242.

Figure 11.7(f) - Type piers

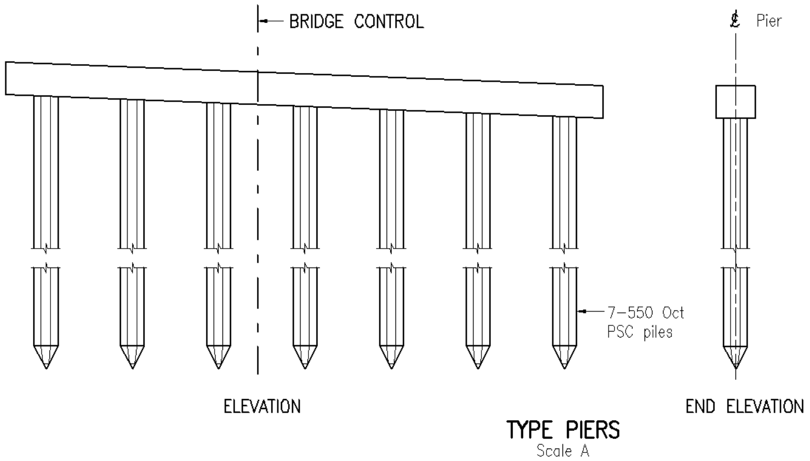


Figure 11.7(g) - Type abutments

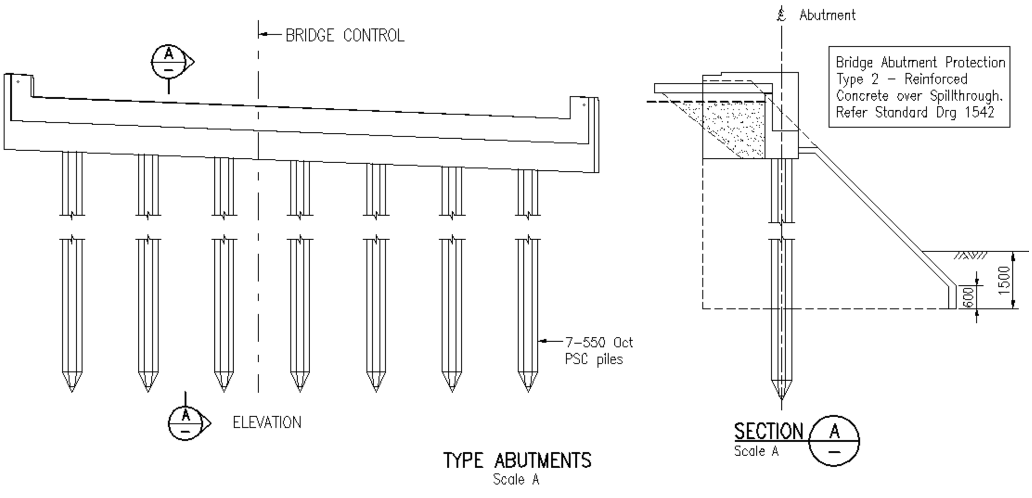
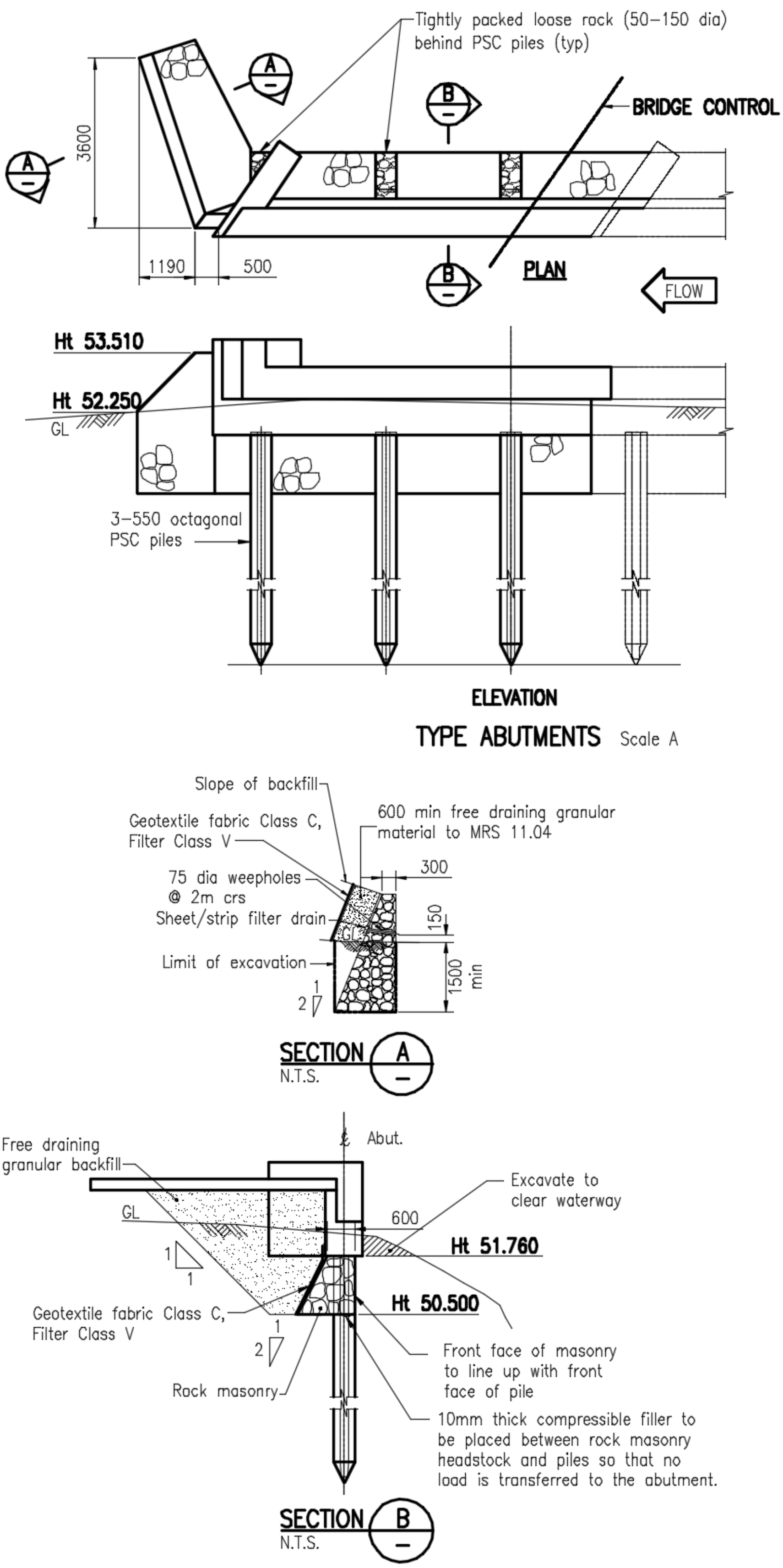


Figure 11.7(h) - Type abutments with rock masonry



Limits of HLP vehicle diagram

All bridges designed with Heavy Load Platform (HLP) capability shall display a diagram showing the allowable deviation of the position of the HLP vehicle on the bridge.

Show the following details:

- pictorial cross section of deck
- allowable HLP dimensions from the Bridge Control to the outside of vehicle, and
- minimum clear distance from the HLP to the kerb face.

The limits of the lateral position of the HLP vehicle is defined in the *Design Criteria for Bridges and Other Structures*.

Minimum clear distances to kerbs shall be shown.

The width of HLP 320 vehicle is 3600 and the width of HLP 400 vehicle is 4500.

Figure 11.7(i) - Limits of HLP vehicle

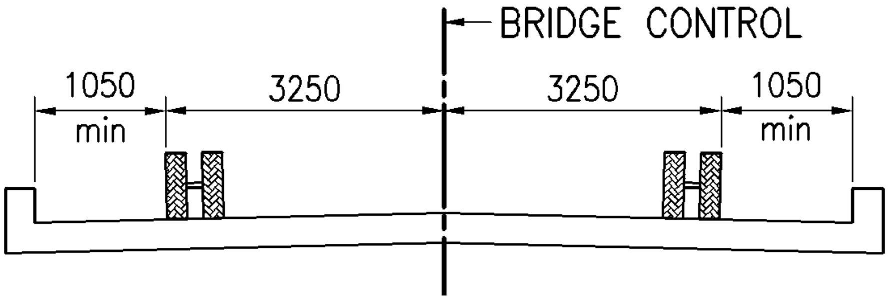


Table of Standard Drawings

Tabulate all standard drawings associated with the project. These drawings shall be marked 'included' in the Standard Documents List in the contract documents.

A sample Table 11.7(j) is shown below. The version date shall be the current published version of the relevant standard drawing.

Table 11.7(j) - Standard Drawings

Drg No	Version	Description
SD1043	03/18	REINFORCING STEEL - STANDARD BAR SHAPES
SD1044	03/18	REINFORCING STEEL – LAP LENGTHS
SD2005	07/16	STANDARD BRIDGE DATE PLATE
SD1145	08/02	STANDARD PVC SCUPPER
SD2255	11/19	BRIDGE APPROACHES – RELIEVING SLAB 3 METRE SPAN
SD2256	11/19	BRIDGE APPROACHES – RELIEVING SLAB 6 METRE SPAN

Design loading notes – Flood forces

Designers are to include key design parameters for flood forces within the project notes, which are to include the following:

- Design event
- Heights
- Velocities
- Scour Heights / depths, and
- Debris depth.

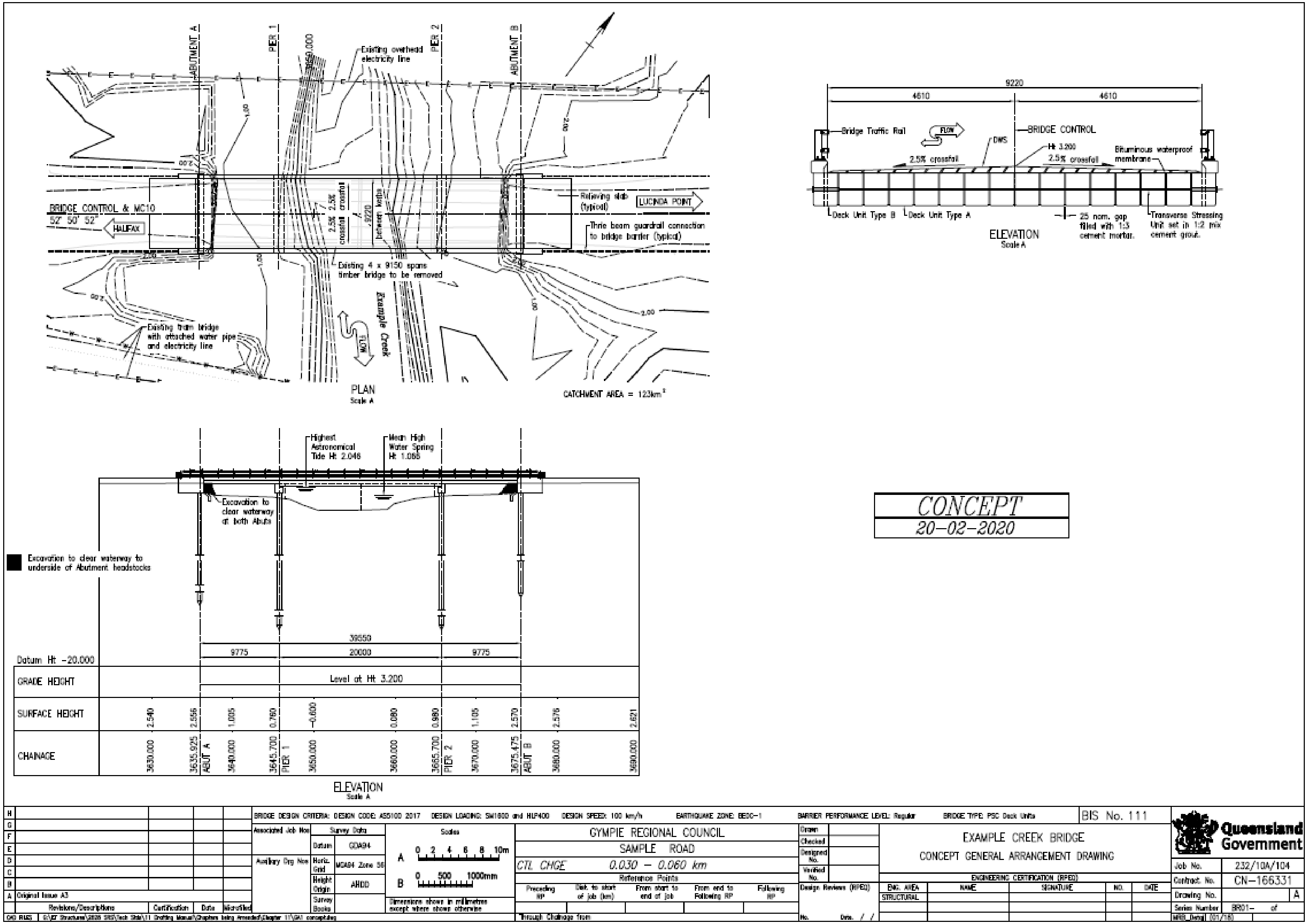
Notes

Notes shall be placed in the bottom right-hand corner of the first GA drawing. If they don't fit there, they shall be moved to another GA drawing. Refer Chapter 5 – *Notes*.

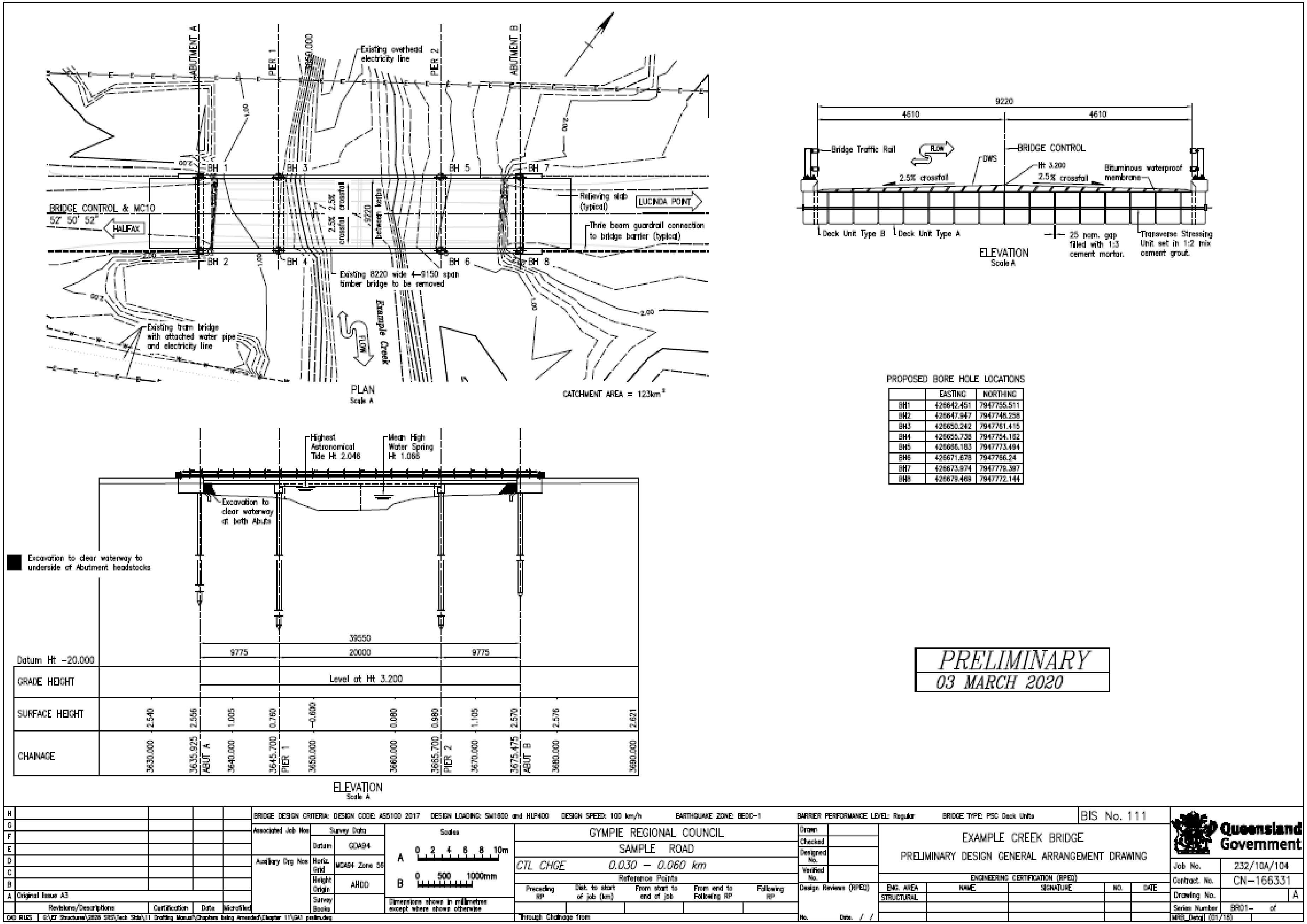
Procedures

Where the design requires stage construction or where the safety and constructability of the project is contingent on an erection or construction procedure, the process shall be documented on the drawings. Enough information shall be provided to clearly explain the steps required to achieve the design intent. This may include detailed procedures, sketches and notes. These details may be included on the GA or on the specific drawings relevant to the process.

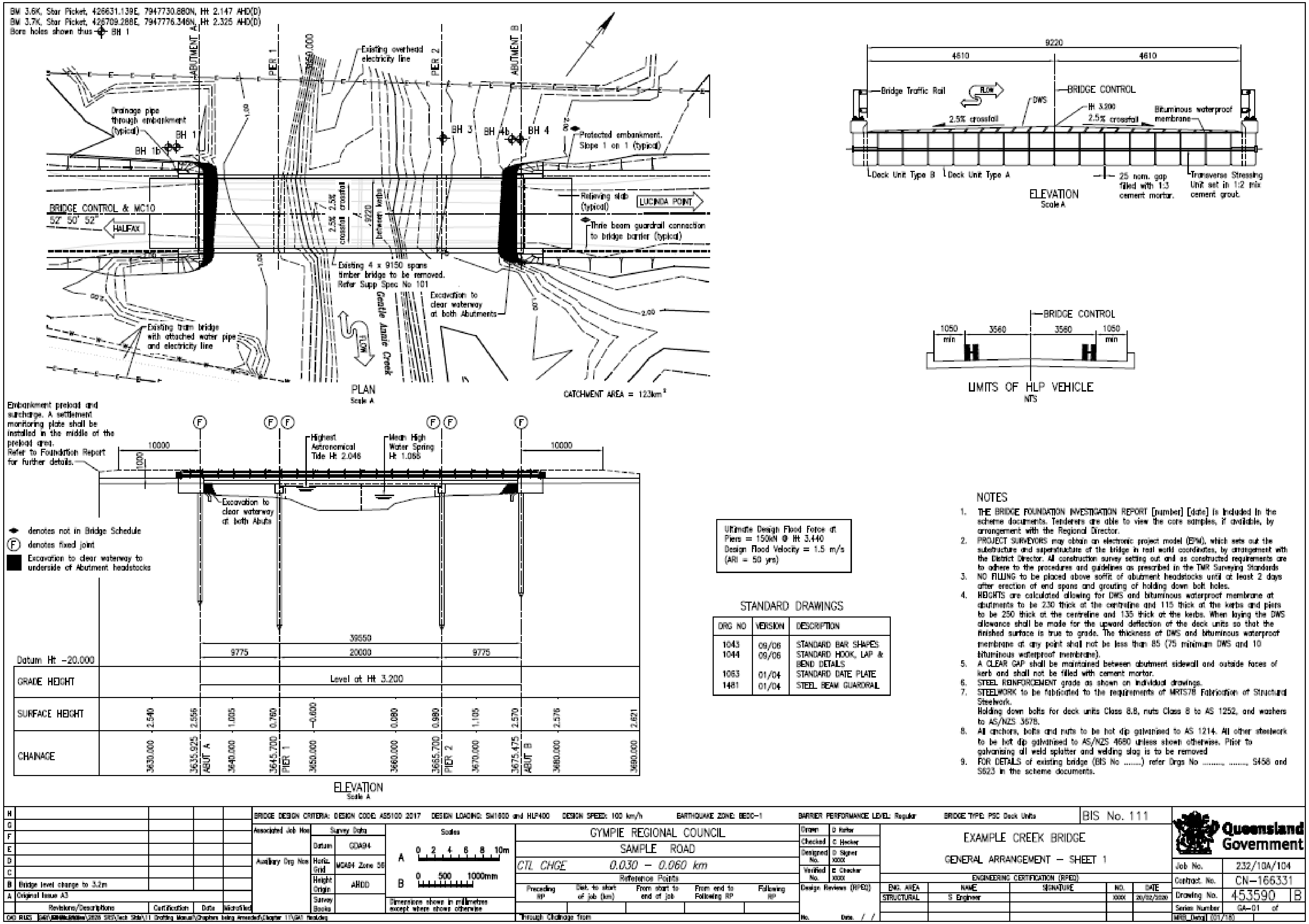
Appendix A - Example Concept GA Drawings



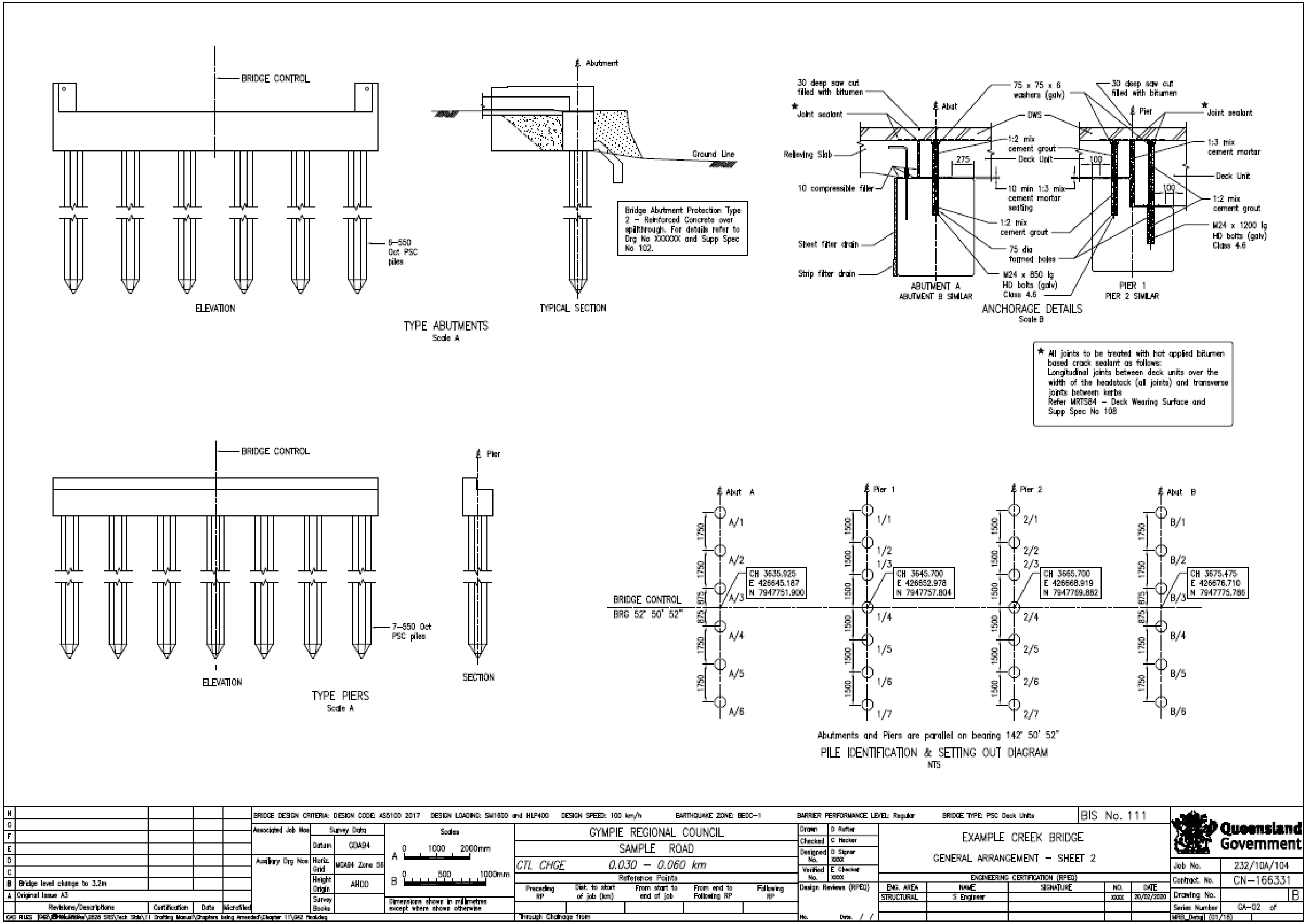
Appendix B - Example Prelim Design GA Drawings



Appendix C - Example Detailed Design GA Drawings – Sheet 1



Appendix C - Example Detailed Design GA Drawings – Sheet 2



Drafting and Design Presentation Standards
Volume 3: Structural Drafting Standards

Chapter 12: Abutments and Piers

January 2021

Queensland Government

Chapter 12 Amendments

Revision register

Issue/Rev No.	Reference Section	Description of Revision	Authorised by	Date
1	–	First Issue.	Manager (Structural Drafting)	April 2011
2	–	Document name change.	Manager (Structural Drafting)	Nov 2011
	12.4	Distance from holding down bolt hole to the end of the deck unit varies when the deck unit is skewed and/or the hole is slotted.		
	12.7	Figure 12.7-1 and formula updated to allow for variable distance between abutment centreline and the ballast wall.		
	12.8	Typical end wall width increased to 300 mm.		
	12.11	Add section Thrie Beam and Conduit Treatment at Abutment Wingwalls.		
	12.12	Transition in barrier height shall be 1 on 10. Figure 12.12-3 amended accordingly.		
	12.15	Add section Alignment of Elastomeric Bearings.		
3	–	**Table of Contents** – 12.11 – Name change	Team Leader (Structural Drafting)	May 2013
	–	**List of Figures** – 12.11-1, 12.11-2 and 12.12-3 name change.		
	12.4	Holding Down Bolt Formed Hole Spacings – paragraph revised. Figure 12.4-1 updated.		
	12.5	Wording revised first paragraph. Figure 12.5-1 updated.		
	12.7	Wording revised. Figure 12.7-2 revised.		
	12.8	Whole clause revised. Figures 12.8-1 to 12.8-4, 12.8-7 and 12.7-8 revised. Figures 12.8-5, 12.8-6, 12.8-9 and 12.8-10 deleted.		
	12.9	Wording parapet replaced with traffic barrier.		
	12.10	Wording parapet replaced with concrete traffic barrier. Abutment wingwall recess wording revised. Figures 12.10-1 and 12.10-2 revised.		

Issue/Rev No.	Reference Section	Description of Revision	Authorised by	Date
	12.11	Re-name section to Thrie Beam and Electrical / Telecommunication Conduit Treatment at Abutment Wingwalls. Figures 12.11-1 and 12.11-2 revised.		
	12.12	Clause revised. Figure 12.12-3 revised.		
	12.15	Wording revised. Figures 12.15-1 and 12.15-2 revised.		
	12.16	Figure 12.16.1 revised.		
	12.17	Figures 12.17-5, 12.17-6, 12.17-10 and 12.17-12 revised.		
	12.19	Clause revised.		
	–	Appendixes A and B – updated.		
4	12.5	General review including the removal of engineering content. Deck Unit Mortar Seating thickness has been revised to alert designers to geometric considerations, so as to avoid deck soffit clashes with headstocks.	Team Leader (Structural Drafting)	Jan 2021

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12 Abutments and Piers

12.1 Glossary of terms

For a complete glossary of terms refer Chapter 1 – *Introduction.*

12.2 Figures and examples shown in this volume

The figures and examples shown in this volume are taken from the typical details / solutions used in past Transport and Main Roads projects which for presentation purposes only and may contain some details that are now superseded. These details have been included for ease of reference, and to show the required standard of drafting presentation. The details are not to be used without an engineering check and certification by an appropriate Registered Professional Engineer of Queensland (RPEQ) to confirm that the details are appropriate for the specific project.

12.3 General

The substructures at each end of a bridge are called abutments, with the first abutment along the gazettal referred to as ABUTMENT A and the other abutment referred to as ABUTMENT B.

If the bridge has multiple spans, the intermediate substructures are called piers. For a two-span bridge the pier is shown as PIER. For bridges with spans of three or more each pier is represented by a number, for example PIER 1, PIER 2 and so on.

When designing abutments and piers for a particular bridge, consideration shall be given to rationalising sizes to ensure good economics due to the repeated use of formwork and design details.

For bridges crossing a waterway, the Plan views of the abutment and piers shall show a flow arrow. For bridges where there is no water flow, the Plan views of the abutment and piers shall show a north point arrow. Refer Chapter 2 – *Standard of Presentation, 2.10 Arrows*.

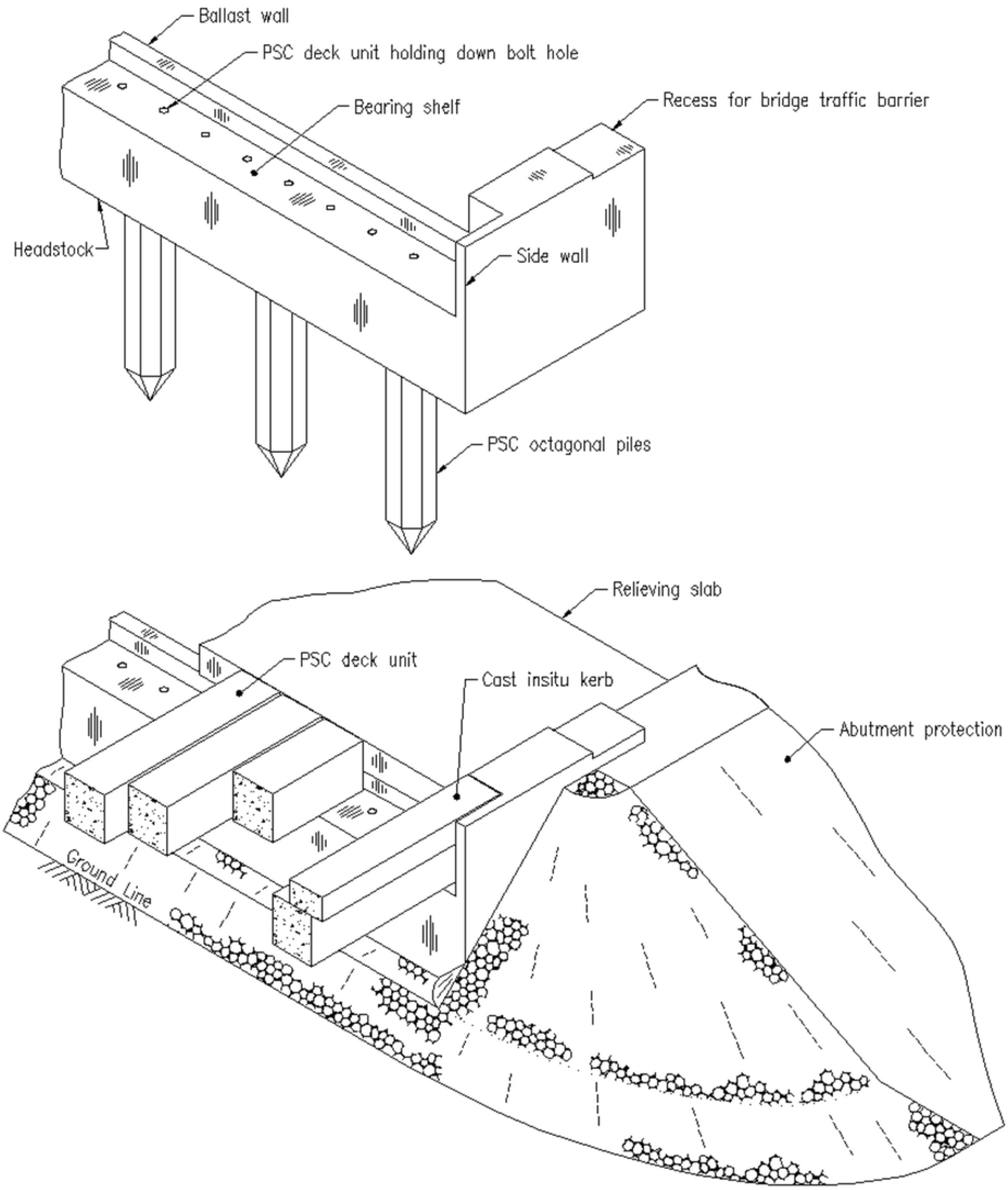
Abutments

An abutment headstock supports the superstructure, for example, deck units, girders. The ballast wall retains the embankment and supports the relieving slab. The abutment wingwalls retain the embankment and provide anchorage for the bridge barrier. The abutment sidewalls provide a separation barrier from the embankment fill and the superstructure and joints. Refer Figure 12.3(a) *Typical Abutment*.

Piers

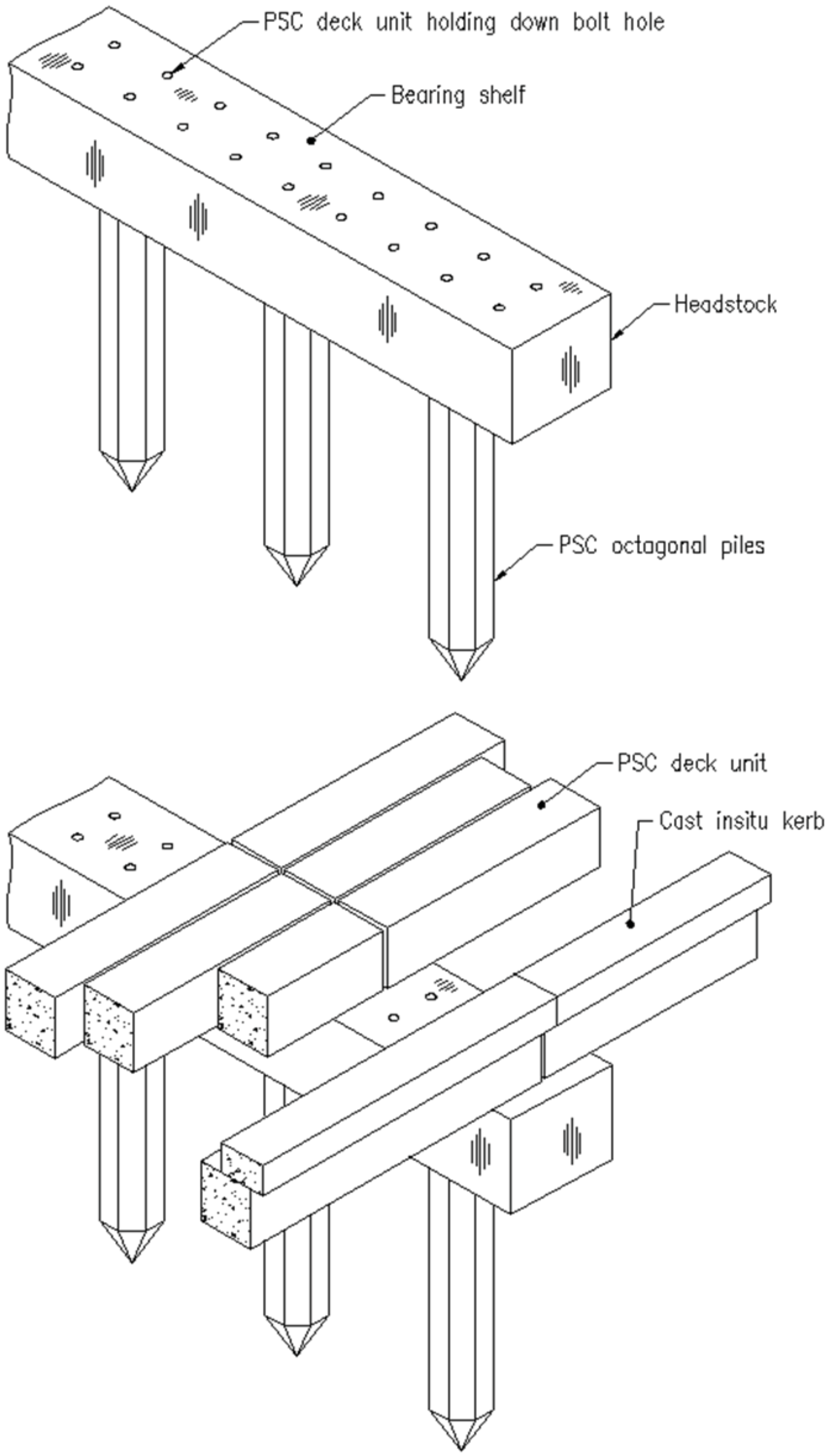
In comparison a pier is relatively simple. Like the abutment headstock, the pier headstock also supports the superstructure. Refer Figure 12.3(b) *Typical Pier*. On deck unit bridges in a highly visible area, for example an overpass on a highway or major river with significant traffic, pier sidewalls may be used to hide the bearings and improve aesthetics. Pier sidewalls may also be used as a control measure to prevent the falling of units or girders, especially for structures with superelevated headstocks.

Figure 12.3(a) - Typical abutment



FIXED ABUTMENT WITH PSC PILES, PSC DECK UNITS AND CAST INSITU KERBS
(THE ABUTMENT DOES NOT HAVE A JACKING SHELF BECAUSE
IT DOES NOT HAVE BEARINGS THAT MAY NEED REPLACING)

Figure 12.3(b) - Typical pier



FIXED PIER WITH PSC PILES, PSC DECK UNITS AND CAST INSITU KERBS
(THE PIER DOES NOT HAVE JACKING SHELVES BECAUSE
IT DOES NOT HAVE BEARINGS THAT MAY NEED REPLACING)

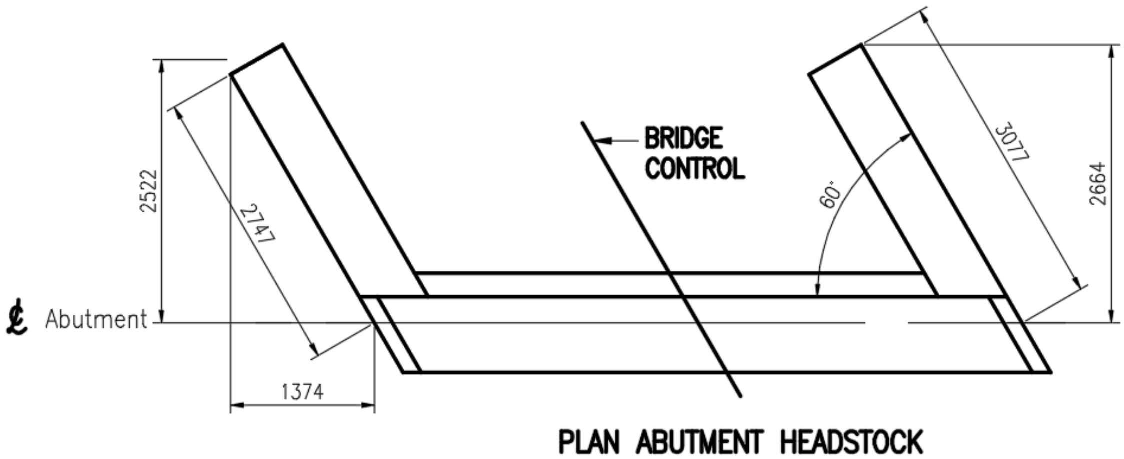
12.4 Deck Unit Bridge - Headstock layout

All headstocks are set out from a nominated point (Set Out Point) being the intersection between the Bridge Control and the headstock centreline at the road surface height. All formed holes, bearings, wingwalls etc are to be set out along a line from this point perpendicular to the headstock centreline. Due to the effects of skew and superelevation on the structure, the lateral position of the headstock shall be considered separately in each case.

> For example, a superstructure depth of 1000 mm including bearings / mortar and DWS on a 3% superelevated deck and a square bridge would result in a 30 mm offset from the bridge control to the centre of the bearing shelf, whereas the same deck with a 30 deg skew would be 26 mm.

Enough dimensions are to be supplied, such that a drawing may be readily understood, without the requirement of further calculation. For example, each feature shall be easily established by a longitudinal and transverse dimension parallel and normal to the abutment centreline, not solely by an offset dimension and a dimension along a bearing.

Figure 12.4(a) – Wingwall dimensioning



Holding down bolt formed holes

Both ends of a deck unit are connected to a headstock with either holding down bolts, threaded rod, or dowel bars set into formed holes in the headstocks. For typical deck unit anchorage details refer Chapter 11 – *General Arrangements*, *11.7 Detailed Design General Arrangement Drawings*. Dowel bars may only be used on overpass bridges that will not be submerged in a 2000 ARI flood.

The formed holes are 90 mm in diameter, 450 mm deep, perpendicular to the bearing shelf, and shall be shown in the headstock Elevation and Section views. Refer *Appendix A – Example Abutment Drawings – Sheet 1*.

Holding down bolt formed hole spacings

The spacing of the formed holes for holding down bolts is determined by the width of the PSC Deck Units, gaps between the deck units and the skew of the bridge. The standard nominal gap between deck units is 25 mm. This gap can vary slightly due to bowing of the deck units.

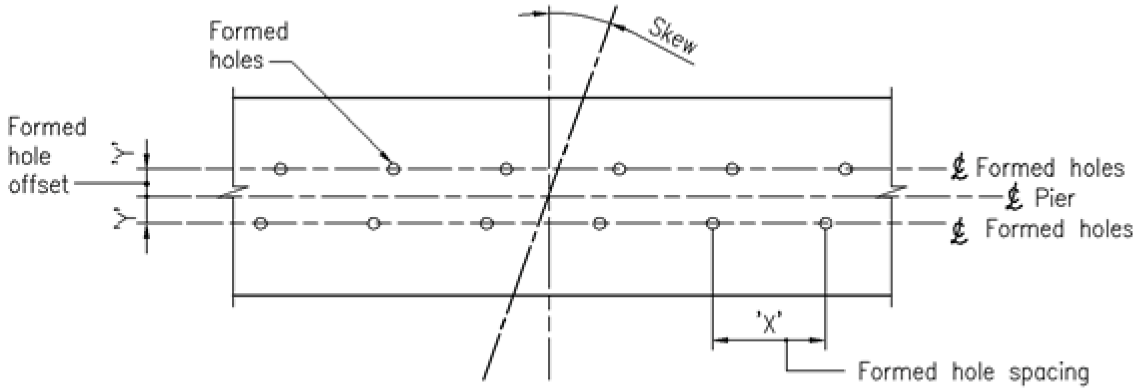
Other spacings may be used. For details refer Chapter 9 – *Bridge Types, 9.5 PSC Deck Units with Cast Insitu Kerbs*.

The following formulas were used for dimensions shown in Figure 12.4(a) *Formed Hole Spacings* and are based on deck units having square ends and at various skews to headstocks:

- On abutment and pier headstocks the formula for dimension 'x' = (width of deck unit + gap between units) ÷ cosine of skew angle.
- On pier headstocks the formula for dimension 'y' = (distance holding down bolt hole from end of unit + half gap between ends of units) x cosine of skew angle.

The dimensions shown in Figure 12.4(b) *Formed Hole Spacings* are based on 596 mm wide deck units with a distance of 220 mm from the holding down bolt hole to the end of the unit. Where the end of the deck unit is skewed and/or has a slotted holding down bolt hole for expansion joints, the end distance will usually be greater and will need to be designed to determine the distance. Also, if the bridge is on a horizontal curve, the skew angle varies between the deck units and the abutment and pier headstocks.

Figure 12.4(b) - Formed hole spacings (for deck units with fixed ends)



Formed Hole Spacing Dimension 'X'

Skew	0°	5°	10°	15°	20°	25°	30°
For 25 mm gaps between units	621	623	631	643	661	685	717

Formed Hole Offset from Pier Centreline Dimension 'Y'

Skew	0°	5°	10°	15°	20°	25°	30°
Distance	245	244	241	237	230	222	212

Square and superelevated bridges

On square and superelevated bridges, the headstock is offset to maintain the correct position of the superstructure.

The offset is calculated as follows:

- Offset = (Depth from top of DWS to the bearing shelf of the headstock) x (% of superelevation)

The offset is applied along the headstock centreline. Refer Figure 12.4(b) *Formed Hole Offset*.

Skewed and superelevated bridges

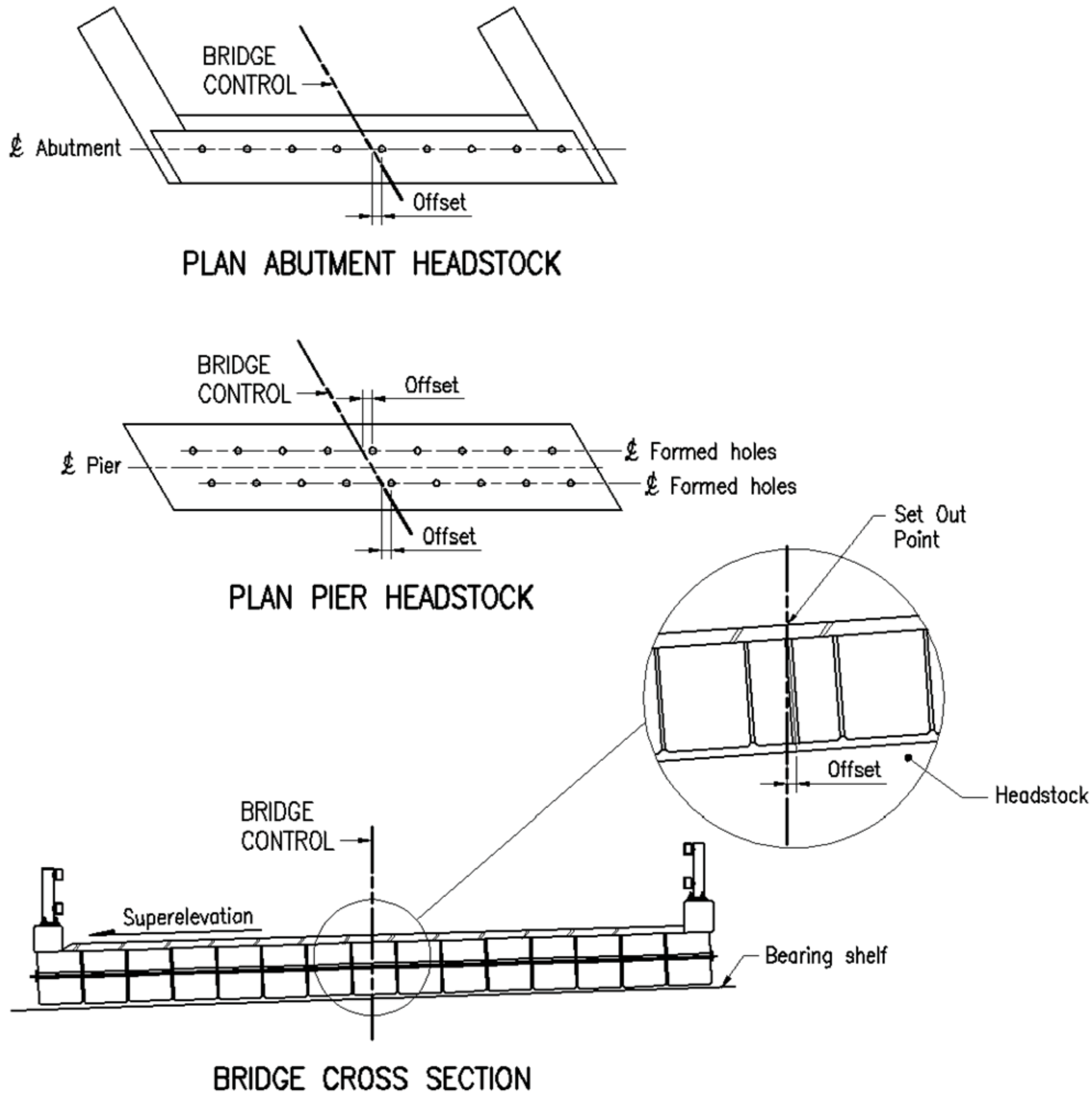
When the bridge is skewed and superelevated, the headstock is offset to maintain the correct position of the superstructure.

The offset is calculated as follows:

- Offset = (Depth from top of DWS to the bearing shelf of the headstock) x (% of superelevation) ÷ (Cosine of the angle of skew)

The offset is applied along the headstock / formed hole centreline. Refer Figure 12.4(c) *Formed Hole Offset*.

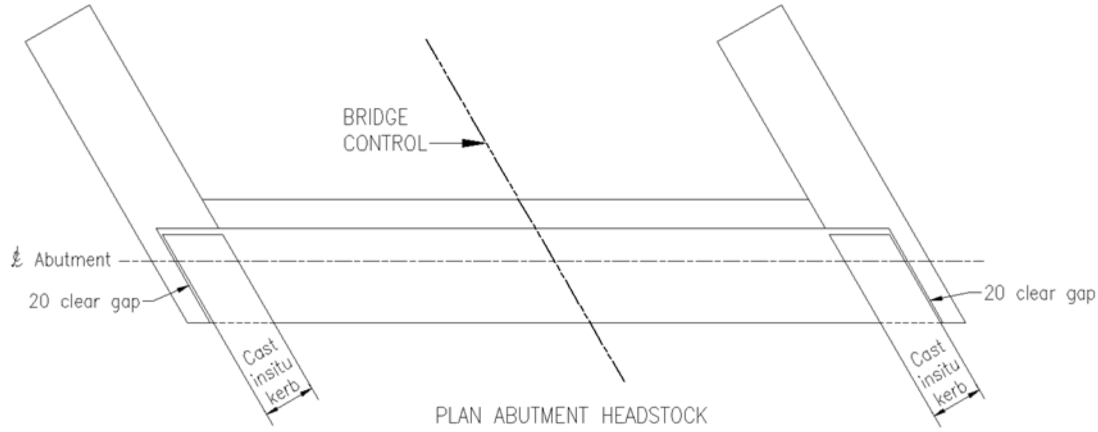
Figure 12.4(c) - Formed hole offset



Abutment sidewalls

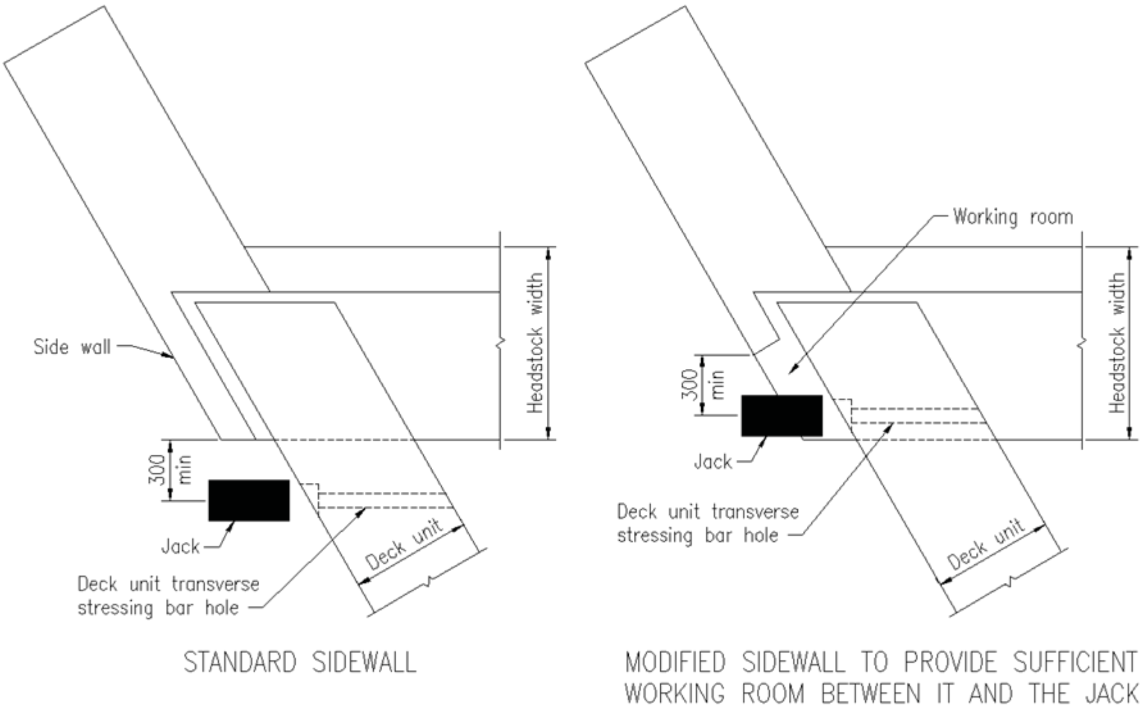
On a deck unit bridge with cast insitu kerbs there is a 20 mm gap between the cast insitu kerb and the 150 mm wide sidewall. Refer Figure 12.4(d) *Clear Gap at Abutment Sidewalls*.

Figure 12.4(d) - Clear gap at abutment sidewalls



On skewed bridges the Drafter must check that the abutment side walls will not interfere with the transverse stressing of the deck units. The side wall may need to be terminated to provide sufficient working room between it and the jack. Refer Figure 12.4(e) *Abutment Side Wall and Transverse Stressing Jack Clearance*.

Figure 12.4(e) - Abutment side wall and transverse stressing jack clearance



Length of abutment headstocks

The length of an abutment headstock is determined by allowing for the overall width of the bridge (between kerbs) plus the width of the wingwall on both sides of the bridge. For wingwall widths refer Section 12.7 *Deck Unit Bridge – Abutment* Wingwalls.

Width of abutment headstocks

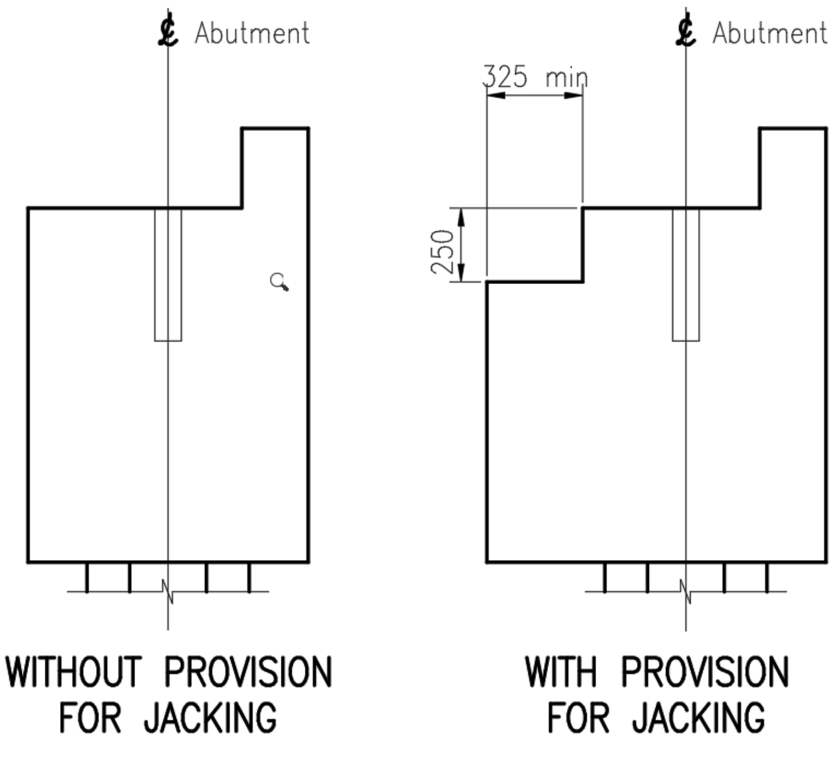
The width of an abutment headstock is determined by the design engineer according to the design loadings and may also be influenced by the extent of the cement mortar / bearings on the bearing shelf, provision for jacking, as well as the pile type and size and piling tolerances. Refer 12.5 *Deck Unit Bridge – Mortar Seating* and Chapter 13 – *Provision for Bridge Jacking Inspection and Maintenance*.

Typically abutment headstocks are 950 mm wide when the deck units they support are on mortar seating, square ended, and the joint is fixed. If the deck units are skewed and/or have a slotted holding down bolt hole, the distance from the holding down bolt hole in the deck unit to the end of the deck unit is increased from the typical dimension of 200 mm. Consequently the abutment width shall be increased.

Where jacking shelves are required for bearing replacement the jacking shelves are to be 325 mm wide (minimum). Depending on the jack size required the jacking shelves may be wider, so it is important to determine the jack size early. Jacking shelves are typically 250 mm deep.

The centreline of the abutment is through the piles and through the deck unit holding down bolt. Refer Figure 12.4(f) Example *Fixed and Square Abutment Headstocks*.

Figure 12.4(f) - Example Fixed and Square Abutment Headstocks



Length of pier headstocks

The length of a pier headstock is determined by the extent of the cement mortar or bearings on top of the headstock. When dimensioned from the Set Out Point the headstock length shall be rounded up to the nearest 50 mm on each side. Refer PIERS – PLAN in Figure 12.5(a) *Mortar Seating Limits*.

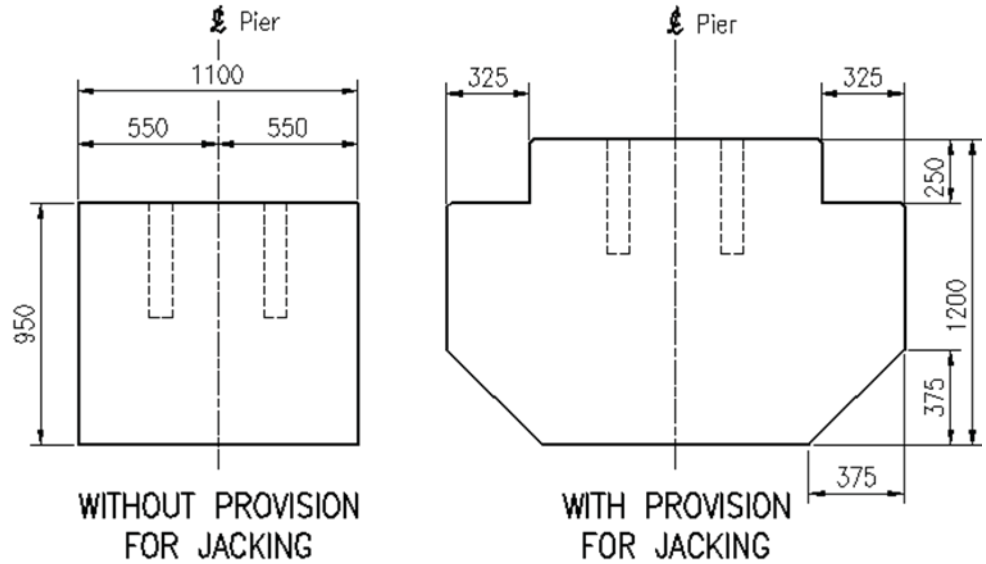
Width of pier headstocks

The width of a pier headstock is determined by the extent of the cement mortar or bearings on the bearing shelf, as well as the pile size and piling tolerances. Refer 12.5 *Deck Unit Bridge – Mortar Seating* and Chapter 13 – *Provision for Bridge Jacking, Inspection and Maintenance*.

Typically, pier headstocks are 1100 mm wide when the deck units they support are on mortar seating, square ended, and the joint is fixed. If the deck units are skewed and/or have a slotted holding down bolt hole, the distance from the holding down bolt hole in the deck unit to the end of the deck unit is increased from the typical dimension of 200 mm. Consequently, the pier width shall be increased.

If the deck units are supported on laminated or single layer elastomeric bearings, a jacking shelf is required. Typically, this is 325 mm wide (or greater, depending on jack size) and 250 mm deep. Refer Figure 12.4(g) *Typical Fixed and Square Pier Headstock Dimensions*.

Figure 12.4(g) - Typical fixed and square pier headstock dimensions



Depth of abutment and pier headstocks

The bridge designer is to determine the project headstock depths based on the specific project requirements. It is to be noted that a headstock designed to incorporate jacking will be typically 250 or more deeper than a headstock which does not include provision for jacking. Refer Figure 12.4(g) *Typical Pier Headstocks*.

12.5 Deck unit bridge - Mortar seating

Mortar seating thickness – Abutments and piers

Transport and Main Roads has experienced insufficient clearance being allowed for in the design of projects where expensive repairs / modifications were required on site. This includes projects designed using 3d software.

Care is to be taken by the designer in the detailing of the bridge to ensure adequate clearance, 15 mm or greater, is achieved at the minimum clearance point between the soffit of the deck units and any point on the abutment and pier headstocks, usually the front edges, taking into account, but not limited to the following factors:

1. hog of deck units (design hog, tolerance - actual hog at installation, final hog after casting of deck or final hog after achieving 100 days cure)
2. skew
3. grade
4. vertical curve
5. horizontal curve
6. fanning of deck units either for curves or for road geometry requirements such as merging lanes or exit ramps
7. slope of headstock, and
8. change in deck profile (design live and dead loads, creep and shrinkage).

The resultant grade of the deck unit soffit will be determined by the approach and departing seating heights and the curve of the deck unit hogs. The pinch points for the least clearance will often be at the higher side of the deck units on the front face of the superelevated headstocks.

NOTE: Any proposal to set Deck Units vertical will complicate the situation further.

Refer Figure 12.5(a) *Mortar Seating Limits*.

With respect to headstock clearance, the following shall apply:

- mortar seating depth may be varied to a maximum thickness of 30 mm to accommodate geometric issues on less complex designs, and
- in cases where a greater thickness of mortar seating would be required to achieve minimum clearance, the bearing shelf (top of the headstock) must be sloped to match the resultant grade.

With respect to abutment ballast wall clearance, the following shall apply:

- Ballast walls are generally designed with a nominal clearance of 50 mm from the end of the deck units to the front face of the wall. Where extreme geometry applies, such as large grades and deeper units, the gap may be increased to achieve a minimum gap of 20 mm.

Mortar seating limits – Abutments

The extent of the mortar seating bed placed under deck units shall extend 200 mm from the formed holes towards the front face of the headstock.

Mortar seating shall not be placed any closer than 175 mm to the front of the headstock in any application. Refer Figure 12.5(a) *Mortar Seating Limits*.

When the width of the headstock exceeds the standard 950 mm, the clear distance to the front of the headstock shall increase to maintain the 200 mm dimension.

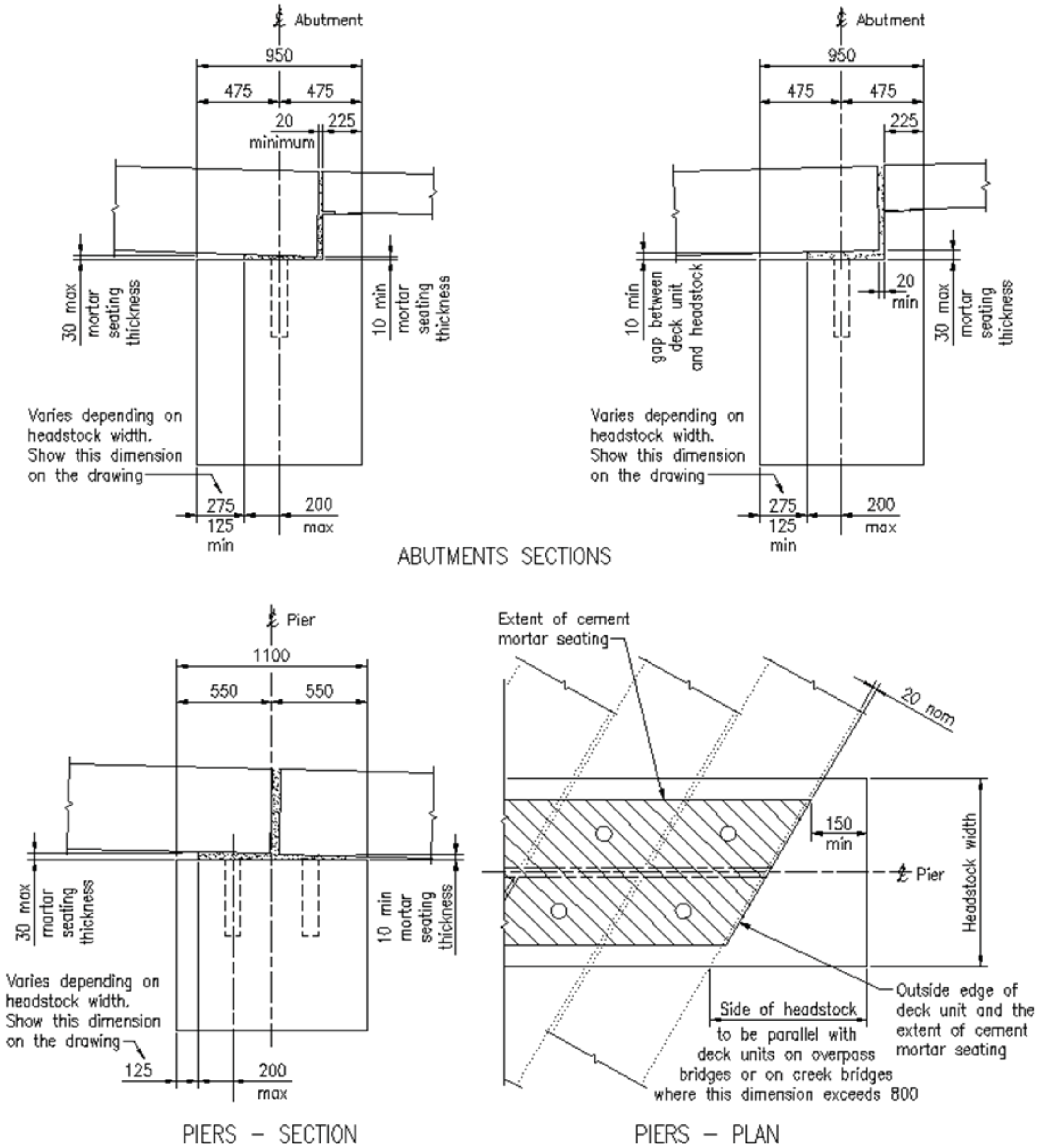
Mortar seating limits – Piers

The extent of the mortar seating bed placed under deck units shall extend 200 mm from the formed holes towards the front face of the headstock.

Mortar seating shall not be placed any closer than 125 mm to the front of the headstock in any application. Refer Figure 12.5(a) *Mortar Seating Limits*.

When the width of the headstock exceeds the standard 1100 mm, the clear distance to the front of the headstock shall increase to maintain the 200 mm dimension.

Figure 12.5(a) - Mortar seating limits



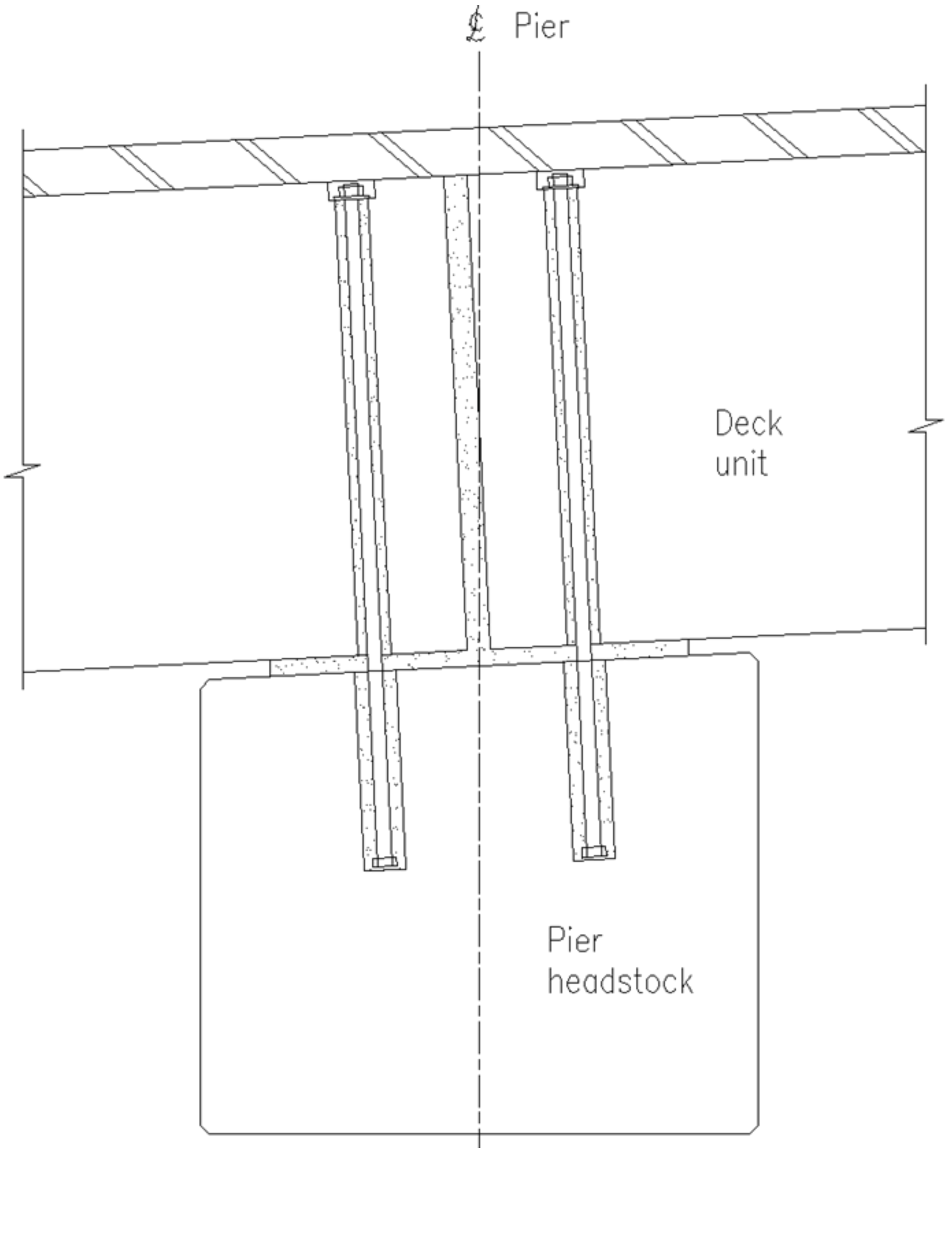
12.6 Deck unit bridge - Sloped headstock bearing shelves

Headstocks with mortar seating

As explained in 12.5 *Deck Unit Bridge – Mortar Seating*, the bearing shelf may need to be sloped to ensure that the mortar seating thickness does not exceed 30 mm. Even when the bearing shelf complies with these guidelines for mortar seating, it may still need to be sloped to allow the deck unit holding down bolts to fit inside the deck unit holding down bolt holes. The 75 x 75 x 6 thick washer for the holding down bolt must be able to sit inside the 100 x 100 x 55 deep recess in the top of the deck unit. Therefore, the bolt can only be off centre a maximum of 12 mm at the top. If the bolt is closer than this the formed hole in the headstock shall be made perpendicular to the deck unit. Consequently, the bearing shelf will be sloped parallel with the grade of the bridge at that particular point.

The possibility of this becoming an issue will increase as the deck units get deeper on bridges with a vertical grade / curve. Refer Figure 12.6(a) *Sloped Bearing Shelf for Mortar Seating*.

Figure 12.6(a) - Sloped bearing shelf for mortar seating (pier shown - abutment similar)



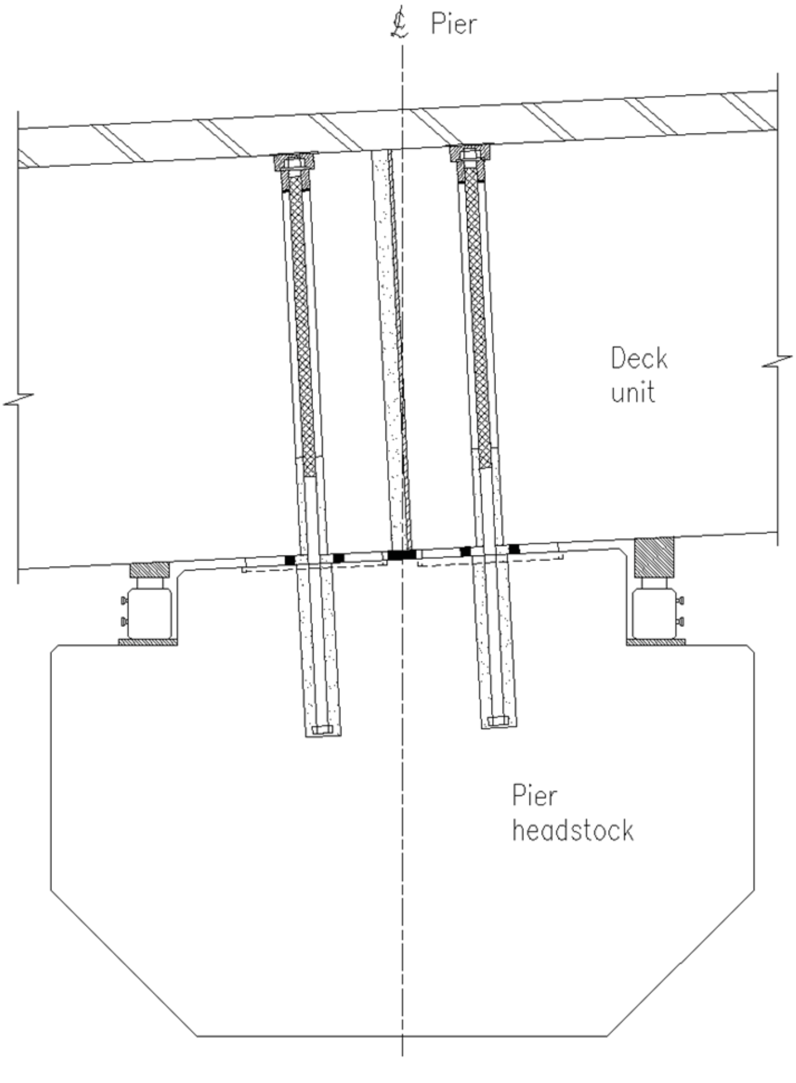
Headstocks with elastomeric bearings

Clause 4.7 of the *Design Criteria for Bridges and Other Structures* defines the circumstances where elastomeric bearings must be used. On bridges with elastomeric bearings, the bearing shelf shall be sloped parallel with the grade of the bridge at that particular point. This is because the holding down bolts must sit centrally in the deck unit holding down bolt holes to suit future jacking requirements of the deck units. This design works for grades up to 5%. For grades in excess of 5%, the design shall be amended to ensure that the bearing sits horizontally. Refer MRTS74 *Supply and Erection of Prestressed Concrete Deck and Kerb Units*. Alternatively, PSC girders may be required when the effects of excessive grade are experienced.

Depending on the required jack size for bearing replacement the jacking shelf widths may be required to be wider than the minimum detailed in Chapter 13, hence it is advisable to discover the jack size early in the abutment and piers detailing process.

Refer Figure 12.6(b) *Sloped Bearing Shelf for Elastomeric Bearings* and Chapter 13 – *Provision for Bridge Jacking Inspection and Maintenance*.

Figure 12.6(b) - Sloped bearing shelf for elastomeric bearings (pier shown - abutment similar)



12.7 Deck unit bridge - Abutment wingwalls

Wingwall widths are typically the width of the cast insitu or precast kerb width + 20 nominal gap + 150 sidewall width. Standard cast insitu kerb widths are specified on Transport and Main Road's Standard Drawing No. 2045.

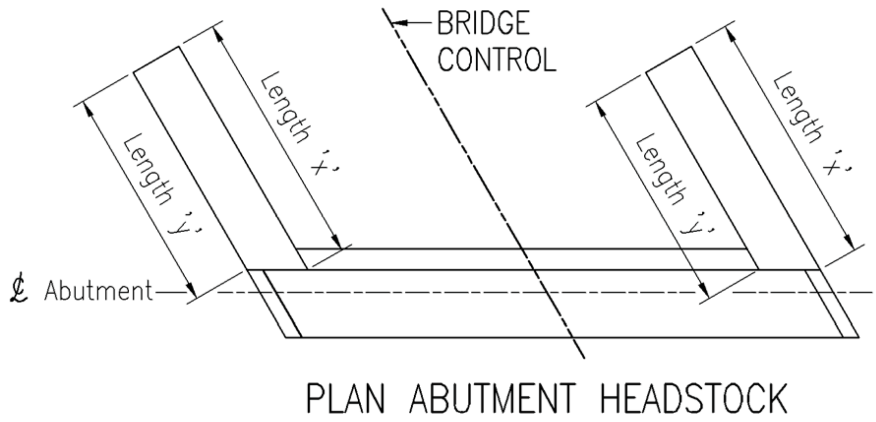
The top of the wingwalls are designed to be flush with the top of the kerbs.

The criteria for conduits in wingwalls are as follows:

- Conduits on bridges are allowed a maximum elbow bend of 22.5° so that the services can be easily pulled through the conduit, and
- Conduits must exit the back of the wingwall 600 mm minimum below ground. This distance may be reduced to 300 mm if the conduits are covered with a concrete protective strip.

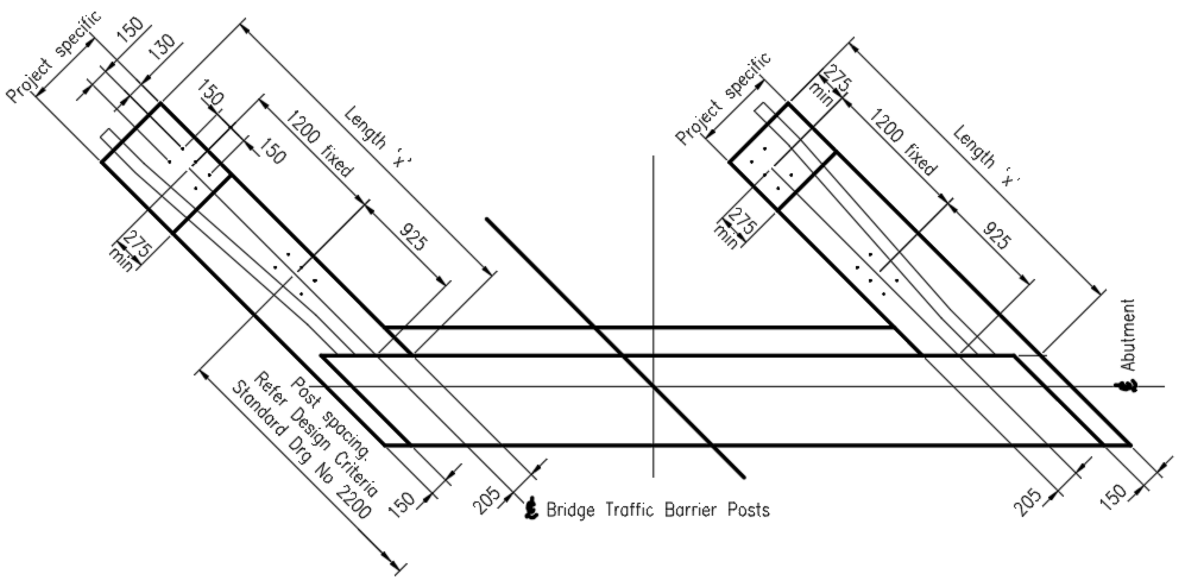
To simplify reinforcing bars, the profile of the wingwalls (in Plan view) shall be the same if possible. Refer Figure 12.7(a) *Wingwall Lengths*.

Figure 12.7(a) - Wingwall lengths



Refer to Design Criteria on Transport and Main Road's Standard Drawing No. 2200 for bridge traffic barrier post spacings and recess depth to be provided at the end of the wingwalls.

Figure 12.7(b) – Deck unit bridge wingwall dimensions



12.8 Girder bridge - Headstock layout

This content is written based on departmental experience with Super T-girders. It is not the intent of this chapter to exclude alternative approved girder types.

All headstocks are set out from a nominated point (Set Out Point) being the intersection between the Bridge Control and the headstock centreline at the road surface Height. All bearings, wingwalls etc are to be set out along a line from this point perpendicular to the headstock centreline.

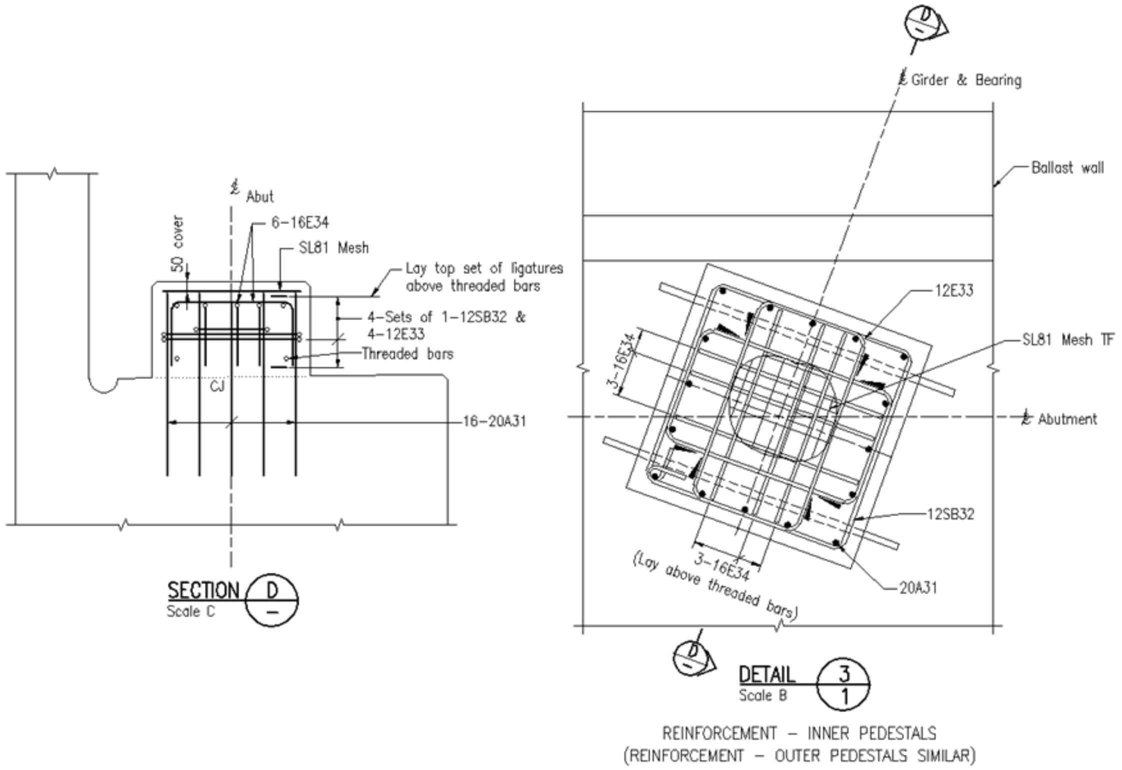
Unlike deck unit bridges, there is no offset to calculate for girder bridge headstock. Super T-girders are placed vertically in all situations so headstocks are not offset in any way at the bearing surface level.

Elastomeric and pot bearings are installed on a reinforced concrete pedestal. The top of the pedestal, and consequently the bearings, shall be level in all directions. Refer Figure 12.8(a) *Pedestal Details* for further details.

Note:

- Girders are placed vertically in all situations.
- Girders are typically placed with a 30 mm gap between top flanges longitudinally Tapered steel plate between the bearing and the girder allows for vertical grade and hog A Height shall be shown at the top of every pedestal.
- Pedestals are typically made from S50/10 reinforced concrete.
- Cover to reinforcing in pedestals shall typically be in accordance with AS 5100 for appropriate exposure classification.
- Heights of pedestals vary and therefore shall be designed individually.

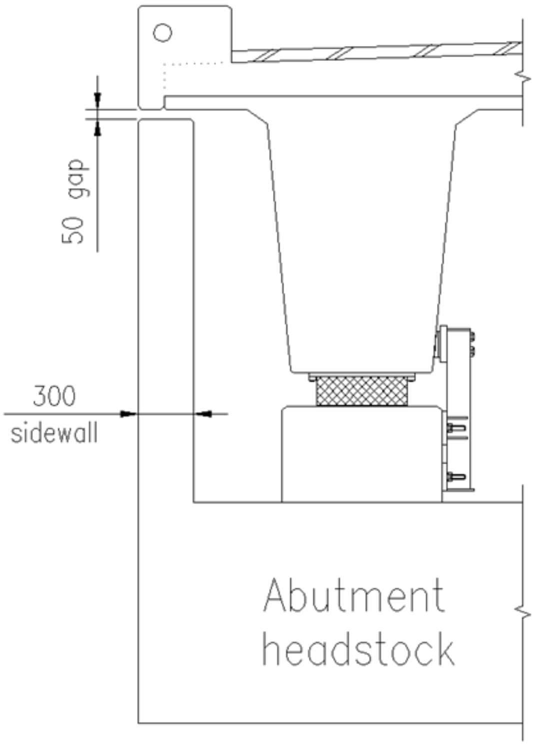
Figure 12.8(a) - Pedestal details



Abutment sidewalls

On girder bridges, sidewalls shall be designed to withstand impact loads during installation of the girders. Typically the sidewalls are 300 mm wide and should finish flush with the outside of the concrete kerb. Refer Figure 12.8(b) *Girder Bridge Abutment Sidewalls*.

Figure 12.8(b) - Girder bridge abutment sidewalls



Length of abutment headstocks

The length of an abutment headstock is determined by allowing for the overall width of the bridge (between kerbs) plus the width of the wingwall on both sides of the bridge. On girder bridges the wingwalls are the same width as the kerb/concrete traffic barrier adjoining it. Refer 12.9 *Girder Bridge – Abutment Wingwalls* and Figure 12.8(b) *Girder Bridge Abutment Sidewalls*.

Width of abutment headstocks

Ballast walls are generally to be 225 mm or greater in width. The width of the bearing shelf is determined by the width of the pedestals plus adequate clearance between the front face of the headstock and the pedestals. There must be at least 250 mm between the bearing and the front face of the pedestal for the placement of non-compressible temporary packers during girder erection.

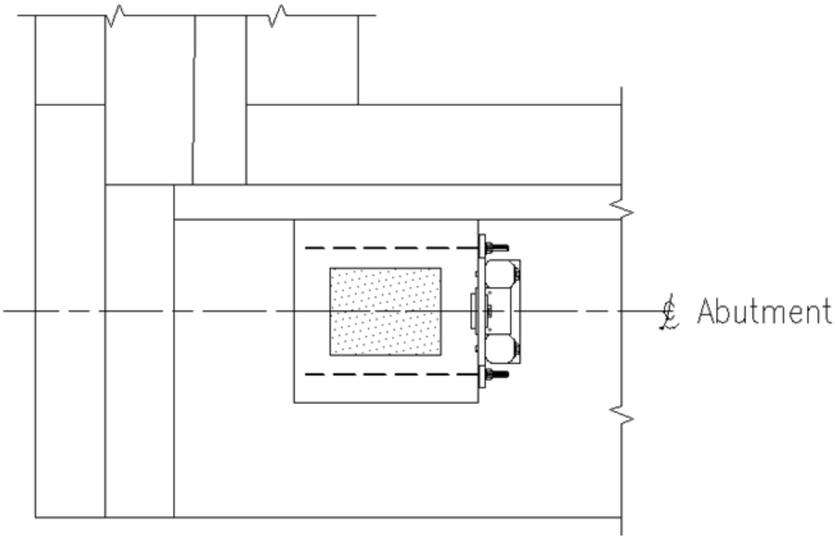
When determining headstock width, the pile size and piling tolerances must also be considered.

The headstock width shall be rounded up to the nearest 25 mm each side when dimensioned from the Set Out Point. When a ballast wall is very tall, for example on a 1800 mm deep super T-girder bridge, the width of the wall may need to be larger than 225 mm.

Square abutment headstocks

Refer Figure 12.8(c) *Abutment Pedestal Profile (Square)*.

Figure 12.8(c) - Abutment pedestal profile (Square)

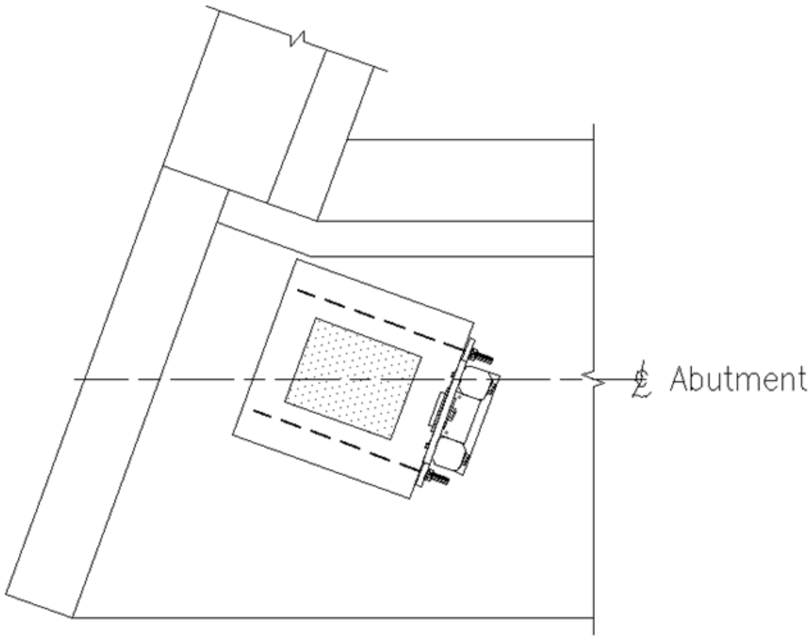


Skewed abutment headstocks

Calculating abutment headstock widths becomes more difficult for skews. Depending on variables such as the bearing and pedestal size and the skew angle, the headstock width may become unproportionally wide.

Refer Figure 12.8(d) *Abutment Pedestal Profile (Skewed).*

Figure 12.8(d) - Abutment pedestal profile (Skewed)



Length of pier headstocks

Depending on the width of the headstock, the skew angle and the importance of aesthetics, the ends of the headstock will be either square or skewed. The headstock length shall be rounded up to the nearest 25 mm each end when dimensioned from the Set Out Point.

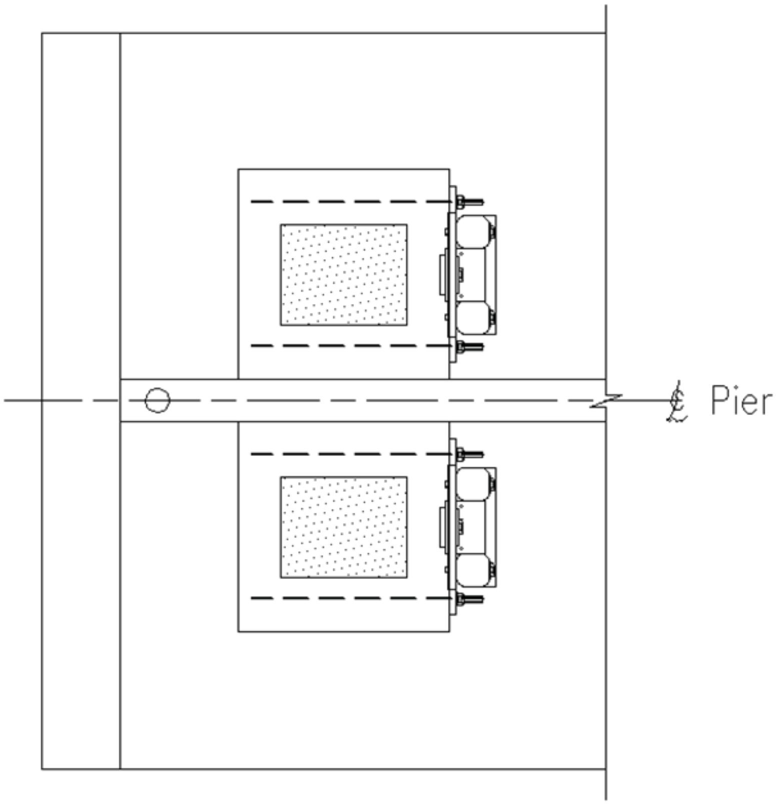
Width of pier headstocks

There must be at least 250 mm between the bearing and the front face of the pedestal for the placement of non-compressible temporary packers during girder erection. The headstock width shall be rounded up to the nearest 25 mm each side when dimensioned from the Set Out Point.

Square pier headstocks

Refer Figure 12.8(e) *Pier Pedestal Profile (Square)*.

Figure 12.8(e) - Pier pedestal profile (Square)

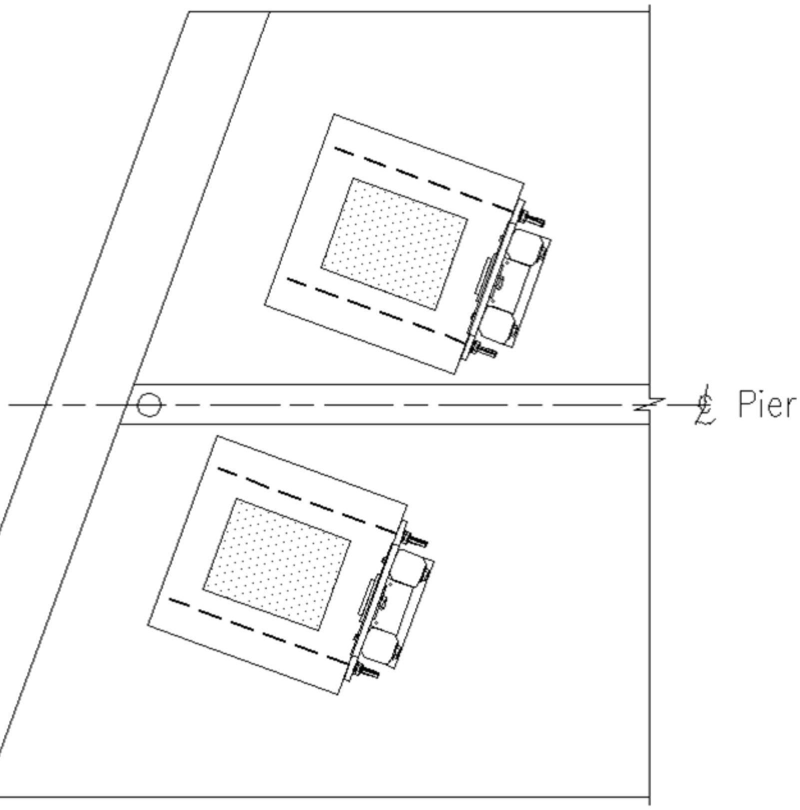


Skewed pier headstocks

Calculating pier headstock widths becomes more difficult for skews. Depending on variables such as the bearing and pedestal size and the skew angle, the headstock width may become unproportionally wide.

Refer Figure 12.8(f) *Pier Pedestal Profile (Skewed).*

Figure 12.8(f) - Pier pedestal profile (Skewed)



12.9 Girder bridge - Abutment wingwalls

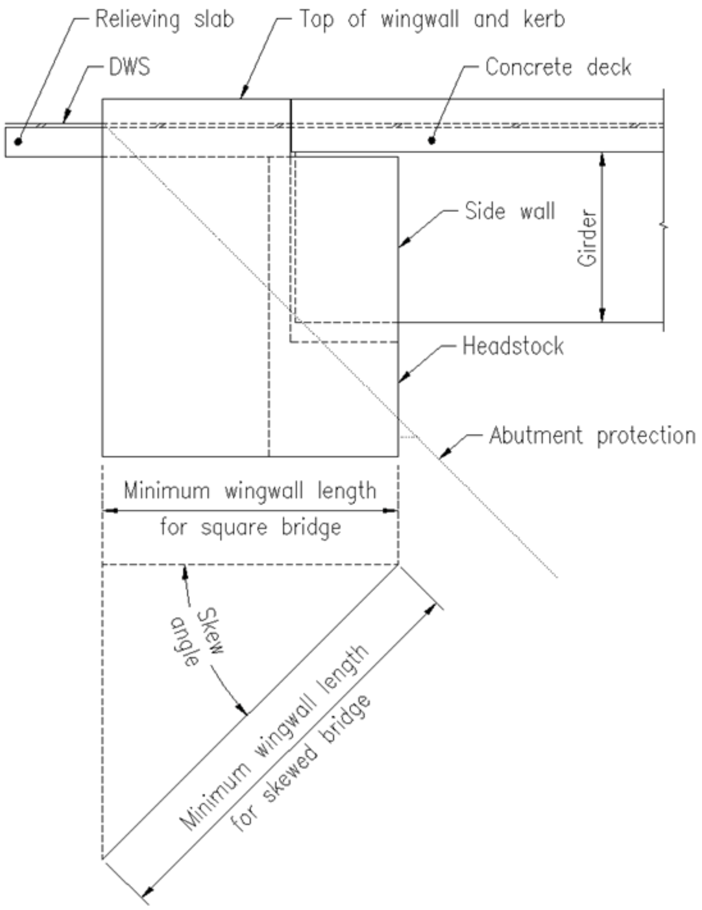
To match the top of the cast insitu kerb, the top of the wingwall is 275 mm above the road running surface. Because the abutment sidewall is located below the kerb/traffic barrier girder bridge abutment wingwalls are the same width as the kerb/traffic barrier adjoining them. Girder bridges cannot use the standard wingwall size tables and therefore shall be designed individually. Points to consider when designing the length of a wingwall include:

- Conduits on bridges are allowed a maximum elbow bend of 22.5° so that the services can be easily pulled through the conduit. By placing conduits as close as possible to the bottom of the traffic barrier unnecessarily long wingwalls can be avoided.
- Conduits must exit the back of the wingwall 600 mm minimum below ground. This distance may be reduced to 300 mm if the conduits are covered with a concrete protective strip.

These two criteria result in a wingwall that is longer than it would be without a conduit.

The wingwalls must be long enough to contain the road embankment. Bridges with deep girders and large skews will need extra length wingwalls. Figure 12.9(a) *Calculating Non-Standard Wingwall Lengths* demonstrates the effect a deep superstructure and a large skew have on the wingwall length.

Figure 12.9(a) - Calculating non-standard wingwall lengths



12.10 Abutment headstock profiles

Top of abutment wingwalls

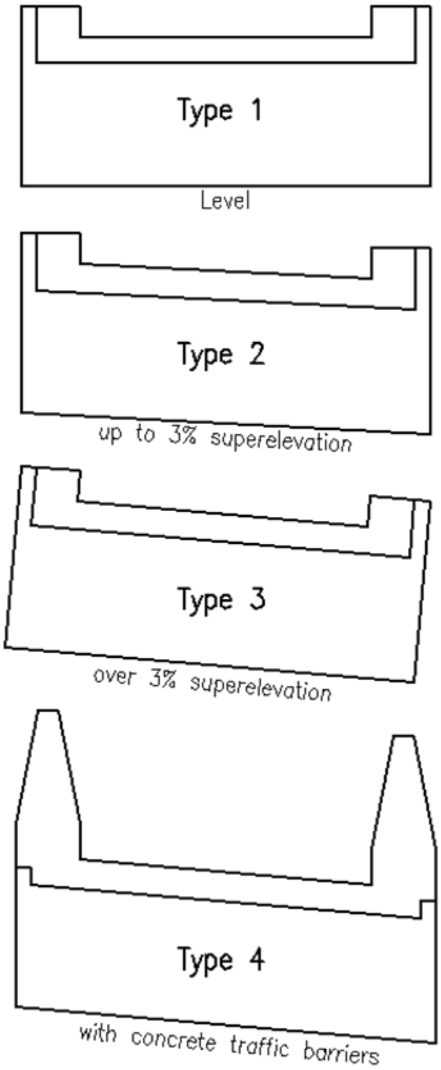
Bridges with cast insitu kerbs: The top face of the kerbs and abutment wingwalls are level on bridges with a crossfall or superelevation up to and including 3% (Type 1 or 2).

Bridges with a superelevation greater than 3%, the top face of the wingwalls follows the superelevation (Type 3).

Bridges with concrete traffic barriers: Regardless of the amount of crossfall or superelevation the concrete traffic barriers shall be vertical and the top face shall be level (Type 4).

The end slope of abutment headstocks shall be perpendicular to the top face of the kerb or wingwall. Refer Figure 12.10(a) *Abutment Headstock Elevation Options*.

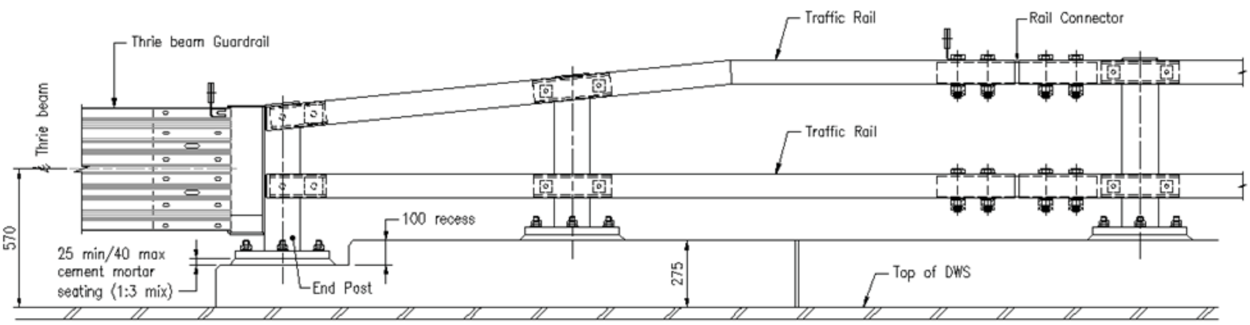
Figure 12.10(a) - Abutment headstock elevation options



Abutment wingwall recess for regular performance level bridge steel traffic barrier connecting to thrie beam guardrail

To suit the end post of a bridge steel traffic barrier a 100 mm deep recess shall be cast into the top of the wingwall. The recess length varies on skewed bridges. Refer Figure 12.7(b) *Deck Unit Bridge Wingwall Dimensions*. Refer Figure 12.10(b) *Abutment Wingwall Recess*.

Figure 12.10(b) - Abutment wingwall recess



Bridge steel traffic barrier connecting to W beam guardrail

W beam guardrail may only be used in low speed environments.

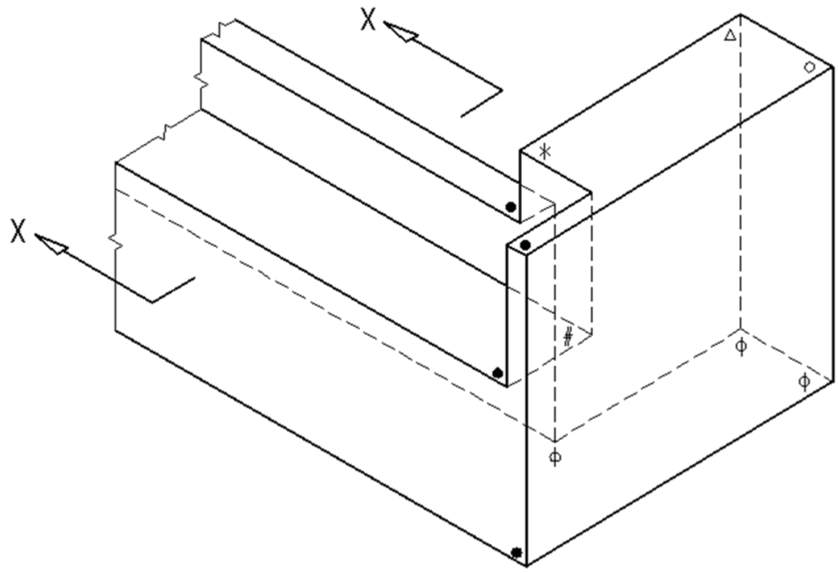
Abutment headstock heights

Variations in geometric conditions (grade, superelevation, skew and so on) on an abutment require Heights to be shown to specific points to clearly define the headstock. Figure 12.10(c) *Abutment Height Notation* defines these points and indicates where Heights are required to be shown.

Note the following:

- Conditions 1, 4 and 7 require Heights to be shown on one side of the abutment only. All other conditions require Heights to be shown on both sides of each abutment.
- The soffit of all headstocks is to be horizontal through Section X-X, and set to the resultant crossfall.
- The soffit of wings to be coplanar with the soffit of the headstock.
- Conditions 4 to 6 will require a Height at a point marked thus '#' when the bearing shelf needs to be sloped due to grade – refer to Figure 12.5(a) *Mortar Seating Limits* for further details.
- A headstock with a jacking shelf requires additional Height(s) to be shown '#' is only needed on a girder bridge when the bridge is skewed.

Figure 12.10(c) - Abutment Height notation



BRIDGE WITH CAST INSITU KERBS

1.	Square on level grade – no superelevation	●					
2.	Square on level grade – with superelevation ≤3%	●					
3.	Square on level grade – with superelevation >3%	●		∗			
4.	Square on longitudinal grade – no superelevation	●	○	∗			
5.	Square on longitudinal grade – with superelevation ≤3%	●	○	∗			
6.	Square on longitudinal grade – with superelevation >3%	●	○	∗	△		
7.	Skewed on level grade – no superelevation	●					
8.	Skewed on level grade – with superelevation ≤3%	●				ϕ	#
9.	Skewed on level grade – with superelevation >3%	●		∗		ϕ	#
10.	Skewed on longitudinal grade – no superelevation	●	○	∗		ϕ	#
11.	Skewed on longitudinal grade – with superelevation ≤3%	●	○	∗		ϕ	#
12.	Skewed on longitudinal grade – with superelevation >3%	●	○	∗	△	ϕ	#

Vertical curves

Abutments within the limits of a vertical curve will require special consideration in determining Heights, while at the same time ensuring that the DWS thickness is not reduced below the minimum allowed either at the ends or at the centre of the span.

12.11 Thrie beam, pit, and electrical / telecommunication conduit treatment at abutment wingwalls

The designer is to consider the interaction and fitment of Guardrails including post positions, conduits and cable joining pits to avoid site clashes.

Figure 12.11(a) *Thrie Beam Connecting to Bridge Concrete Traffic Barrier* and Figure 12.11(b) *Thrie Beam Connecting to Bridge Steel Traffic Barrier* provide samples for consideration.

Figure 12.11(a) - Thrie beam connecting to bridge concrete traffic barrier

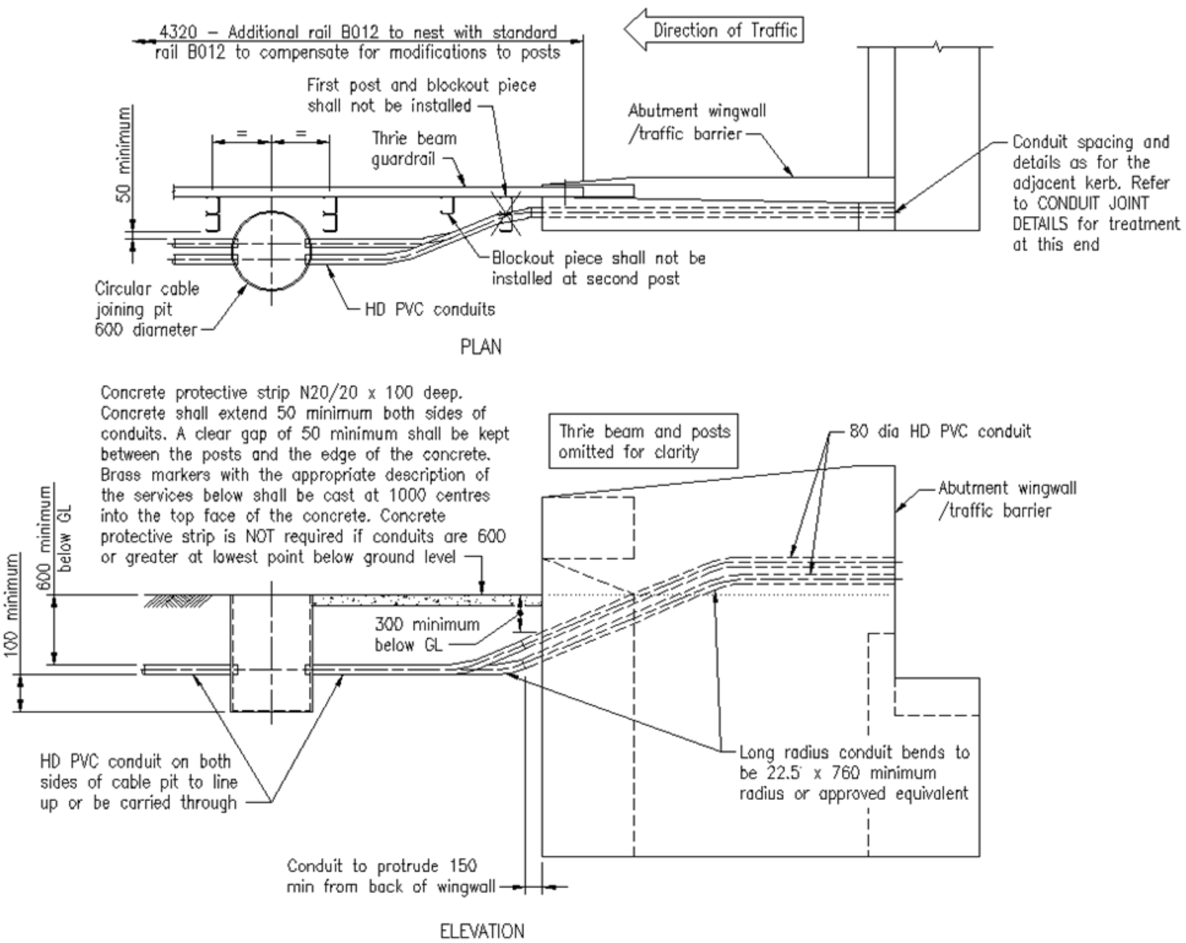
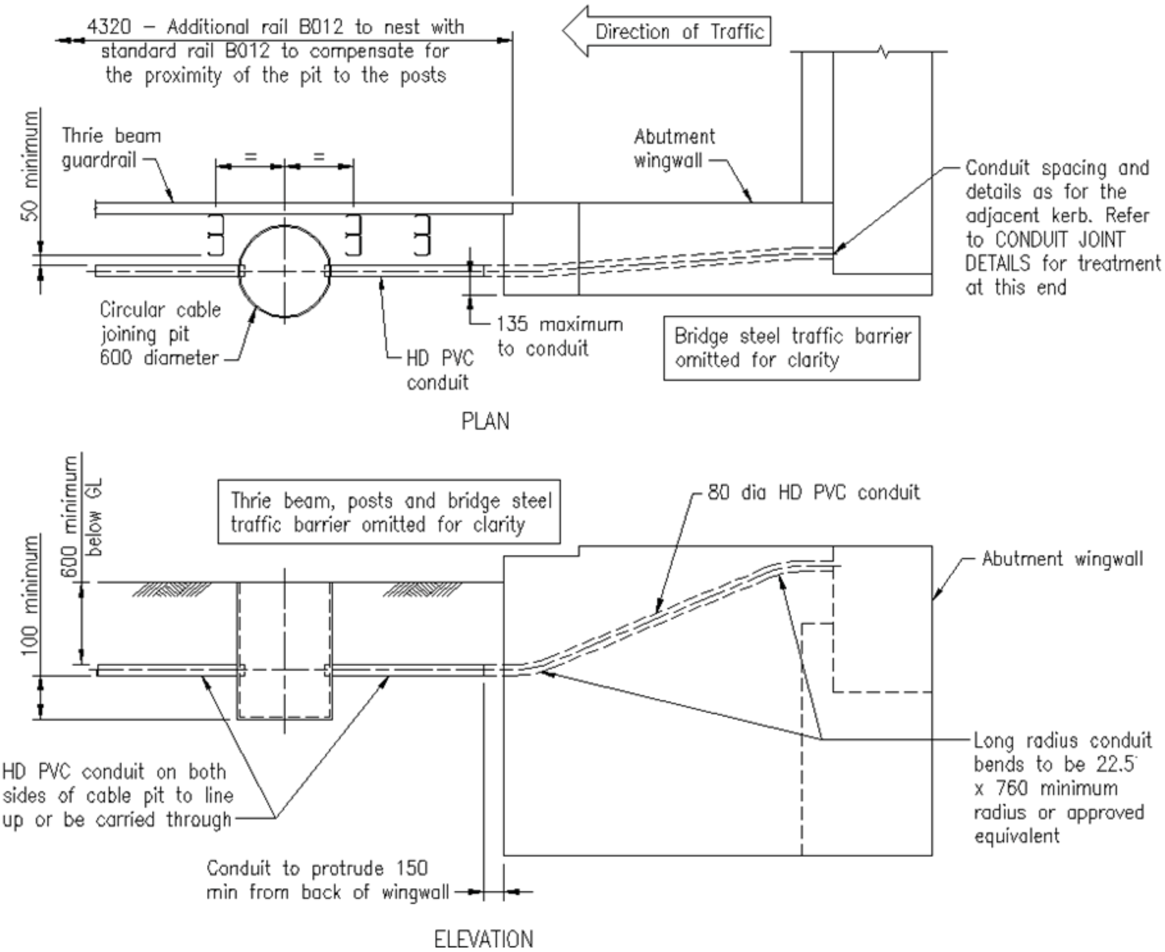


Figure 12.11(b) - Thrie beam connecting to bridge steel traffic barrier



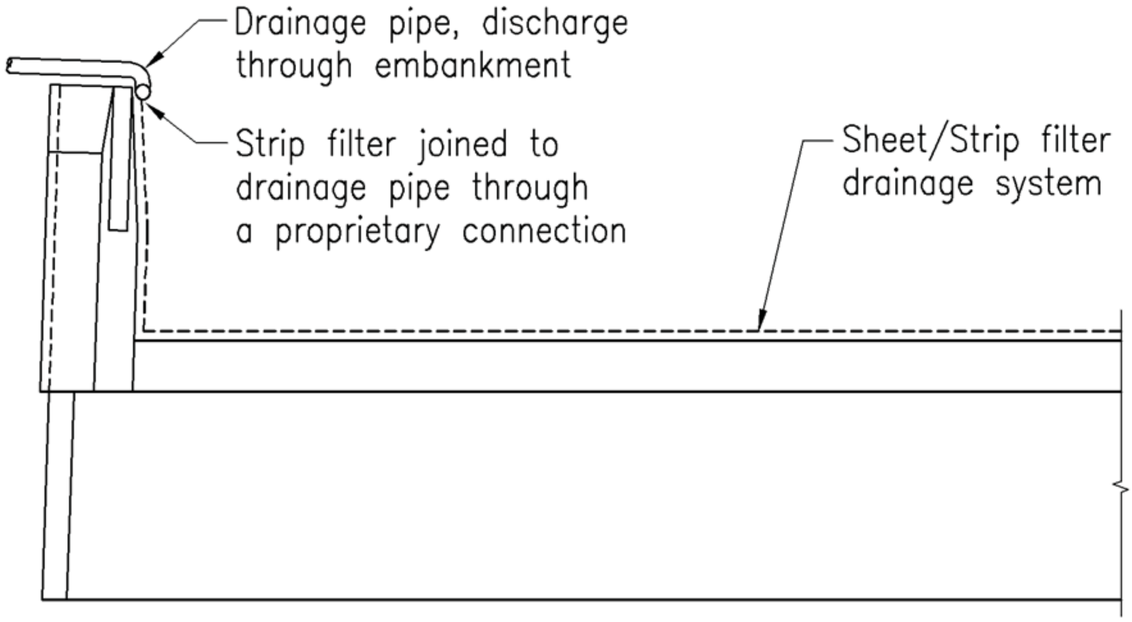
12.12 Abutment headstock additional details

Abutment headstock drainage

The embankment behind an abutment headstock must be drained to prevent hydrostatic pressure being applied to the abutment. A sheet filter placed above a strip filter shall be placed behind the headstock and wingwalls. Drainage pipes are to be connected to strip drains through proprietary connections and shall be drained through the embankment either side of the headstock.

For an example of the details required on the abutment drawings refer Figure 12.12(a) *Abutment Headstock Drainage*. For examples of the details required on the General Arrangement drawings refer Chapter 11 – *General Arrangements*, Figure 11.7(a) *Deck Unit Anchorage Detail – No Provision for Jacking*.

Figure 12.12(a) - Abutment headstock drainage



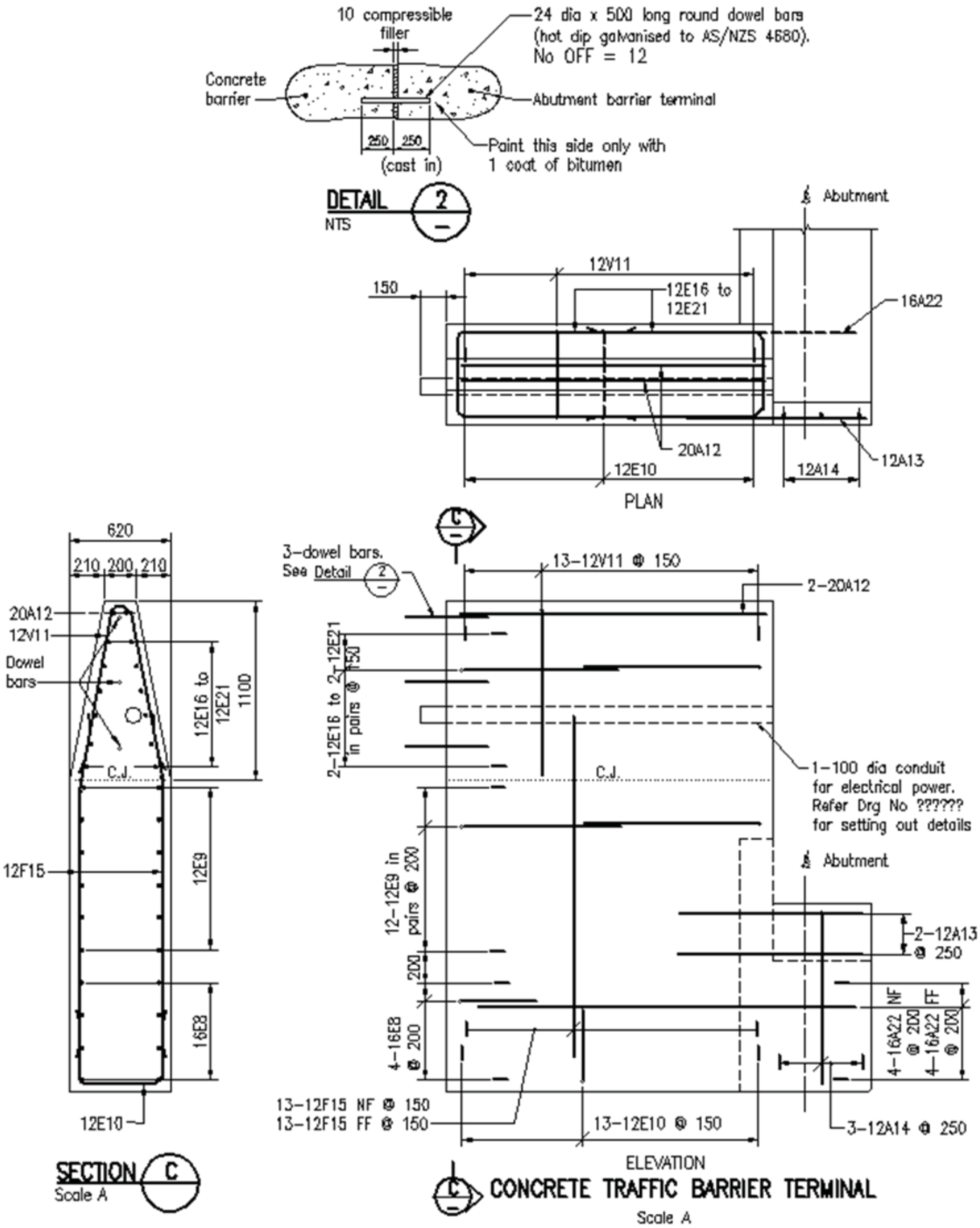
Wingwall (concrete traffic barrier type) connection to extruded barrier

Bridges with concrete traffic barriers can connect to a concrete median barrier rather than guardrail. In this case the back of the wingwall will finish vertically and have dowel bars protruding for the median barrier to connect to.

Dowelled joints are not to be used at abutment barriers or pier barrier joints where they may interfere with future jacking operations.

Refer Figure 12.12(b) *Wingwall Connection to Extruded Barrier*.

Figure 12.12(b) - Wingwall connection to extruded barrier



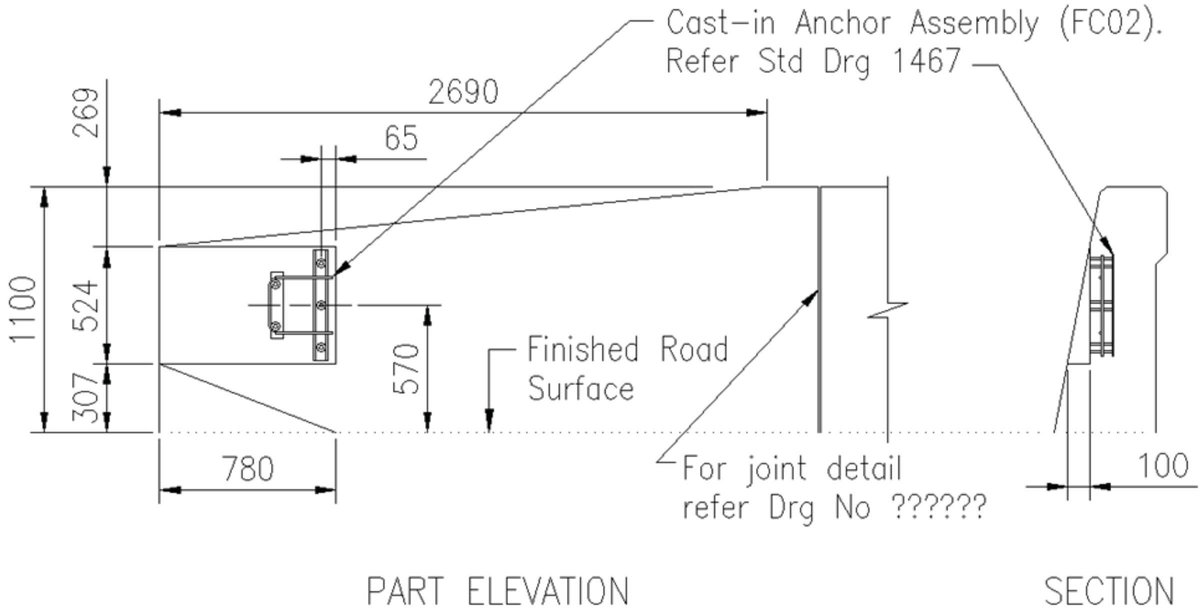
Wingwall (concrete traffic barrier type) connection to guardrail

On bridges with concrete traffic barriers, an anchor is to be cast into each wingwall to accommodate guardrail connection.

Thrie beam guardrail connects to cast-in anchor assembly (part number FC02).

For anchor details refer to Transport and Main Road's Standard Drawing 1467 *Cast in Anchor Assembly for W and Thrie Beam Guardrail Connection*. For an example of the details required on the abutment drawings refer Figure 12.12(c) *Wingwall Connection to Thrie Beam Guardrail*. Note that the transition in barrier shall be one on ten (1 on 10). This results in a relatively long wingwall which may need to be supported by a pile.

Figure 12.12(c) - Wingwall connection to thrie beam guardrail



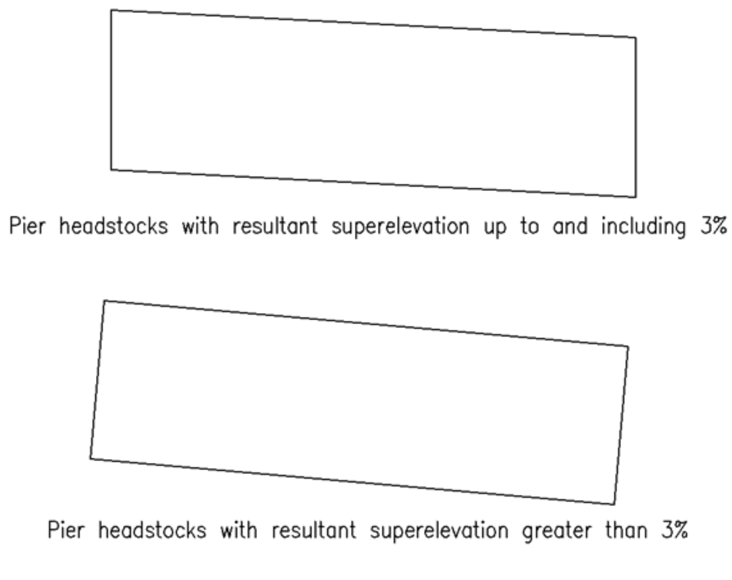
12.13 Pier headstock profiles

End slope of pier headstocks

Resultant superelevation is the slope of the headstock after superelevation, vertical grade and skew are accounted for.

Pier headstocks with a resultant superelevation up to and including 3% have vertical ends. Pier headstocks with a superelevation greater than 3% have ends sloped perpendicular to the top of headstock. Refer Figure 12.13(a) *End Slope of Pier Headstocks*.

Figure 12.13(a) - End slope of pier headstocks



Pier headstock Heights

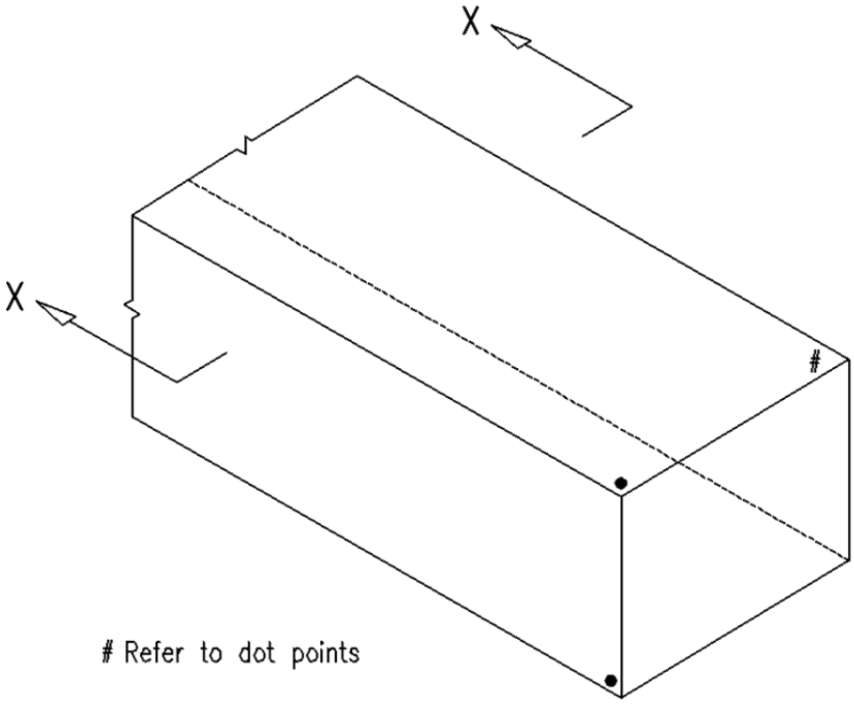
Variations in geometric conditions (grade, superelevation, skew and so on) on a pier require Heights to be shown to specific points to clearly define the headstock.

Figure 12.13(b) *Pier Height Notation* defines these points and indicates where Heights are required to be shown. The points indicated are based on a simple headstock that is rectangular in Plan view. Headstocks that are not rectangular require separate consideration.

Note the following:

- Conditions 1, 3 and 5 require Heights to be shown on one side of the pier only.
- The soffit of all headstocks is to be horizontal through Section X-X, and set to the resultant crossfall.
- Conditions 3, 4, 7 and 8 will require a Height at a point marked thus '#' when the bearing shelf needs to be sloped due to grade – refer to Figure 12.5(a) *Mortar Seating Limits* for further details.
- '#' is only needed on a girder bridge when the bridge is skewed.
- A headstock with a jacking shelves requires additional Height(s) to be shown.

Figure 12.13(b) - Pier Height notation



1. Square on level grade – no superelevation •
2. Square on level grade – with superelevation •
3. Square on longitudinal grade – no superelevation •
4. Square on longitudinal grade – with superelevation •
5. Skewed on level grade – no superelevation •
6. Skewed on level grade – with superelevation •
7. Skewed on longitudinal grade – no superelevation •
8. Skewed on longitudinal grade – with superelevation •

Vertical curves

Piers within the limits of a vertical curve will require special consideration in determining Heights, while at the same time ensuring that the DWS thickness is not reduced below the minimum allowed either at the ends or at the centre of the span.

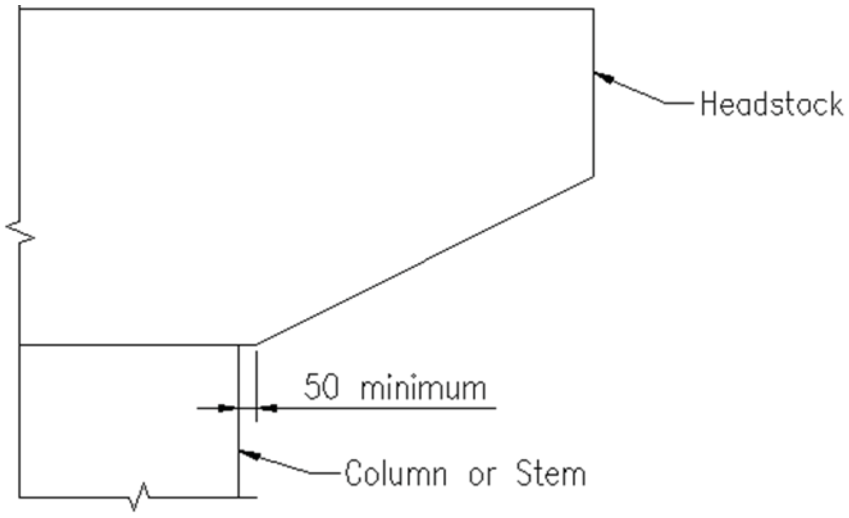
12.14 Tapering of pier headstocks

Tapered pier headstocks – Profile

Pier headstocks that are supported by columns or a solid blade stem are often tapered from the outer column or stem to the end of the headstock.

A 50 mm minimum clearance is required from the column or stem before the taper commences. Refer Figure 12.14(a) *Tapered Pier Headstocks – Profile* for details.

Figure 12.14(a) - Tapered pier headstocks – Profile



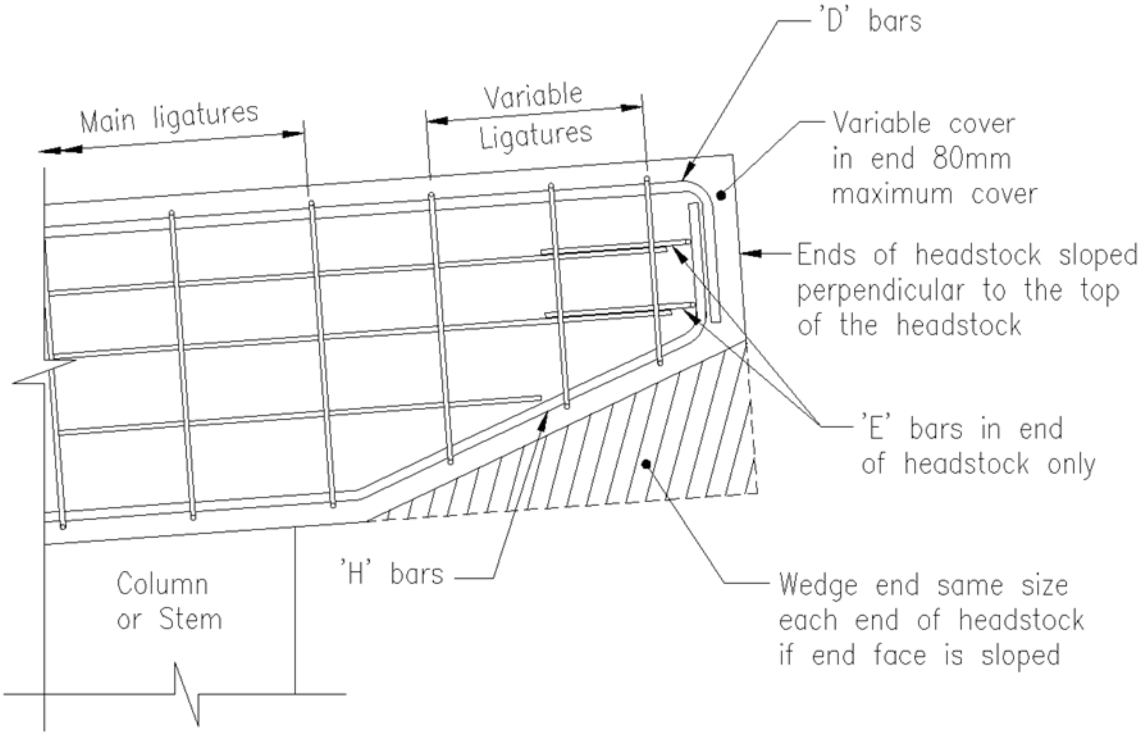
Tapered pier headstocks – Reinforcement

The arrangement of reinforcing steel in tapered pier headstock should be as follows:

- Main headstock bars should assume H or D shape; that is, legs bent at right angles to longitudinal direction of the bar – refer Transport and Main Road's Standard Drawing 1043 *Standard Bar Shapes.*
- Cover may vary at ends up to a maximum of 80 mm.
- Ends of headstock shall be sloped perpendicular to the top of the headstock. This is done so that both tapered ends contain the same shaped reinforcement.

Refer Figure 12.14(b) *Tapered Pier Headstocks – Reinforcement* for details.

Figure 12.14(b) - Tapered pier headstocks – Reinforcement



Stepped pier headstocks

A pier headstock will be stepped when it supports PSC deck units or PSC girders of different depths on adjacent spans. The depth of the step shall be calculated to ensure that the top of the PSC components align. Refer Appendix B *Example Pier Drawings – Sheet 1*.

12.15 Alignment of elastomeric bearings

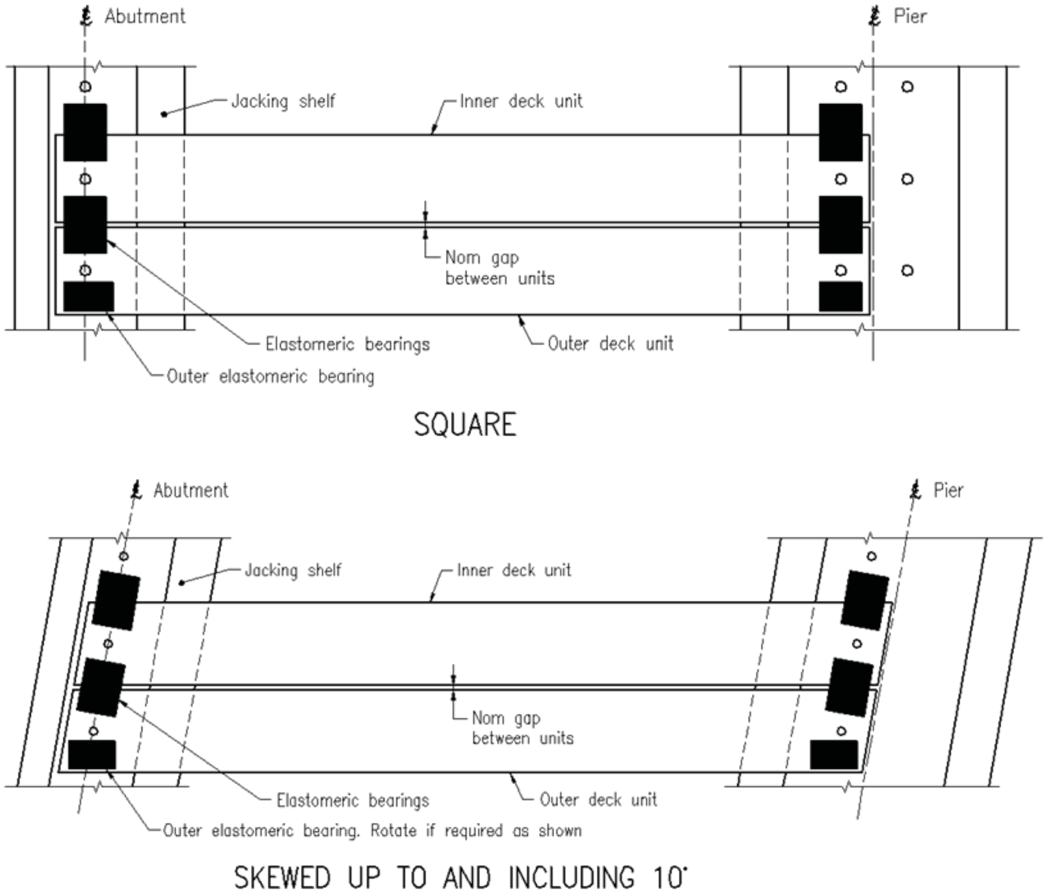
Alignment of bearings on deck unit bridges

On square bridges, and those skewed up to and including 10° and have a maximum nominal gap of 40 mm between each deck unit, bearings shall be positioned parallel to the headstock. Refer Figure 12.15(a) *Alignment of Bearings on Deck Unit Bridges Skewed ≤10°*.

The bearings shall also be positioned between the deck unit holding down bolts so that the bearings are loaded by the two adjacent deck units. Placing the bearings between the holding down bolts rather than in front of them allows for a substantial reduction of the headstock width.

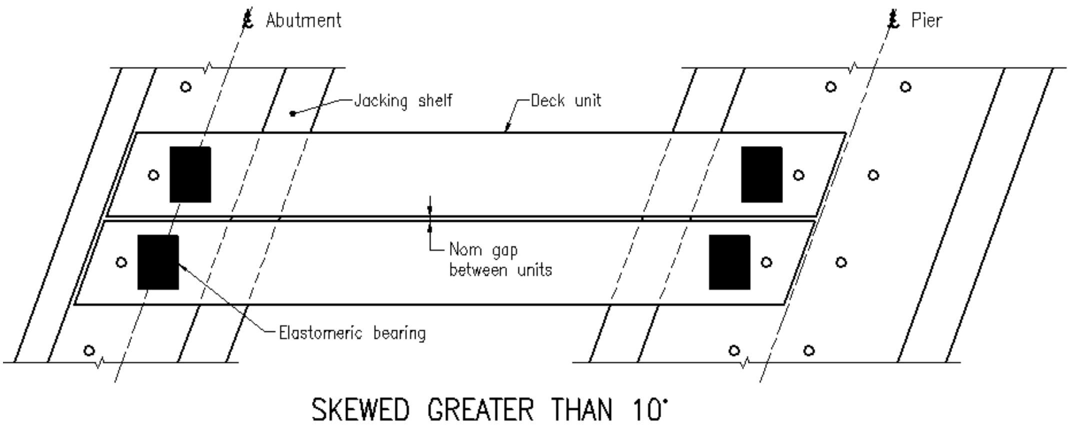
Smaller bearings (typically a non-standard size), are placed under the outer deck units. Because of the limited space available to position these bearings, they need not be parallel with the headstock. If the small outer bearings cannot accommodate the forces applied by a composite deck and/or long span lengths, the method of positioning all of the bearings for a bridge skewed more than 10° should be used.

Figure 12.15(a) - Alignment of bearings on deck unit bridges skewed ≤10°



On bridges skewed more than 10° or bridges that have a nominal gap between the deck units greater than 40 mm, the bearings shall be positioned in front of the deck unit holding down bolt holes, and square to the longitudinal axis of the deck unit. They are positioned in this manner to avoid unequal loading of each half of the bearing which would happen if it was positioned between the deck units. Refer Figure 12.15(b) *Alignment of Bearings on Deck Unit Bridges Skewed >10°*.

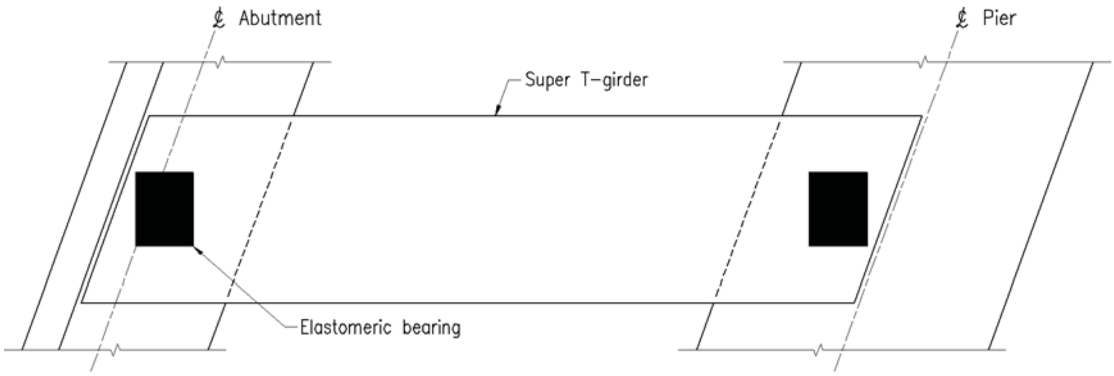
Figure 12.15(b) - Alignment of bearings on deck unit bridges skewed >10°



Alignment of bearings on Super T-girder bridges

At all joints, elastomeric bearings shall be parallel with the girders. This allows for rationalisation of both the drawings and construction of the girders. Refer Figure 12.15(c) *Alignment of Bearings on Girder Bridges*.

Figure 12.15(c) - Alignment of bearings on girder bridges



12.16 Provision for bridge jacking

Deck unit bridges

Abutment and pier headstocks of a deck unit bridge must incorporate jacking shelves wherever there are elastomeric bearings or bearing strips. Provision must be made to jack the span and replace the bearings. The shelf will also be used to support temporary packers when the bearings are being installed.

Typically the shelf shall be 250 mm deep and 325 mm wide. To stop the edge of the jacking shelf from breaking away during jacking, the jack must sit at least 175 mm from the side of the headstock.

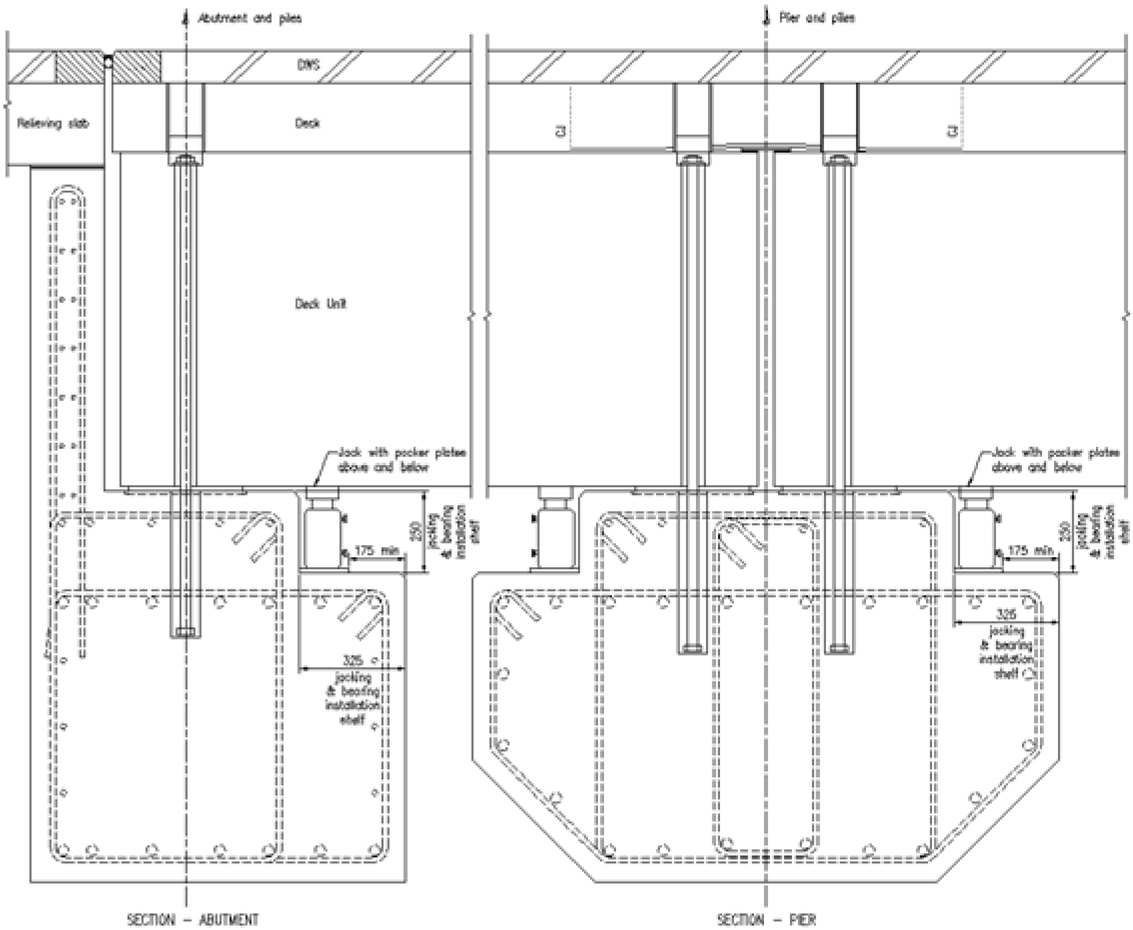
Similarly, the bearing must sit at least 175 mm from the edge of the bearing shelf on a square bridge. On a skewed bridge this distance may be reduced because only one corner of the bearing is not within tolerance.

Elastomeric bearings are used on a headstock in following instances:

- bridges with an insitu reinforced concrete deck always sit on elastomeric bearings; the expansion joint end of a span always sits on elastomeric bearings
- deck units 21 m long or greater always sit on elastomeric bearings, even if there is no concrete deck and/or expansion joint.

For further details refer Figure 12.16(a) *Headstock Jacking Shelf Details* and Chapter 13 *Provision for Bridge Jacking, Inspection and Maintenance*.

Figure 12.16(a) - Headstock jacking shelf details



Girder bridges

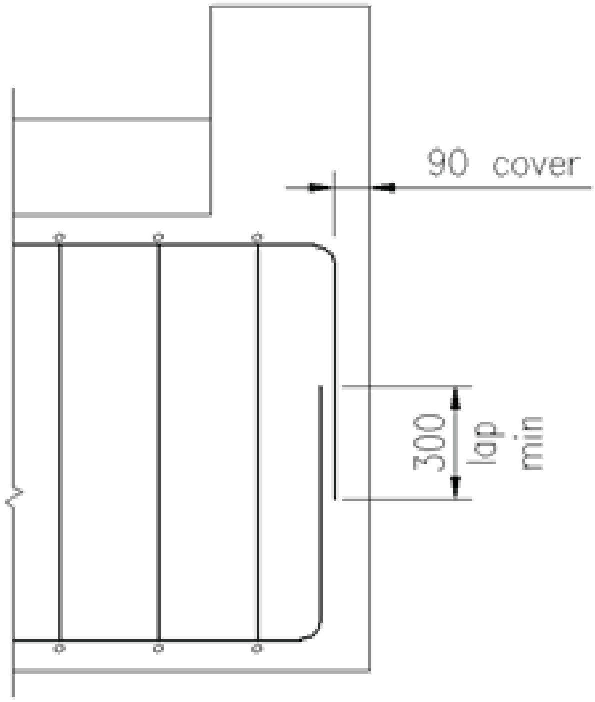
Girders always sit on bearings rather than cement mortar seating, therefore provision must be made for jacking to replace the bearings.

12.17 Reinforcement

Cover to ends of abutment headstocks

The main reinforcement in abutment headstocks shall have 90 mm of cover at the ends of the headstock to allow room for the wingwall reinforcement to bond into the headstock. If the concrete cover is more than 60 mm, the 90 mm of cover at the ends will need to be increased accordingly. The cover is unusually large to allow for fitment of the wingwall reinforcement. Refer Figure 12.17(a) *Cover at Ends of Abutment Headstocks*.

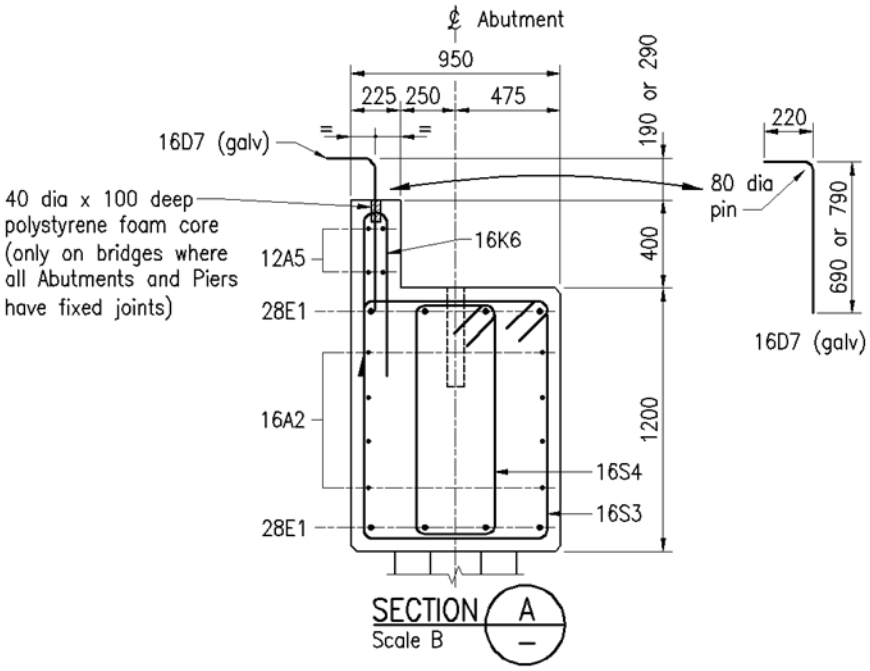
Figure 12.17(a) - Cover at ends of abutment headstocks



Relieving slab starter bars

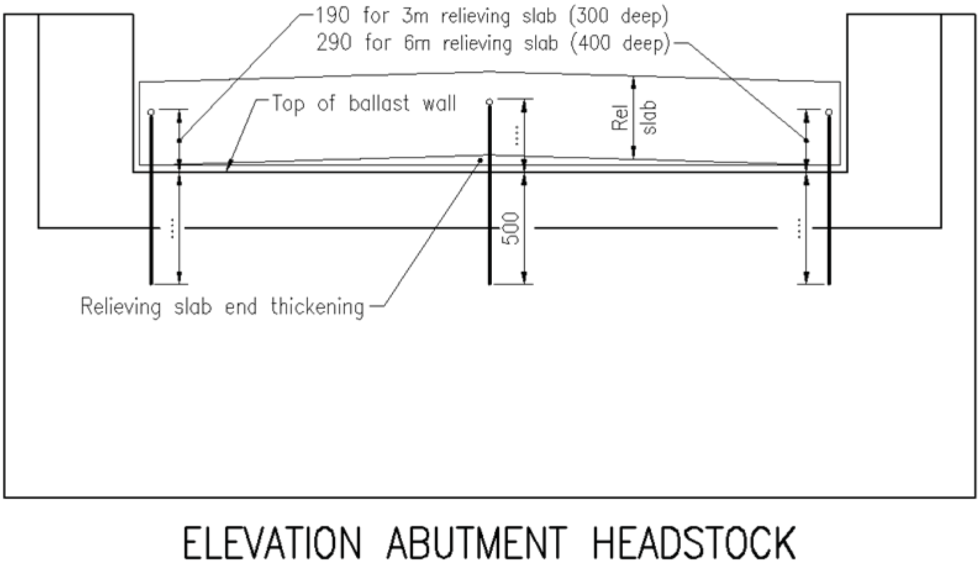
All starter bars for relieving slabs are to be hot dip galvanised to AS/NZS 4680 and spaced at 200 mm centres. A dimension must be given to the top of the bar from the top of the ballast wall. For 3 m span (300 mm deep) relieving slabs the bars shall protrude 190 mm. For 6 m span (400 mm deep) relieving slabs the bars shall protrude 290 mm. In both cases the bars shall bond 500 mm into the ballast wall. Refer Figure 12.17(b) *Relieving Slab Starter Bars*.

Figure 12.17(b) - Relieving slab starter bars



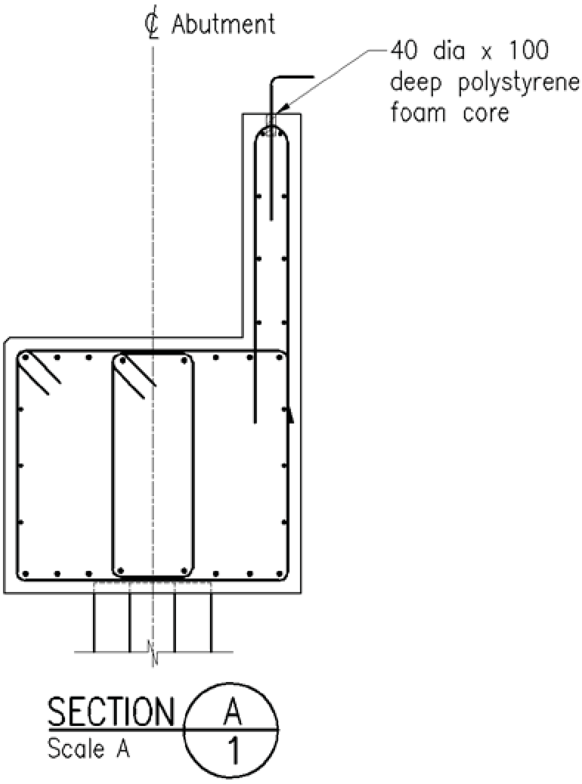
If the bridge deck has crossfall both ways from the bridge centreline and the abutment ballast wall ignores the crossfall, the relieving slab will require end thickening. The highest bar and lowest bars must be dimensioned on the abutment drawing. The starter bars shall all be the same size and shall be bonded a minimum of 500 mm into the ballast wall. Refer Transport and Main Road's Standard Drawings 1505 and 1506 and Figure 12.17(c) *Variable Relieving Slab Starter Bars*.

Figure 12.17(c) - Variable relieving slab starter bars



A deck unit bridge that does not have an expansion joint must have a 40 mm diameter x 100 mm deep polystyrene foam core to be placed around every starter bar. Refer Figure 12.17(d) *Relieving Slab Starter Bar Polystyrene Foam Core*.

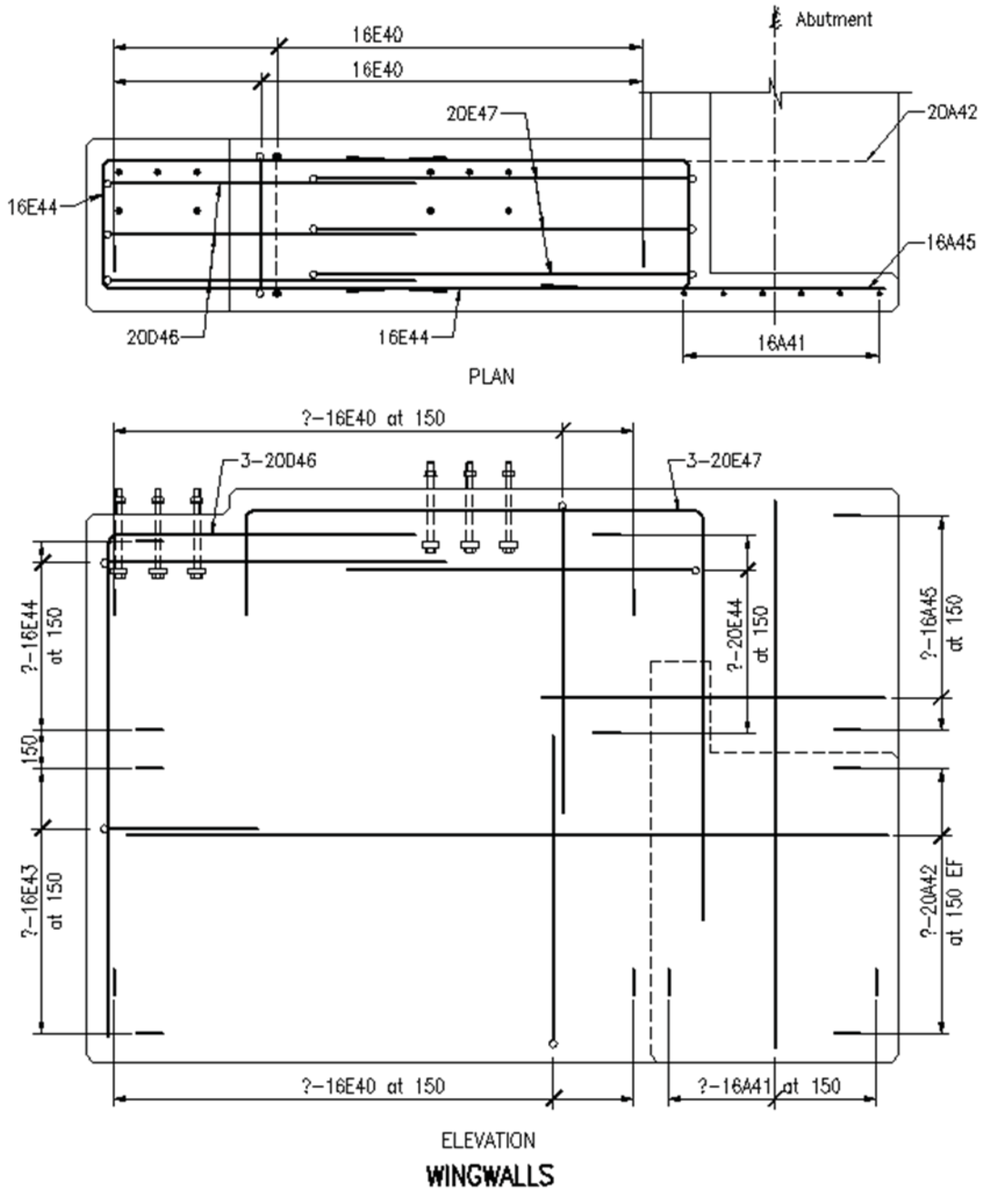
Figure 12.17(d) - Relieving slab starter bar polystyrene foam core



Wingwall reinforcement (bridge steel traffic barrier type)

Sample reinforcing details are supplied for reference in Figure 12.17(e) *Wingwall Reinforcement Details (Bridge Steel Traffic Barrier Type)*. Project specific designs are required to be assessed and certified for each project.

Figure 12.17(e) - Wingwall reinforcement details (bridge steel traffic barrier type)

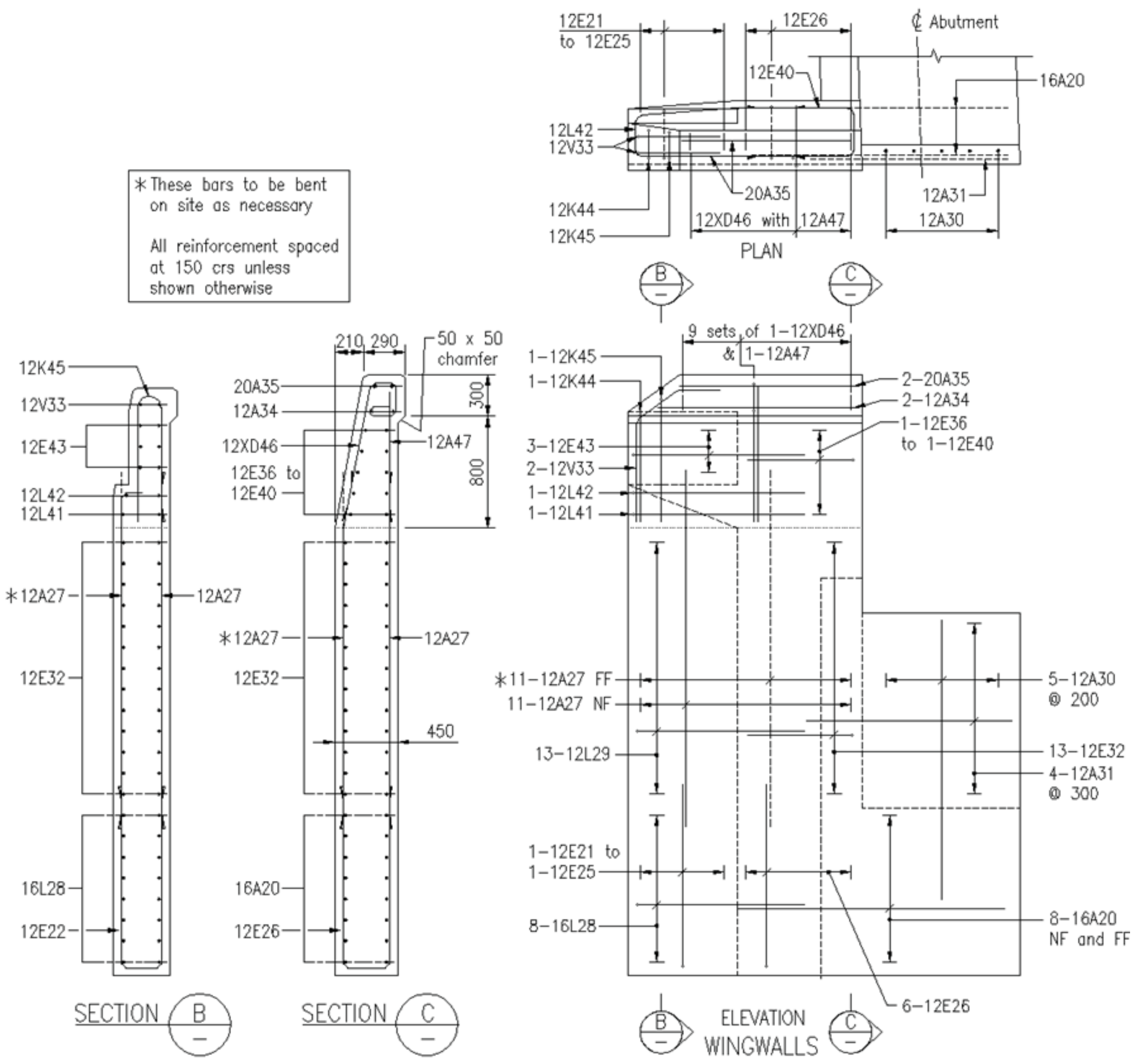


Wingwall reinforcement (concrete traffic barrier type)

The bar size and spacing of reinforcing steel is standard with the number and length of bars depending on the height, width and length of the wingwalls.

Refer Figure 12.17(f) *Wingwall Reinforcement Details (Concrete Traffic Barrier Type)* for an example of the details required on an abutment drawing. Note that this incorrectly shows the transition in barrier height at approximately one on one. It should be one on 10.

Figure 12.17(f) - Wingwall reinforcement details (concrete traffic barrier type)

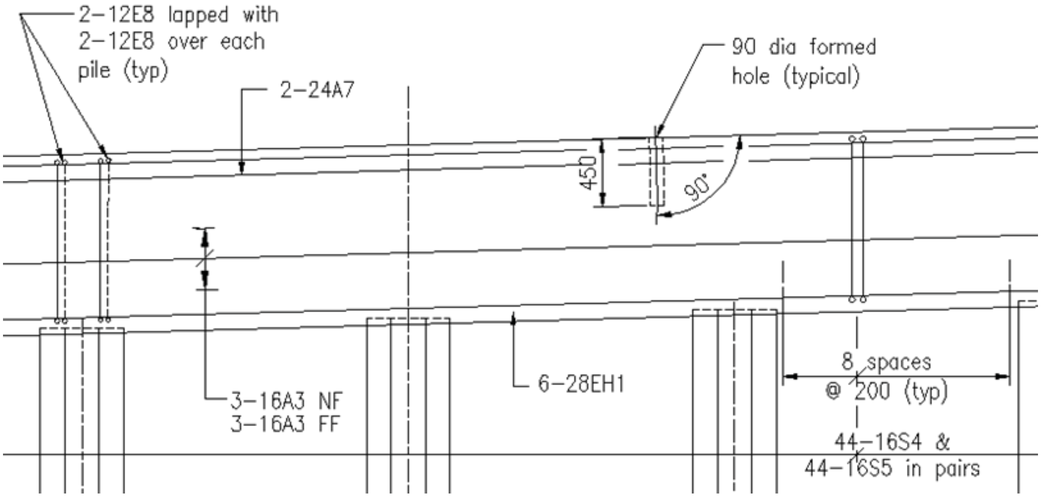


Reinforcement over piles

The designer is to determine the number, diameter and shapes of shear reinforcement over piles considering the ease of fitment of bars.

The minimum cover to the reinforcing from the headstock / pilecap soffit shall be 80 mm.

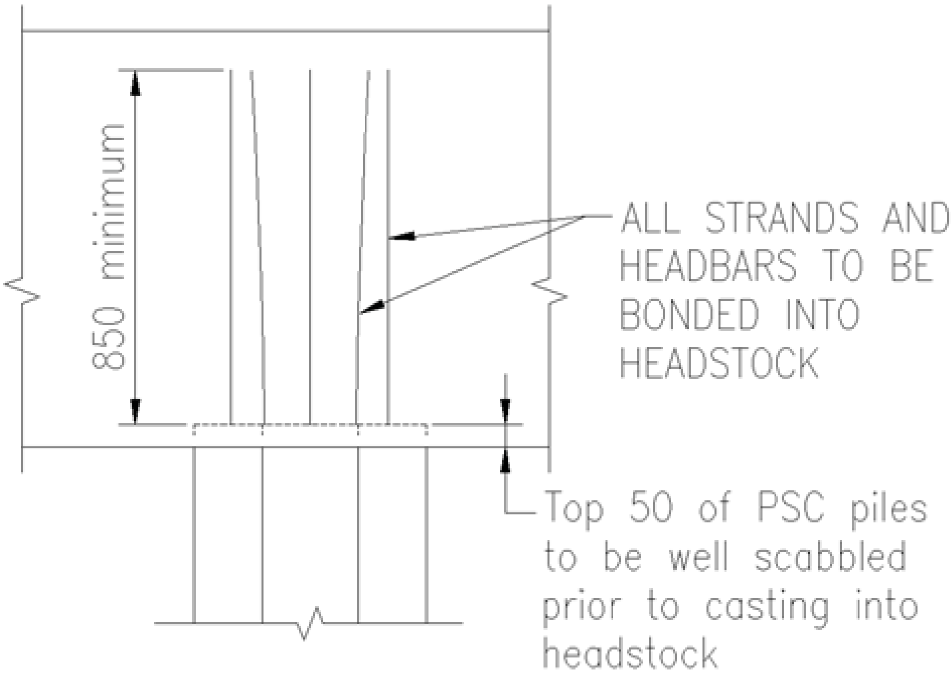
Figure 12.17(g) - Reinforcement over piles



Bonding of PSC pile steel

PSC pile steel must be bonded into the headstock / pilecap. The bond length shall be shown on the drawings. The top of the pile shall be cut away to a height which allows 50 mm of penetration of the pile. To emphasise the importance of the pile steel bonding into the headstock / pilecap, a separate detail shall be included on the drawing. Refer Figure 12.17(h) for an example of *PSC Pile Bond Detail*.

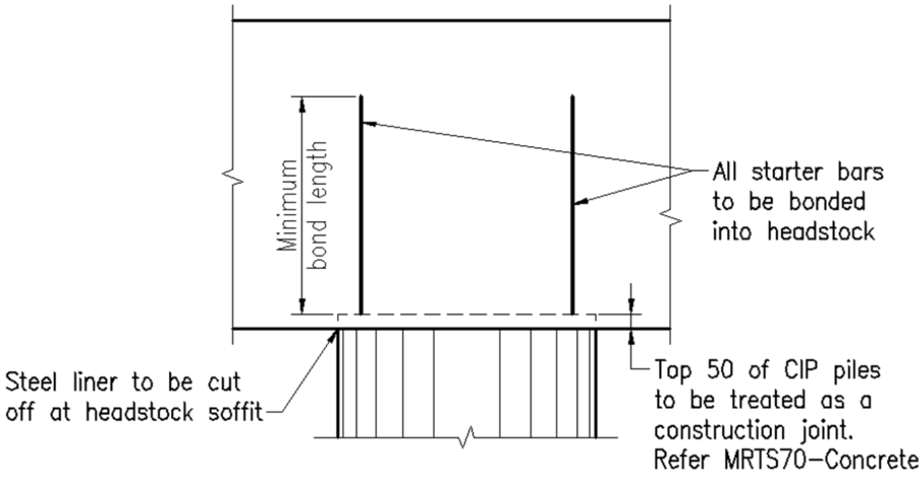
Figure 12.17(h) - PSC pile bond detail



Bonding of Cast-in Place (CIP) pile steel

CIP pile steel must be bonded into the headstock / pilecap. The bond length shall be the minimum standard lap distance for the bar diameter in question and shall be shown on the drawing. The top of the pile shall be cast 50 mm into the headstock / pilecap. The steel liner must be cut off at the headstock / pilecap soffit to expose the top 50 mm of pile. The top of the concrete shall be treated as a construction joint. Refer MRTS70 *Concrete*.

Figure 12.17(i) - Cast-in Place pile bond detail



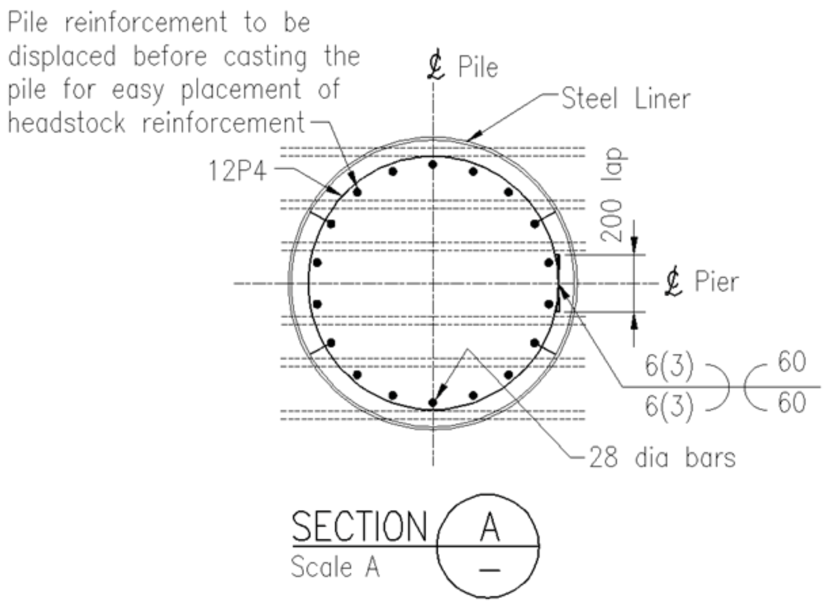
Bonding of column / stem / blade steel

Column / stem / blade starter bar steel must be bonded into the headstock / pilecap. The bond shall be shown on the drawing. The top of the column / stem / blade concrete shall be cast 50 mm into the headstock / pilecap. The top of the concrete shall be treated as a construction joint. Refer MRTS70 *Concrete*.

Cast-in Place pile reinforcement displacement

It may be difficult for the headstock / pilecap reinforcement to be placed when there is a lot of pile steel in the way. To make the builders aware of the potential problem, the main bars of the headstock / pilecap shall be shown in the pile section detail with a note that the pile steel may be displaced before the pile is cast. Refer Figure 12.17(j) for an example of *Cast-in Place Pile Reinforcement Displacement Detail.*

Figure 12.17(j) - Cast-in Place pile reinforcement displacement detail



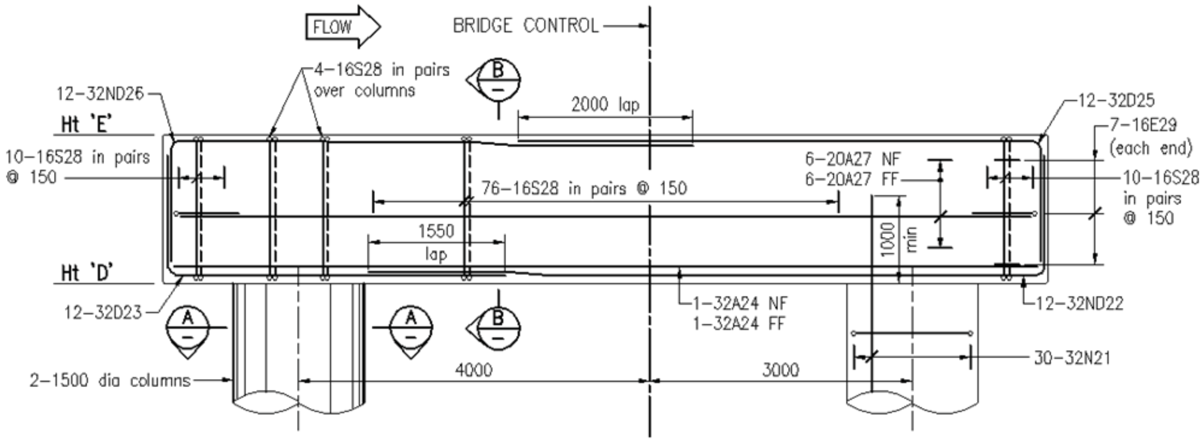
Lap position of main reinforcement in headstock / pilecap

The laps of the main reinforcing bars are to be positioned where the concrete is in compression rather than tension. Refer Figure 12.17(k) *Lap Positions*.

The position in the lower face shall be as close as practical to the piles / columns / stem, while ensuring the lap is located away from the congestion of the starter bar reinforcement.

The position in the upper face shall be midway between the piles / columns.

Figure 12.17(k) - Lap positions

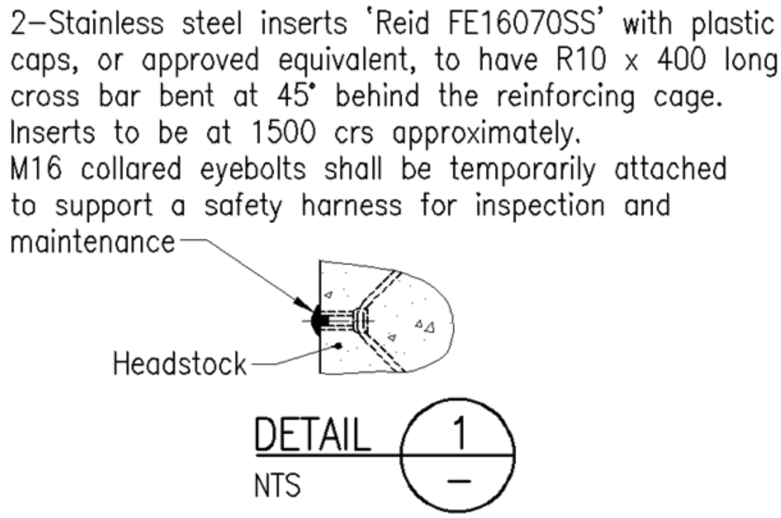


12.18 Inserts for safety harness attachment

Inserts may need to be cast into the abutment headstock to allow for attachment of a safety harness. For requirement guidelines refer Chapter 13 – *Provision for Bridge Jacking, Inspection and Maintenance*, *13.7 Abutment Protection*.

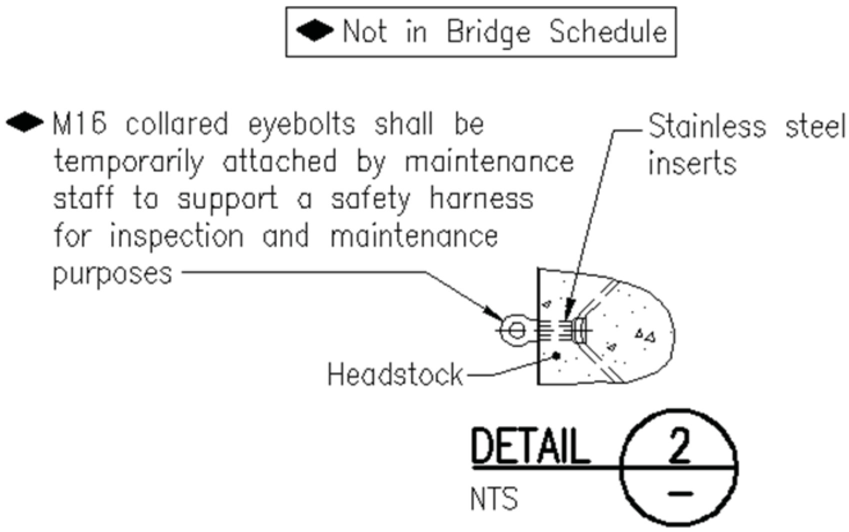
If inserts are required, the details shown in Figure 12.18(a) *Insert Details at Abutments* shall be shown on the abutment drawing.

Figure 12.18(a) - Insert details at abutments



The details shown in Figure 12.18(b) *Eyebolt Details* shall be shown on the maintenance and inspection drawings. It refers back to the abutment drawing for the insert details.

Figure 12.18(b) - Eyebolt details



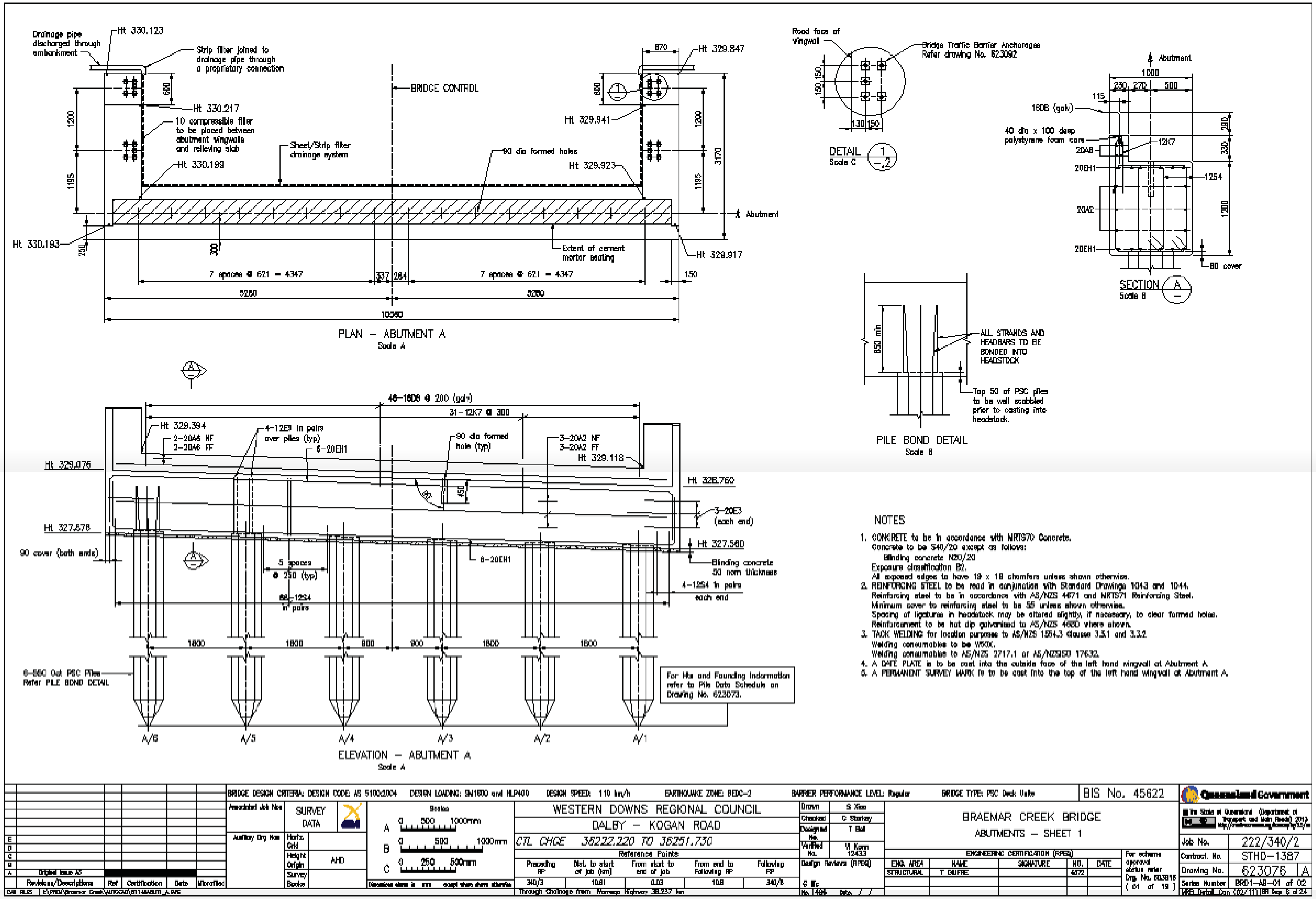
12.19 Abutment protection

Abutments form the transition from bridge deck to the road embankment. The embankment is protected against scour and erosion by the abutment protection. For design criteria and general notes for the various abutment protection types refer Transport and Main Road's Standard Drawings 2232 to 2242 and Chapter 13 *Provision for Bridge Jacking, Inspection and Maintenance*.

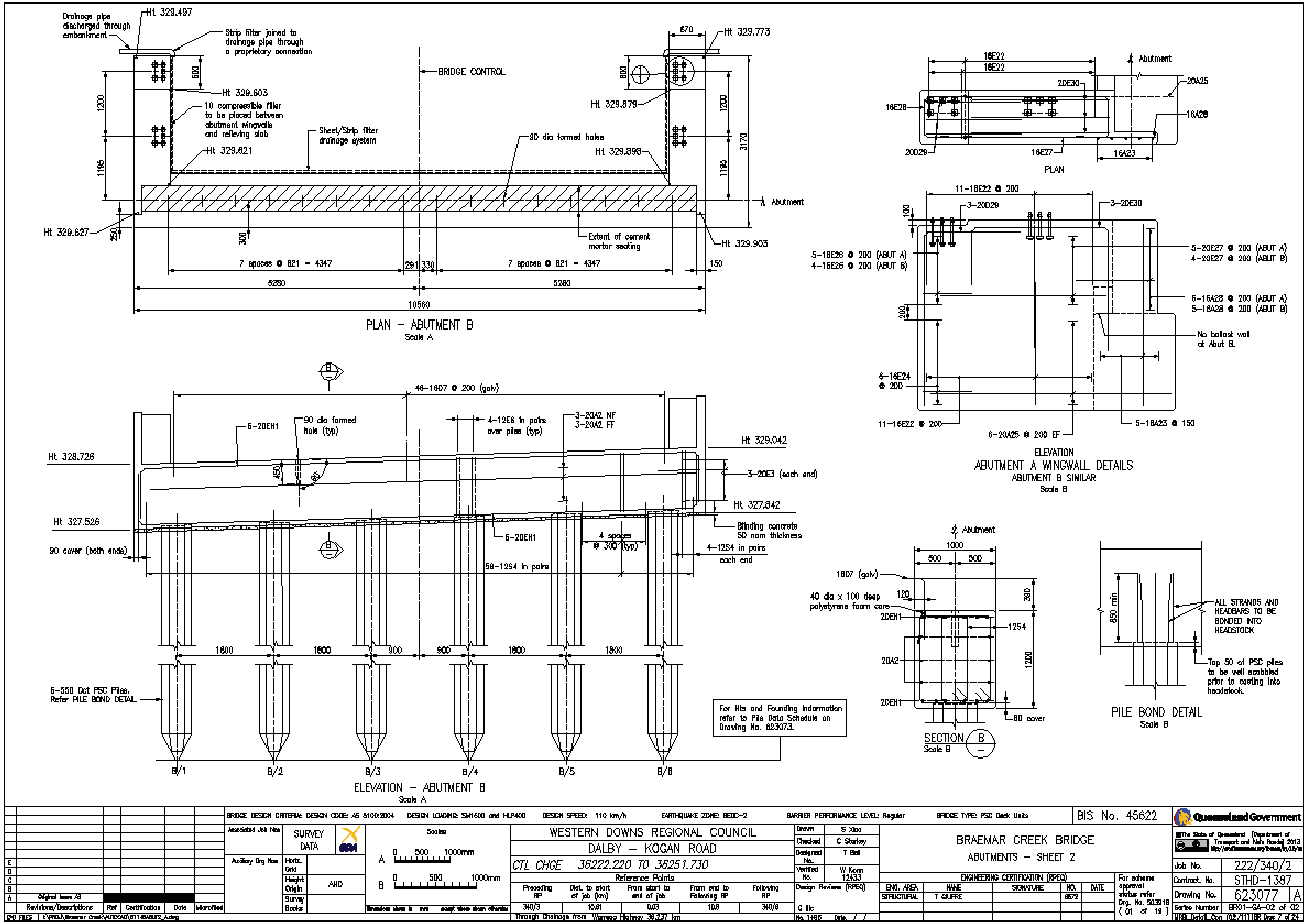
For an explanation of the details required on the General Arrangement drawings refer Chapter 11 - *General Arrangement Drawings, Detailed Design General Arrangement Drawings*.

Appendix A – Example Abutment Drawings

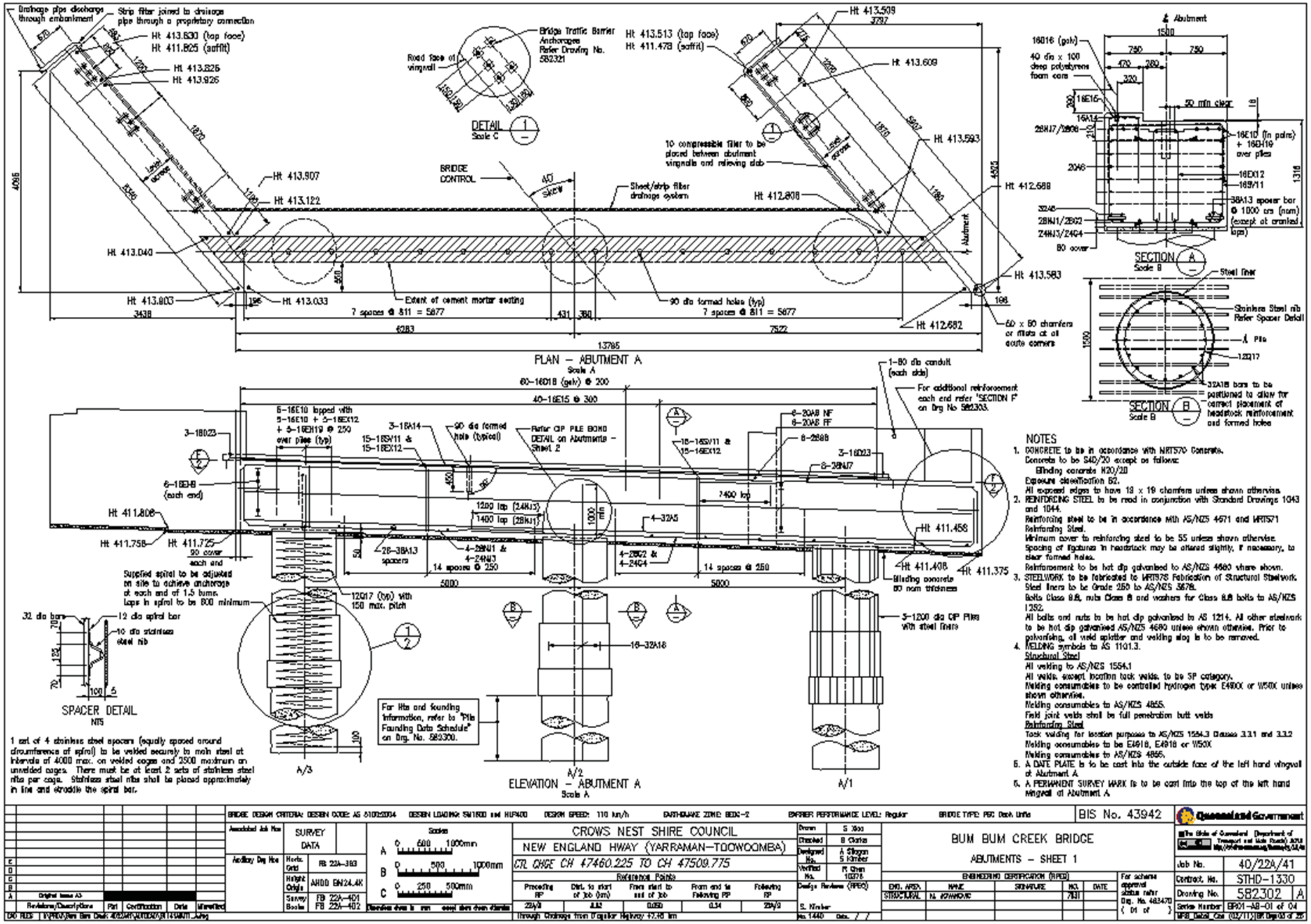
Appendix A - Example Abutment Drawings – Sheet 1



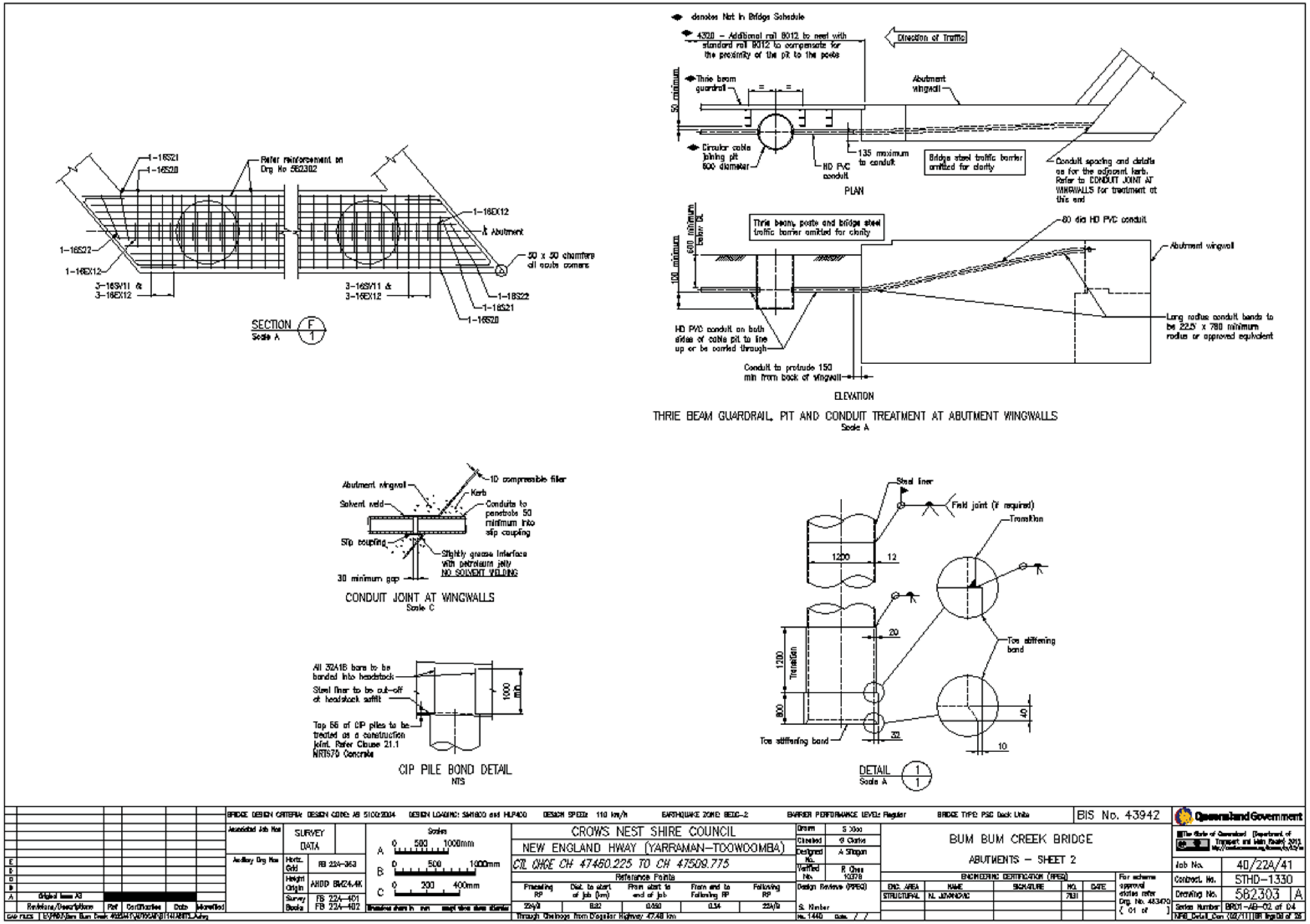
Appendix A - Example Abutment Drawings – Sheet 2



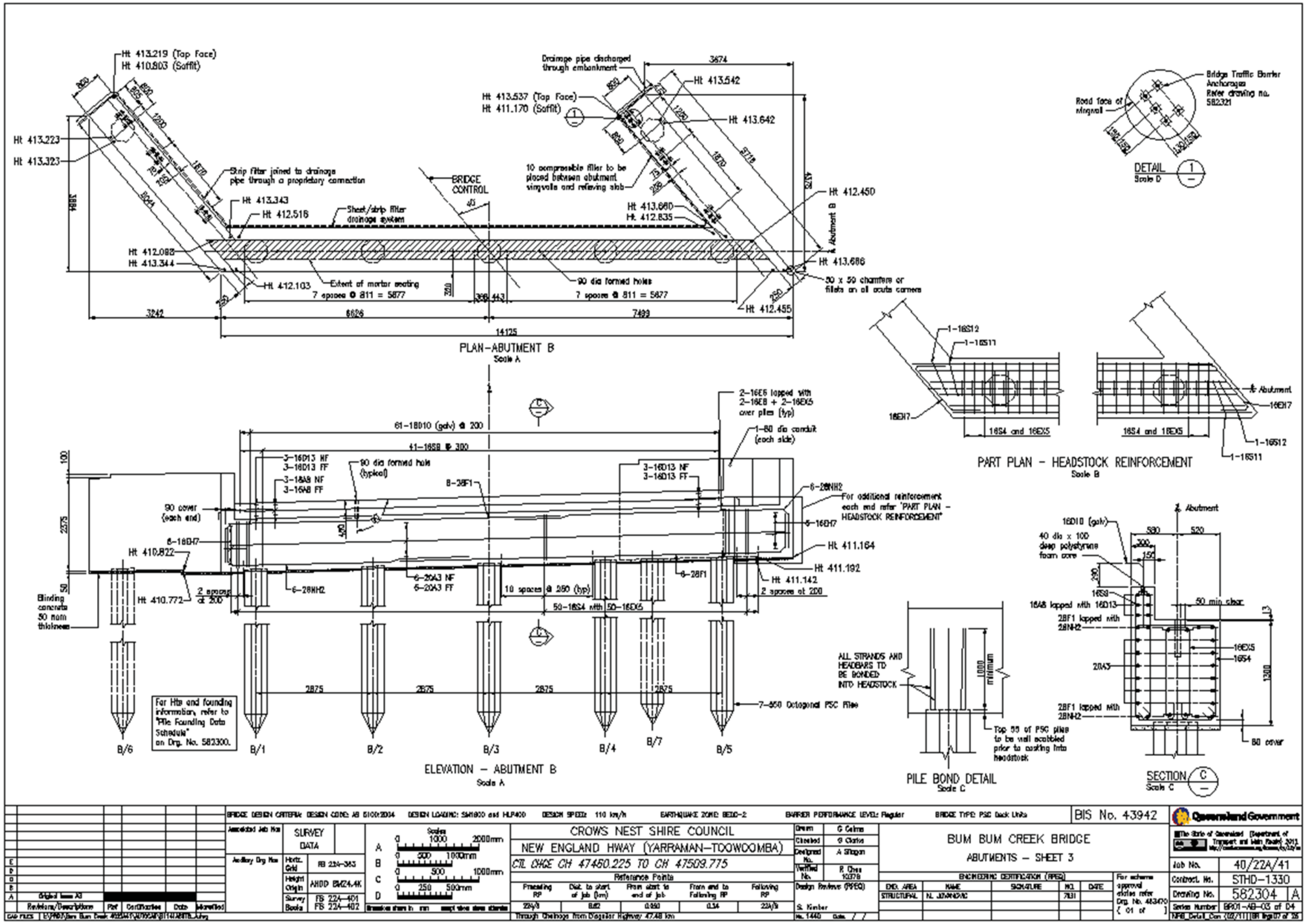
Appendix A - Example Abutment Drawings – Sheet 3



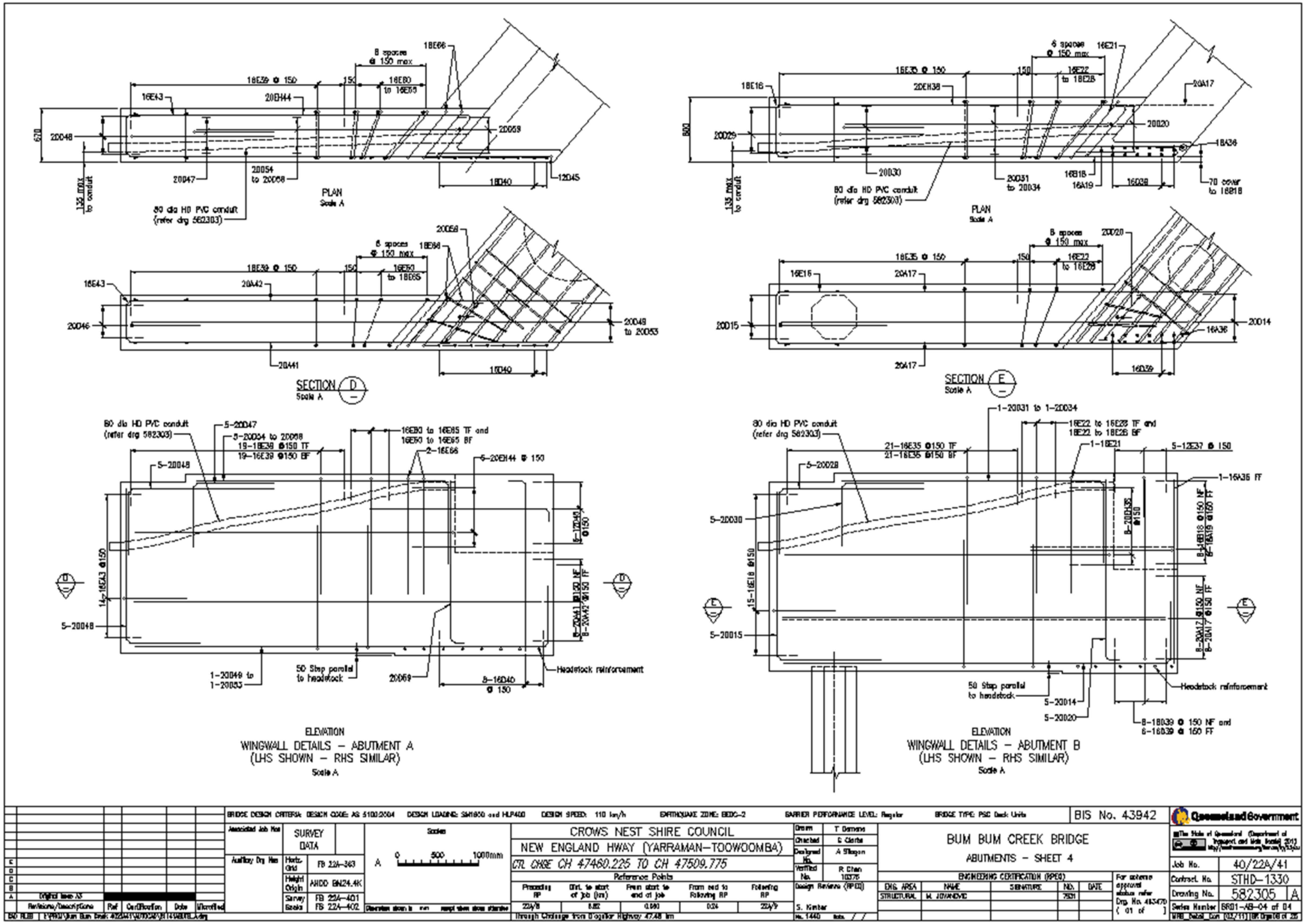
Appendix A - Example Abutment Drawings – Sheet 4



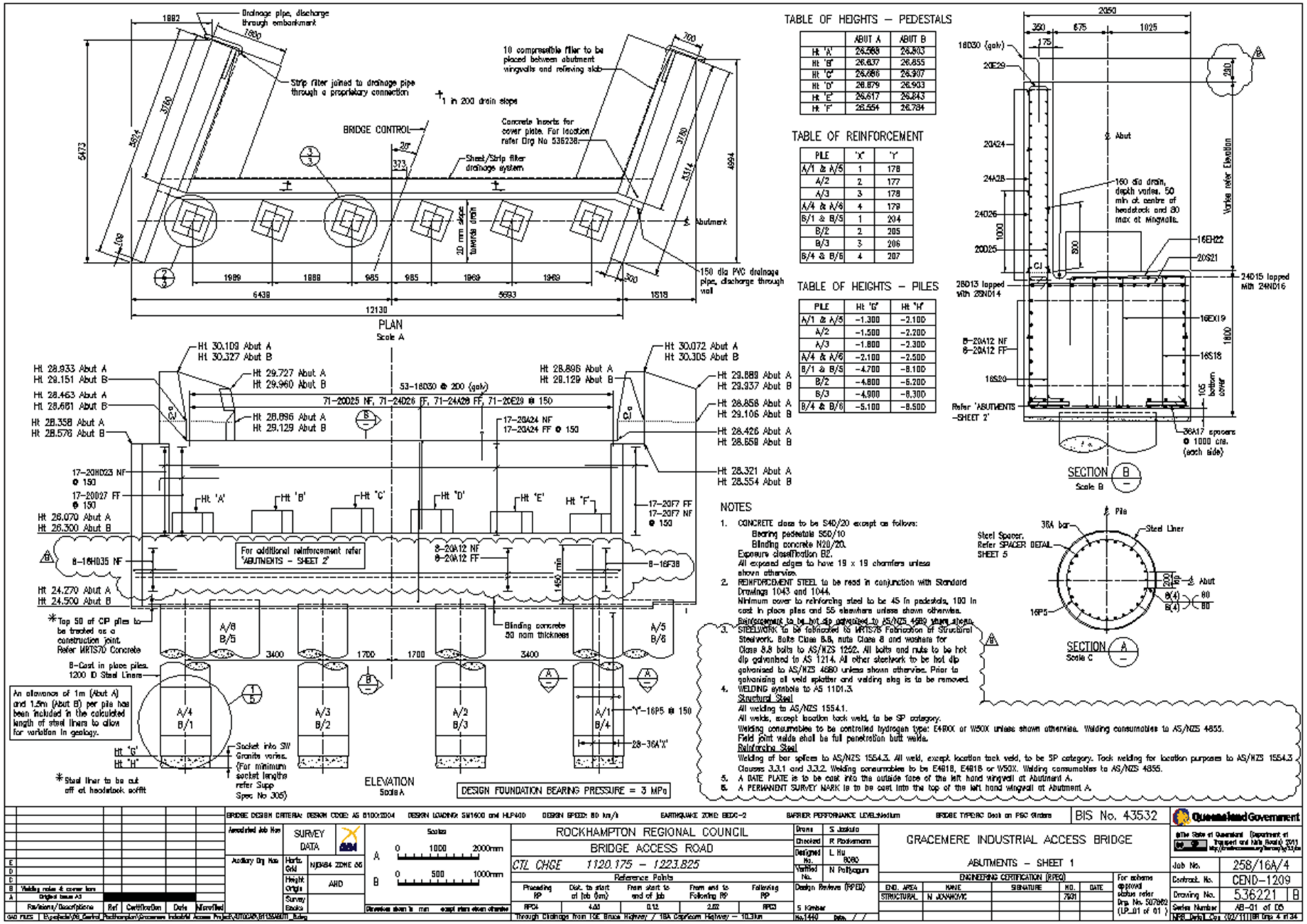
Appendix A - Example Abutment Drawings – Sheet 5



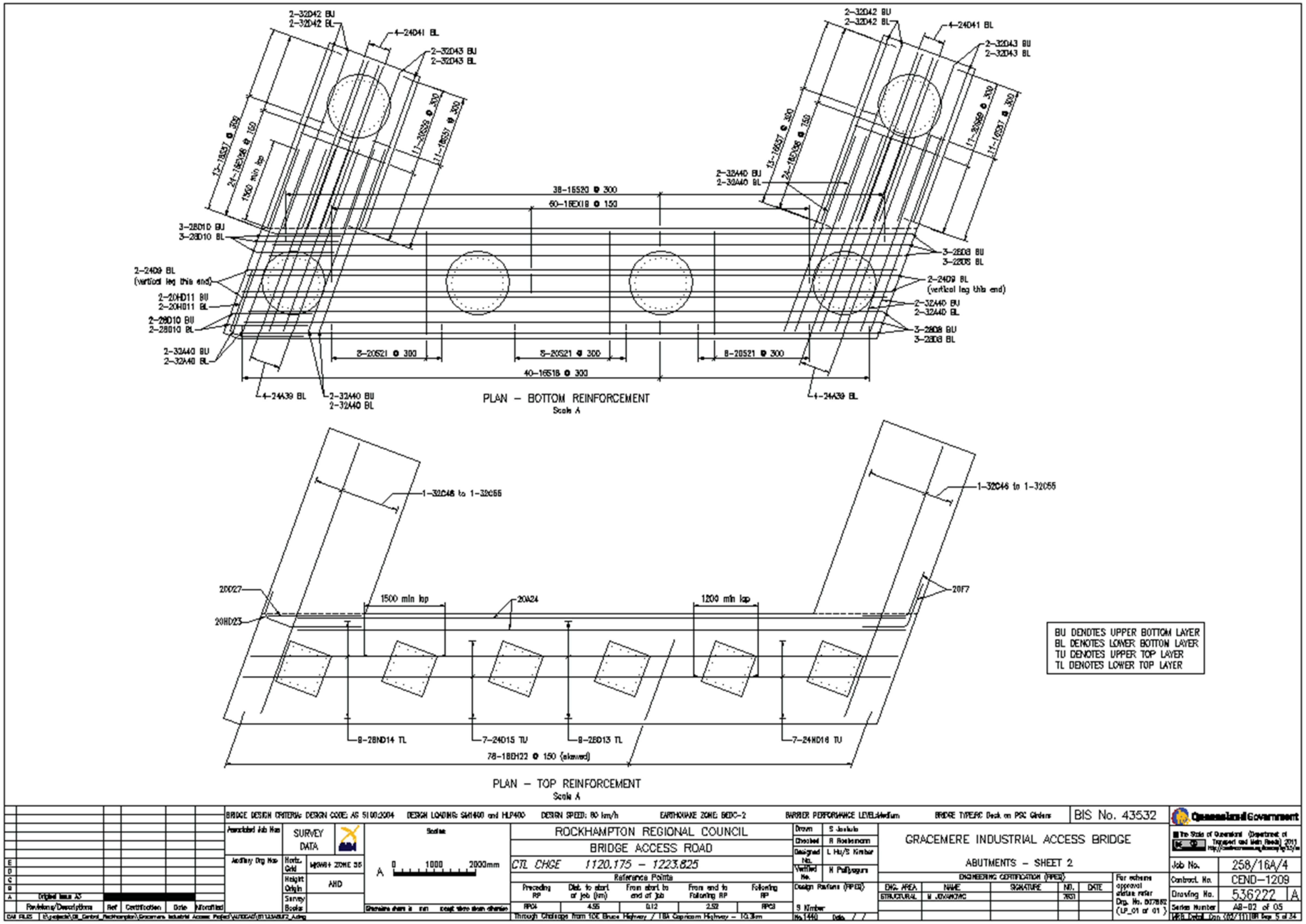
Appendix A - Example Abutment Drawings – Sheet 6



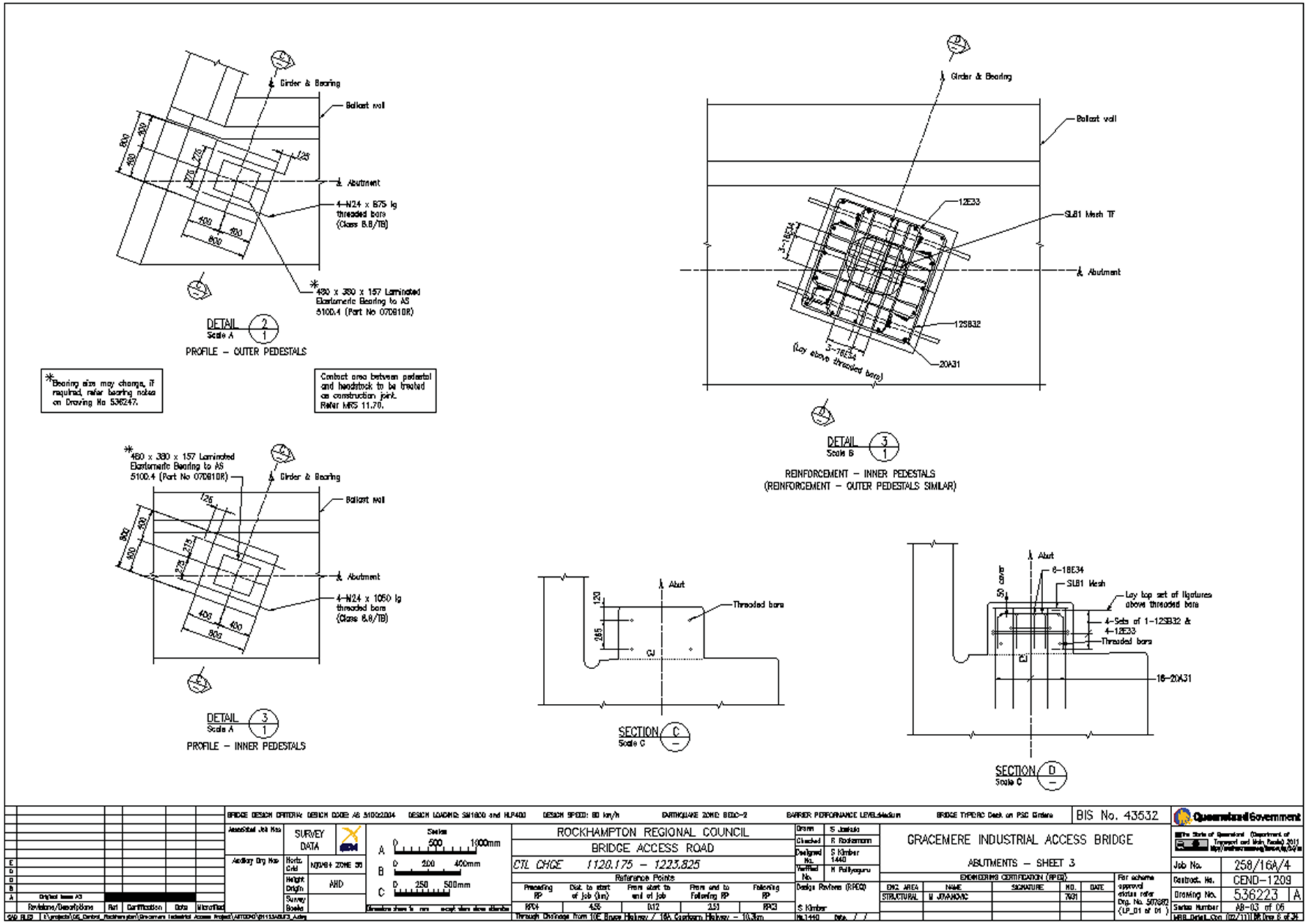
Appendix A - Example Abutment Drawings – Sheet 7



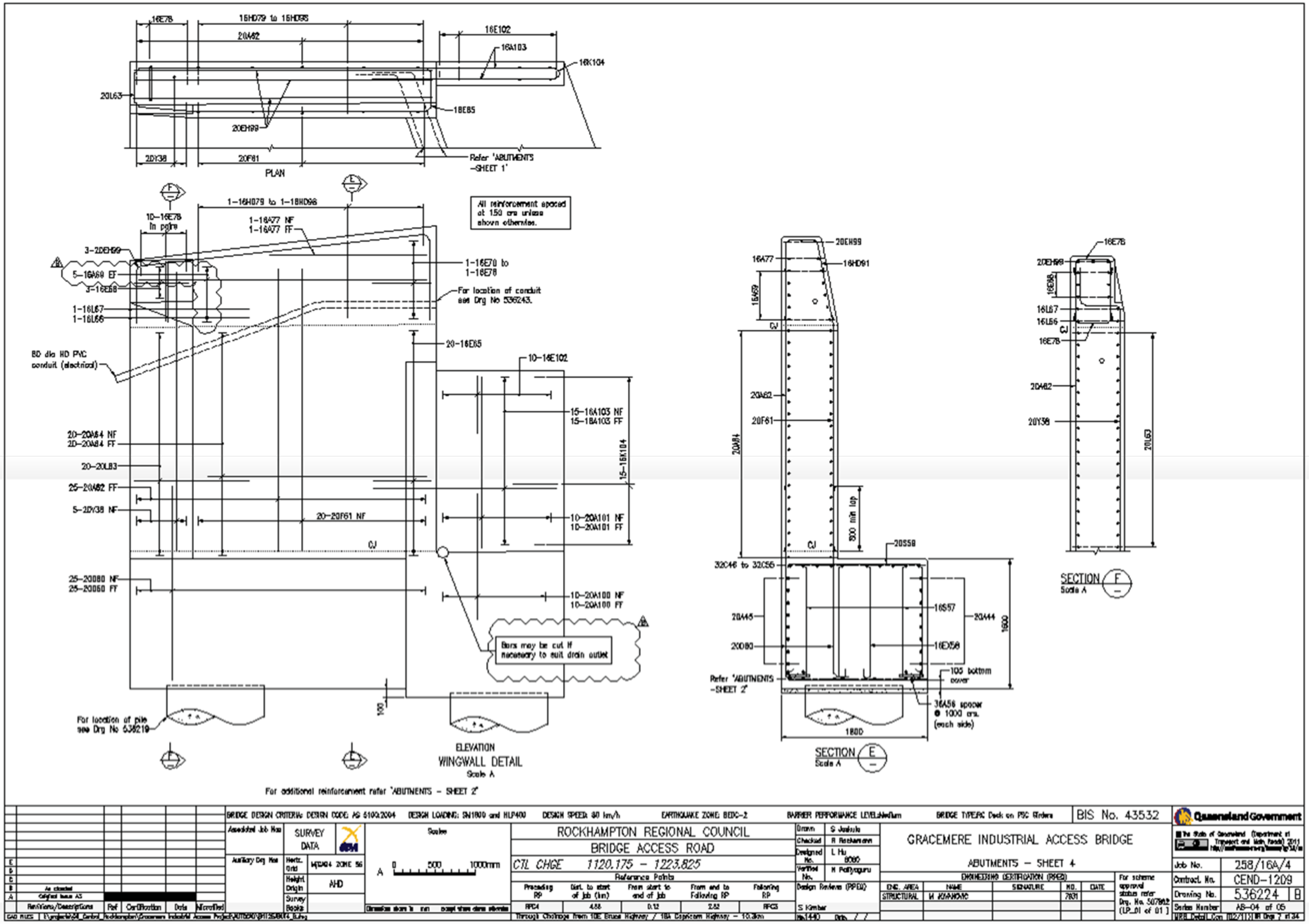
Appendix A - Example Abutment Drawings – Sheet 8



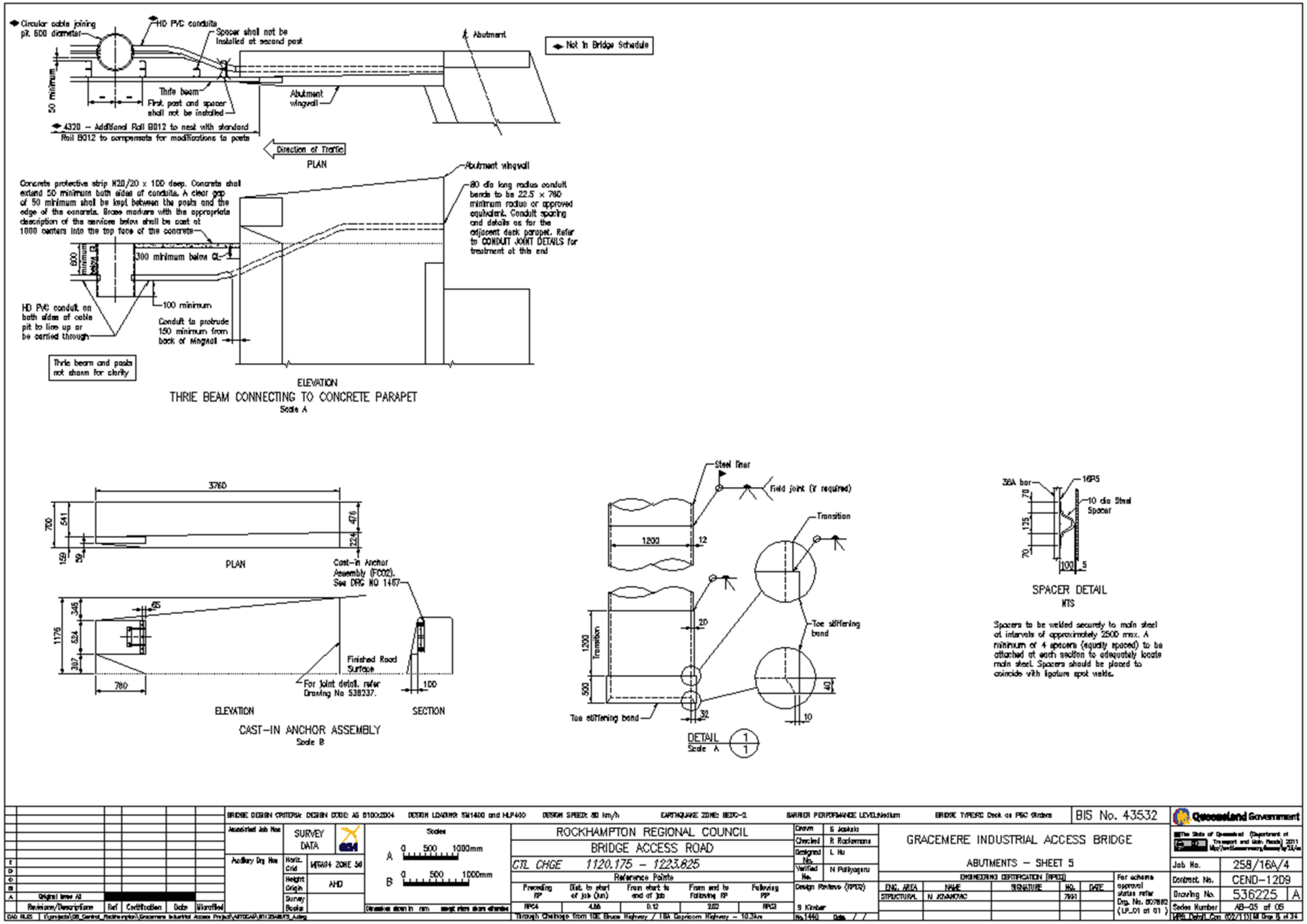
Appendix A - Example Abutment Drawings – Sheet 9



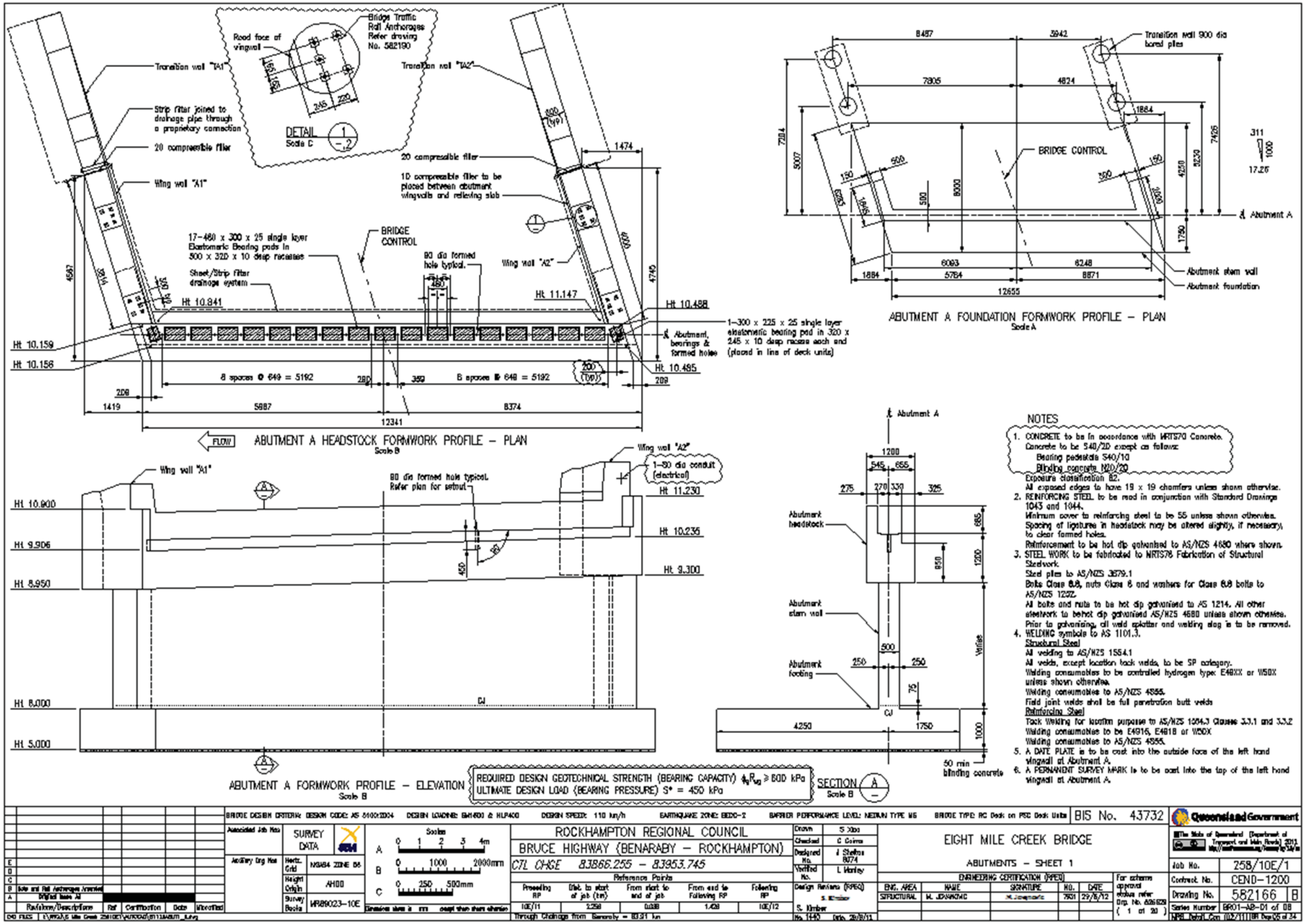
Appendix A - Example Abutment Drawings – Sheet 10



Appendix A - Example Abutment Drawings – Sheet 11



Appendix A - Example Abutment Drawings – Sheet 12



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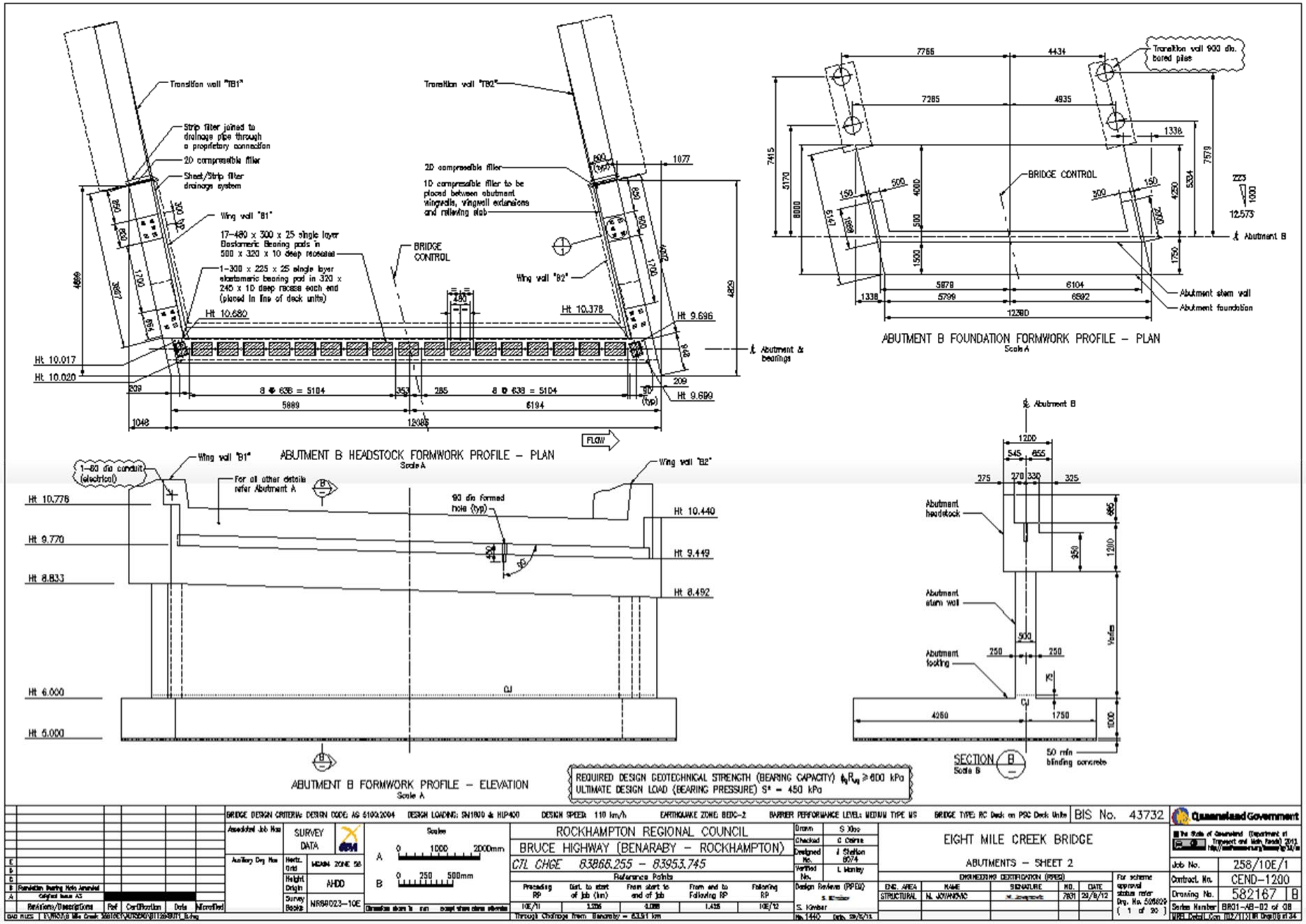

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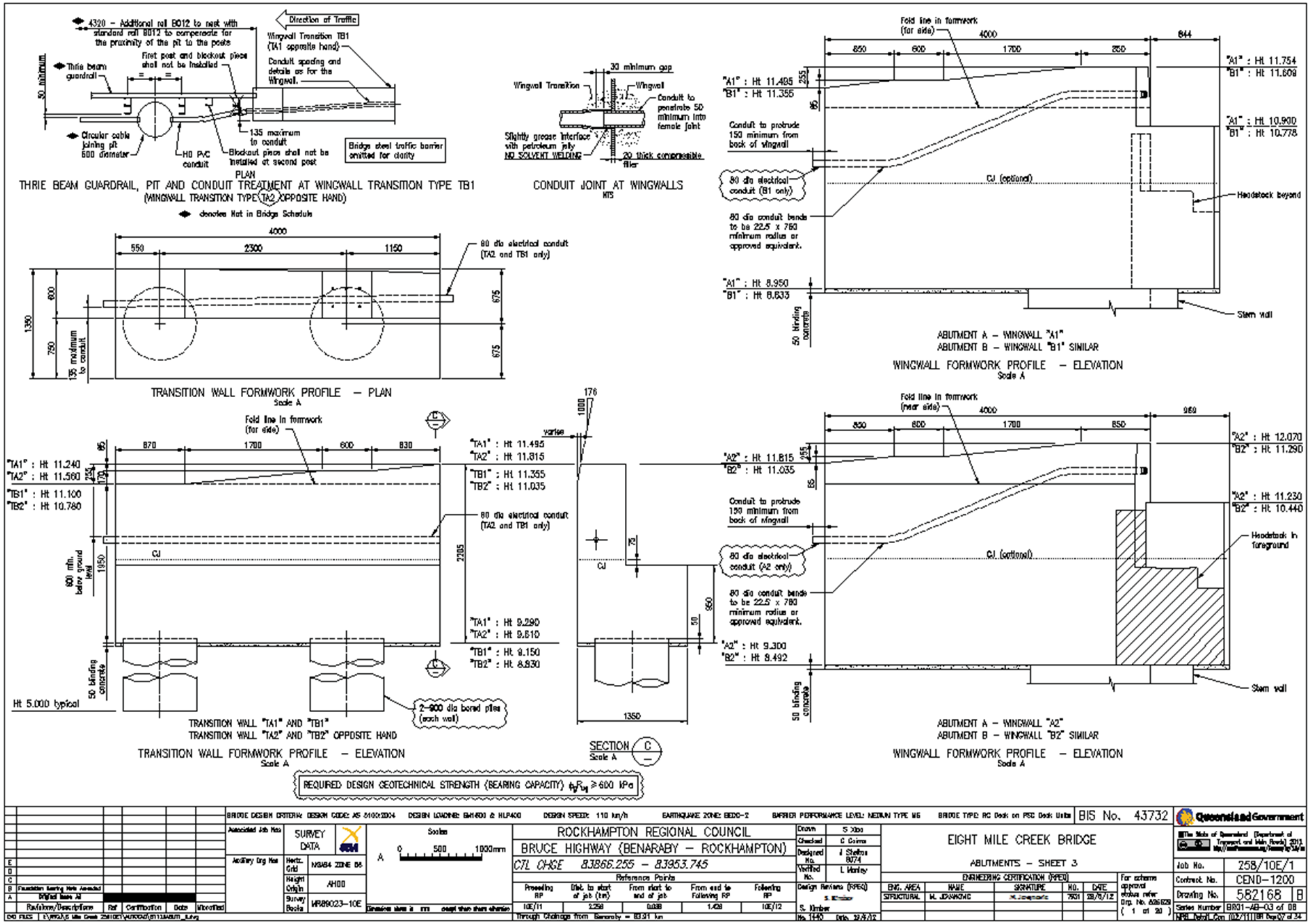

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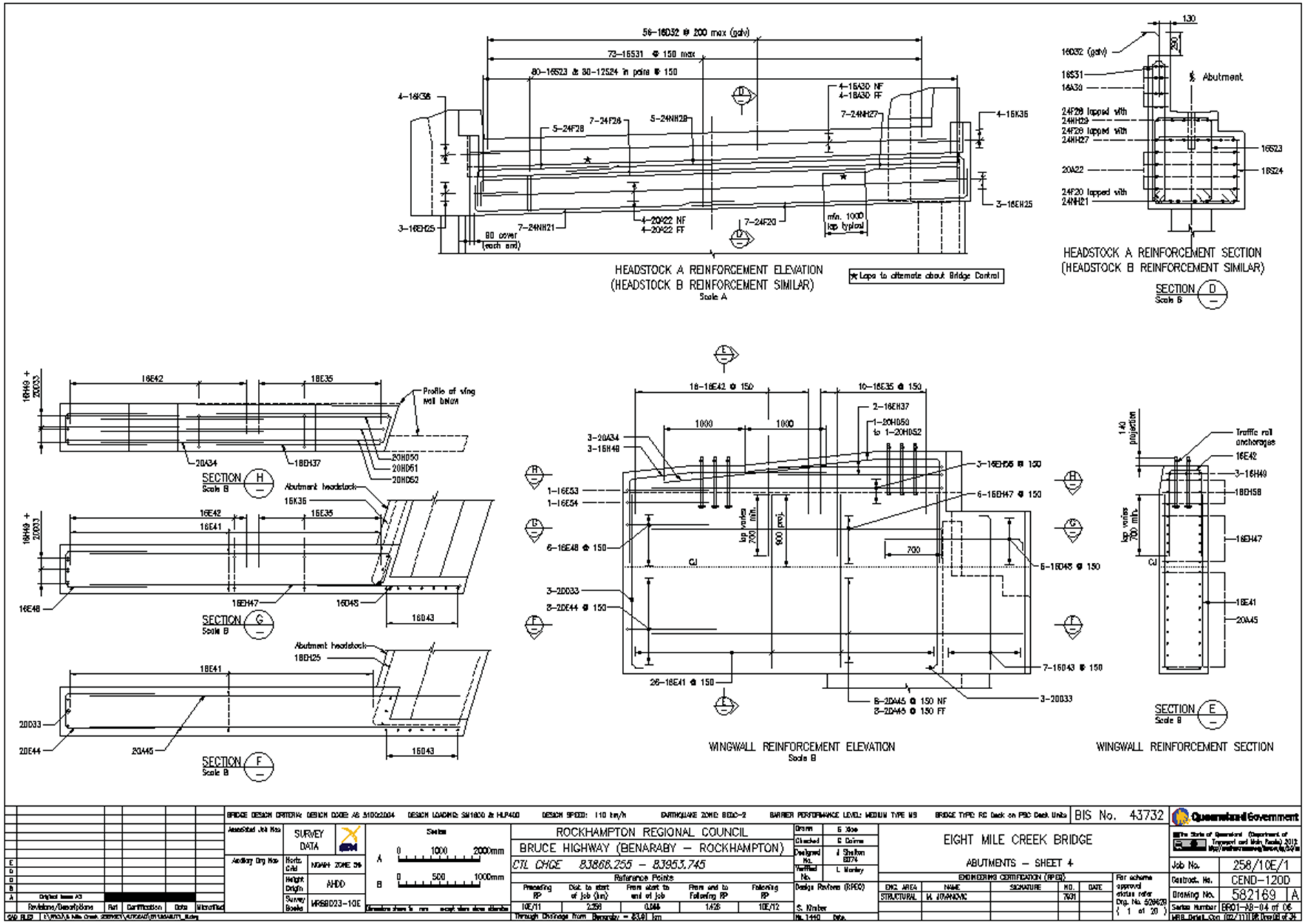

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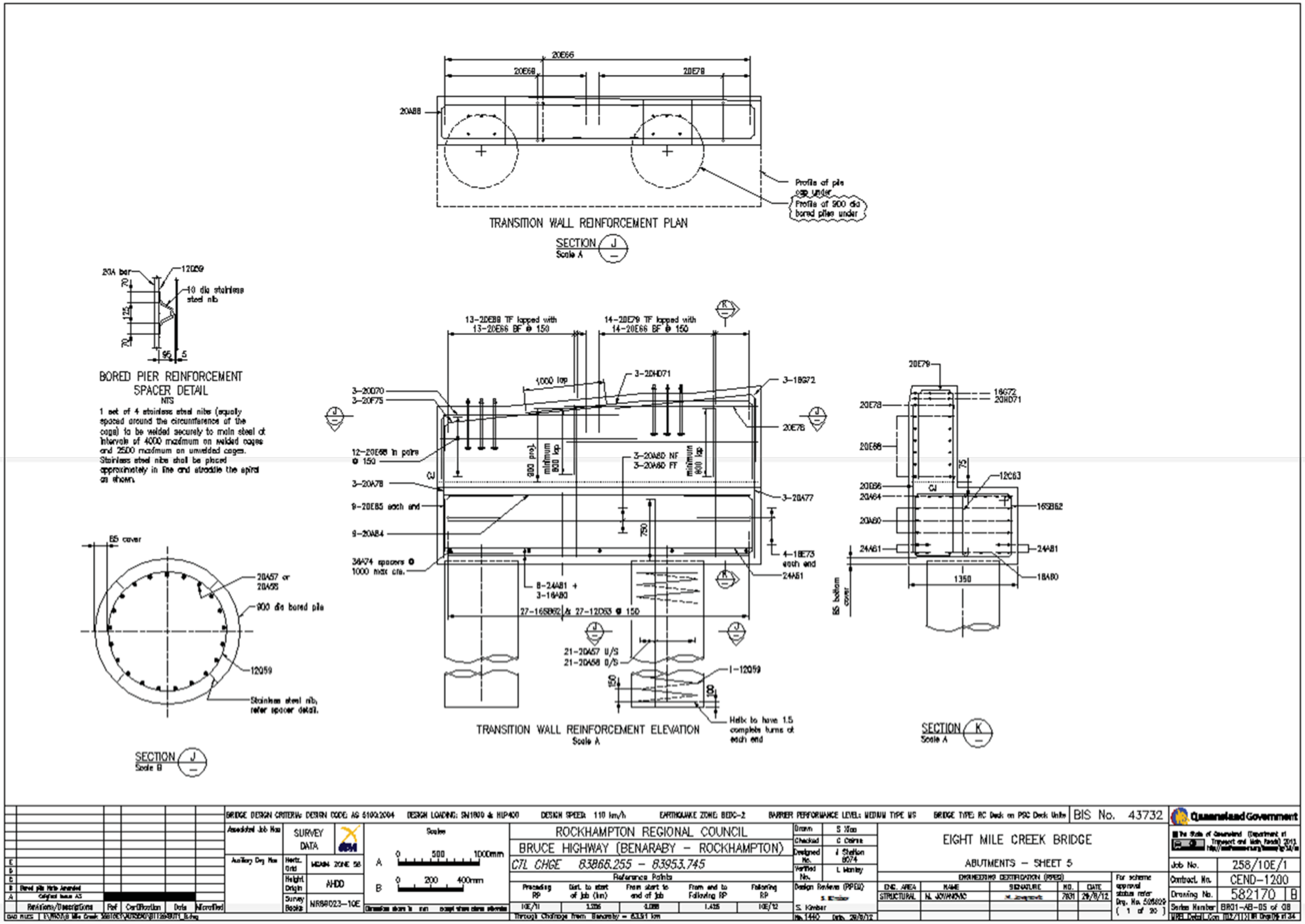

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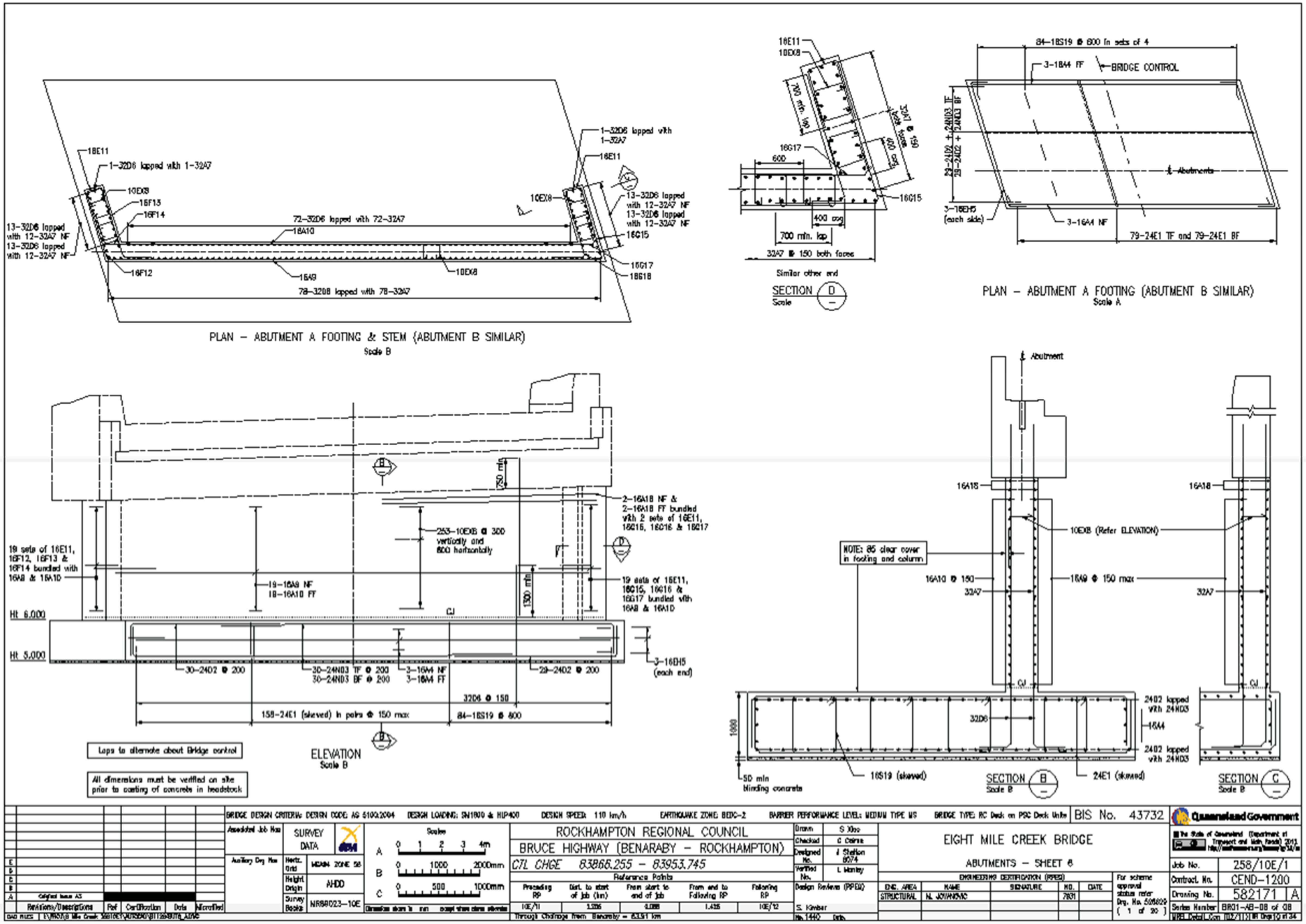
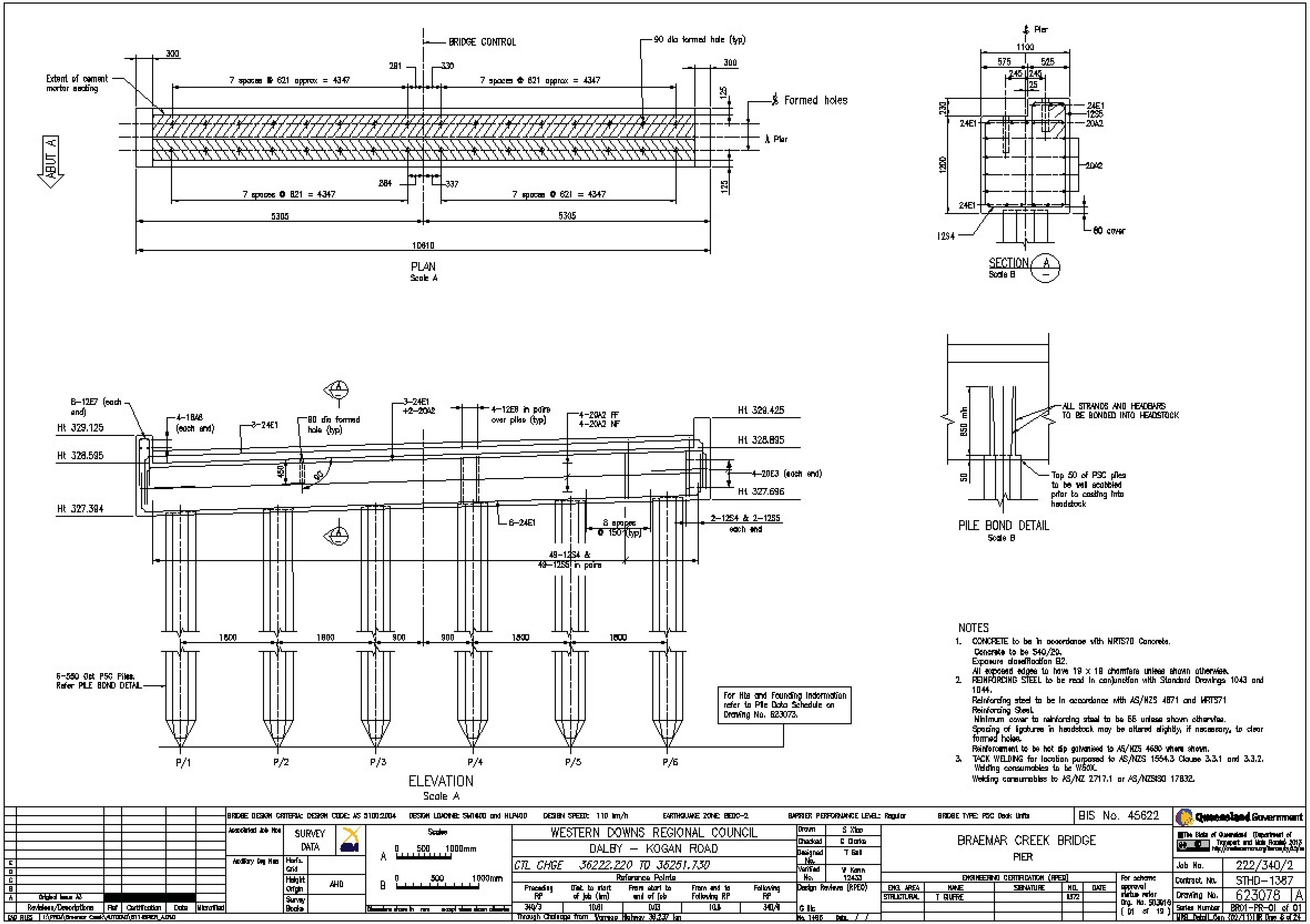
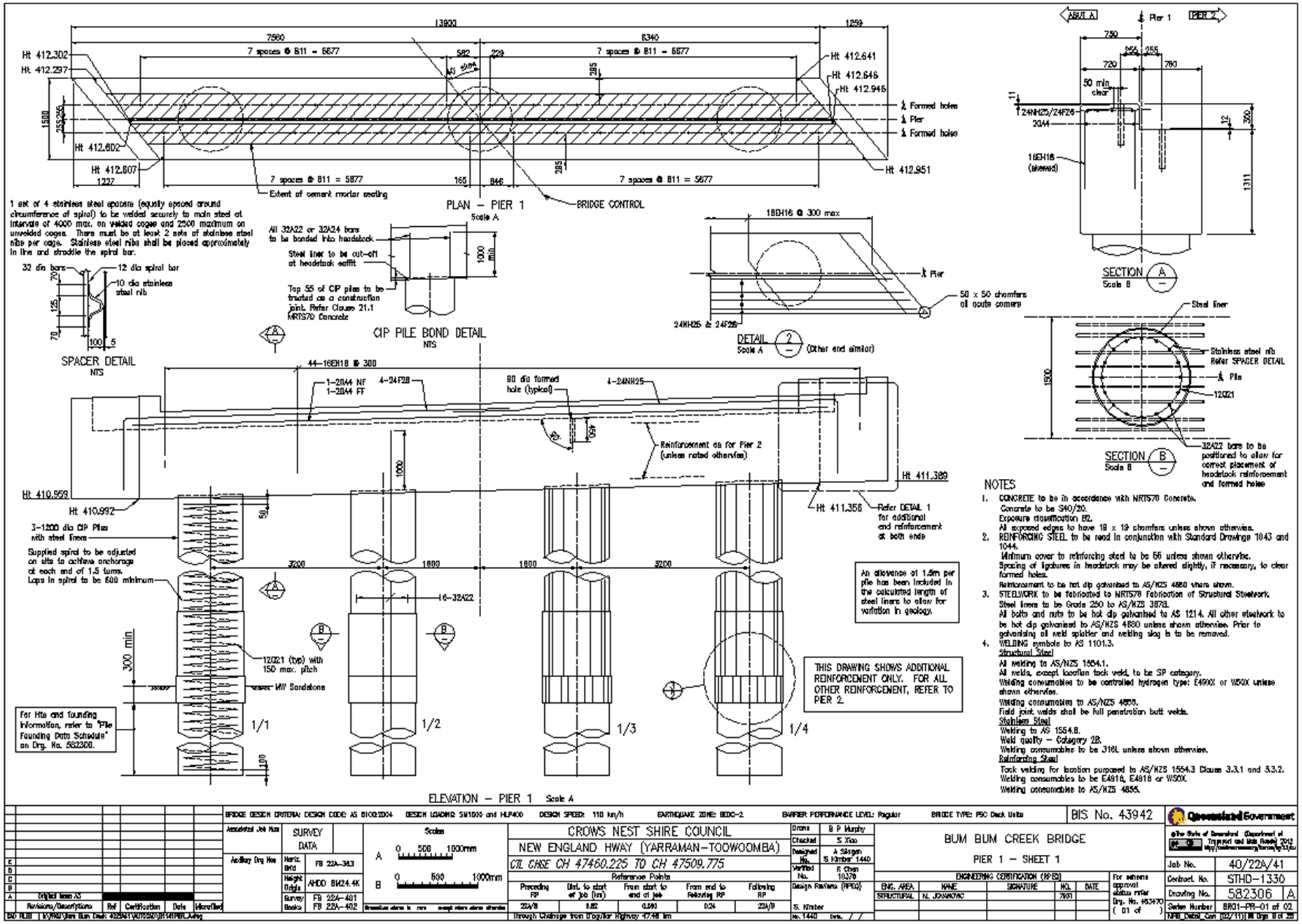


Appendix B - Example Pier Drawings

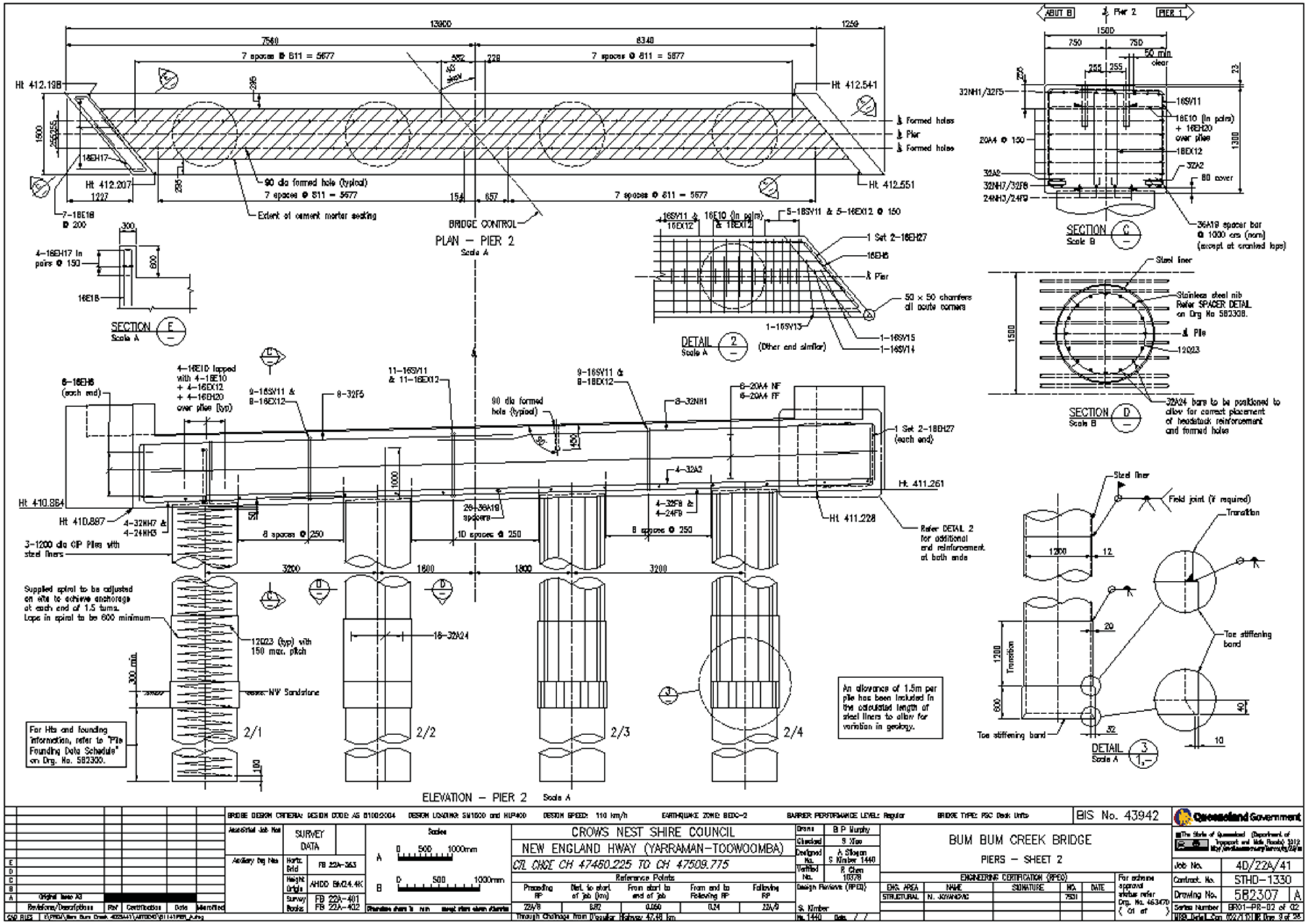
Appendix B - Example Pier Drawings – Sheet 1



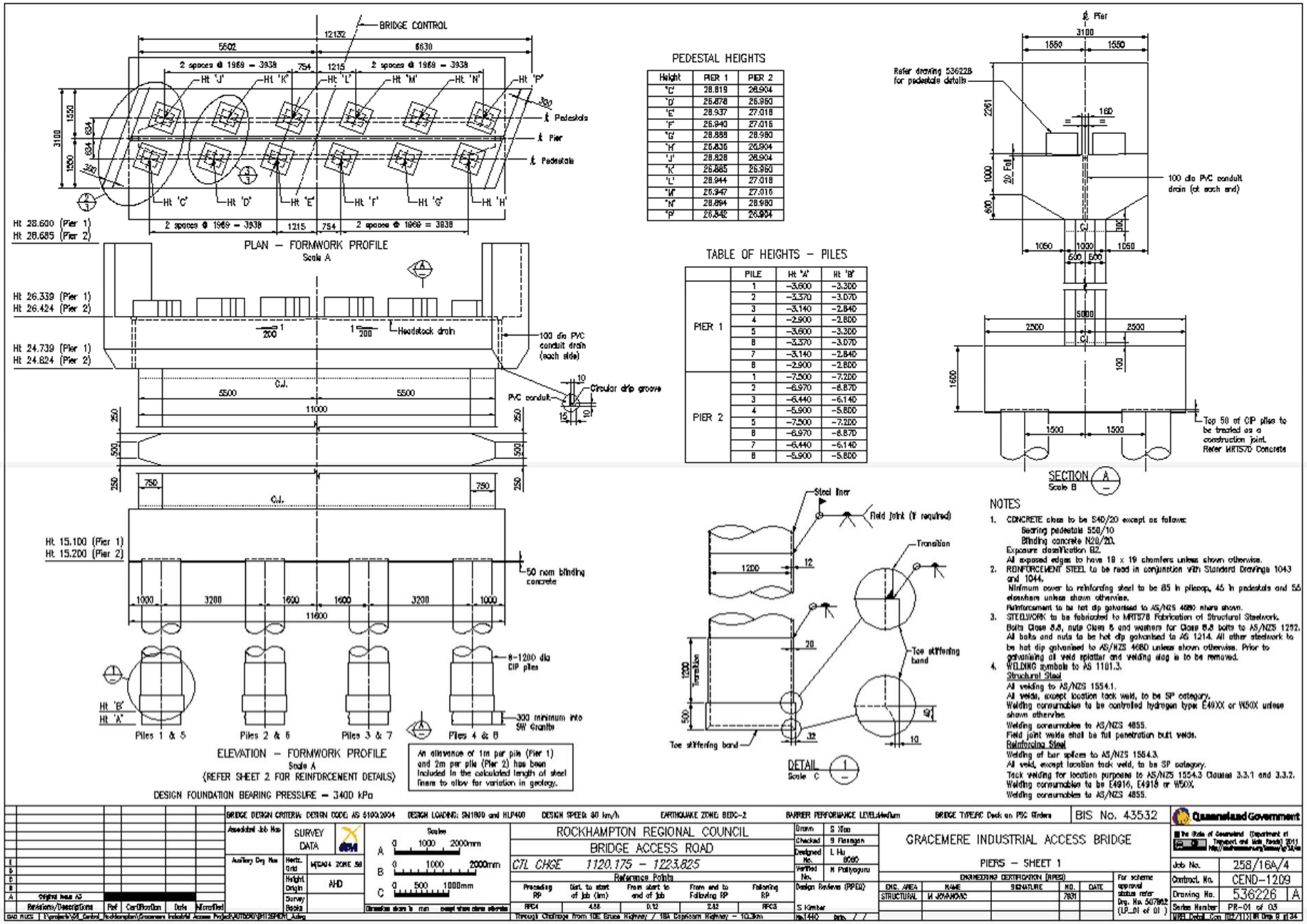
Appendix B - Example Pier Drawings – Sheet 2



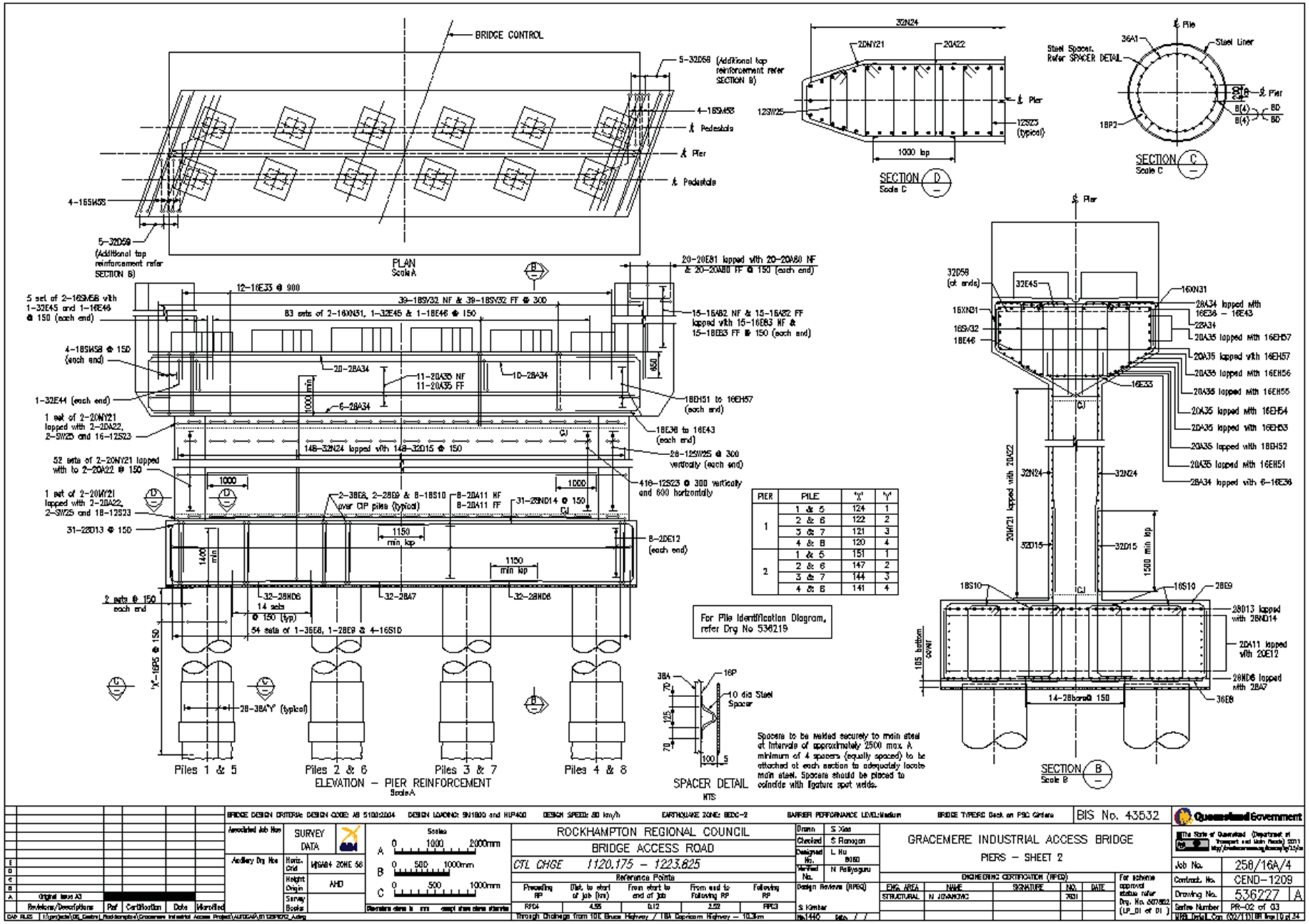
Appendix B - Example Pier Drawings – Sheet 3



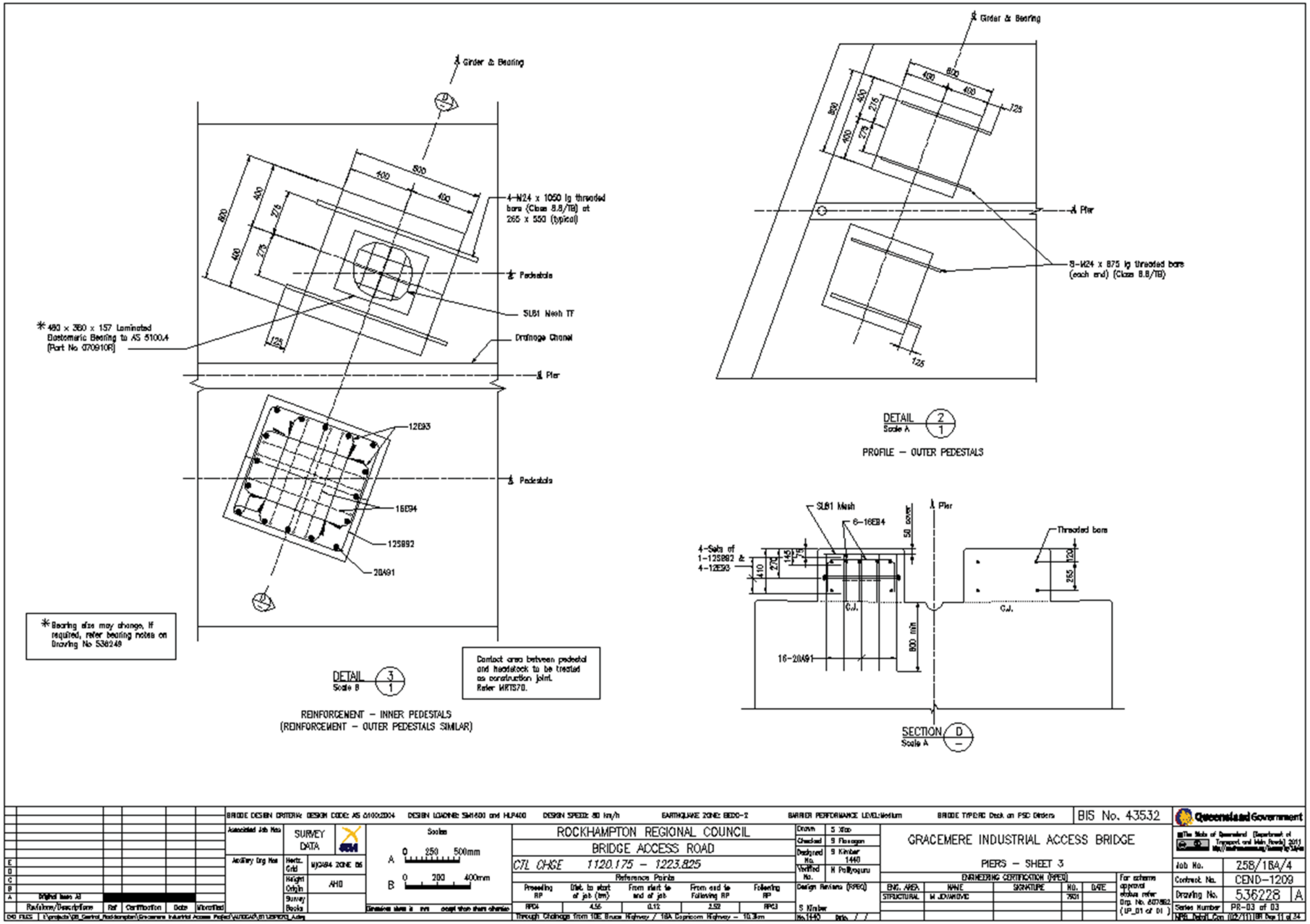
Appendix B - Example Pier Drawings – Sheet 4



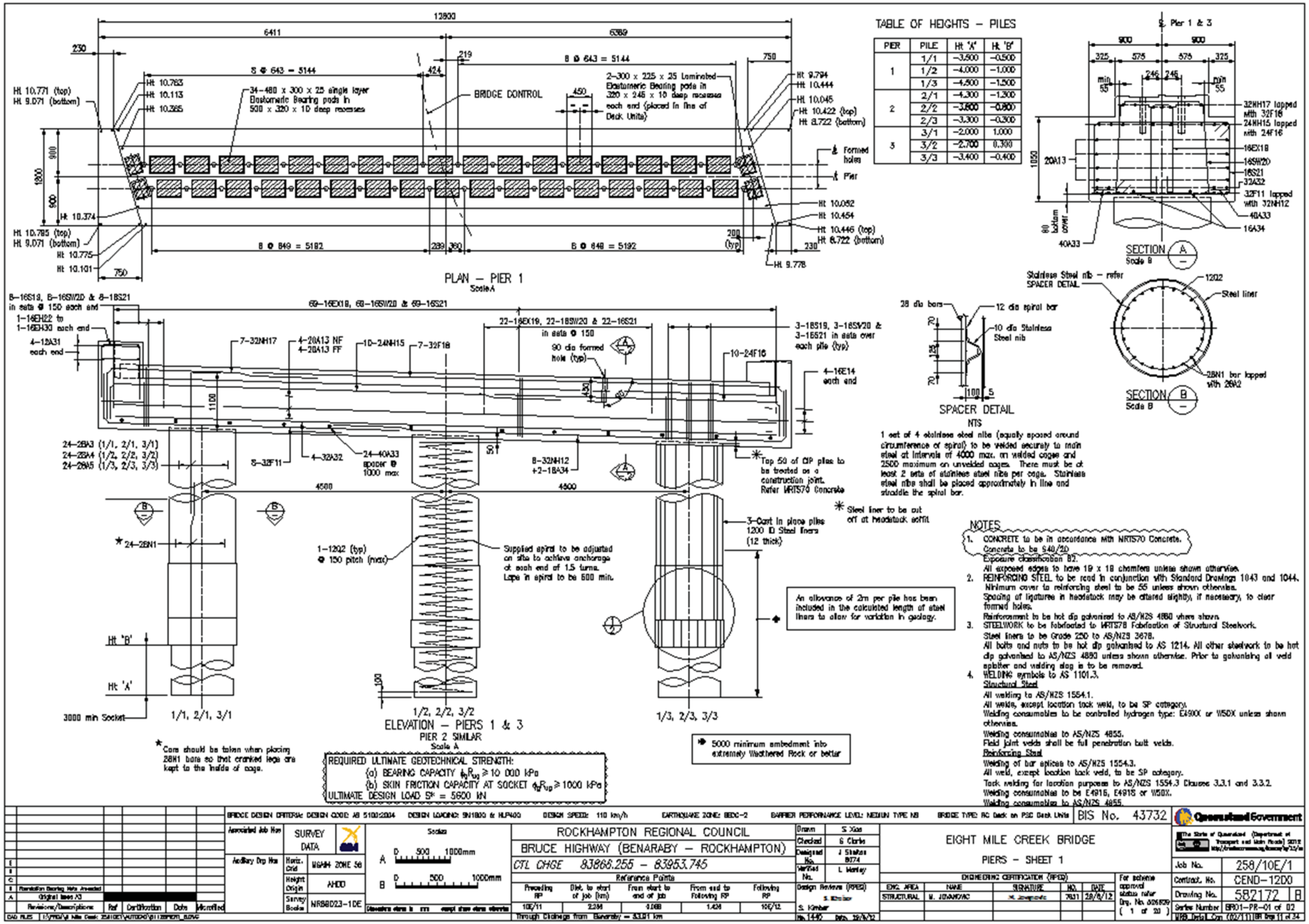
Appendix B - Example Pier Drawings – Sheet 5



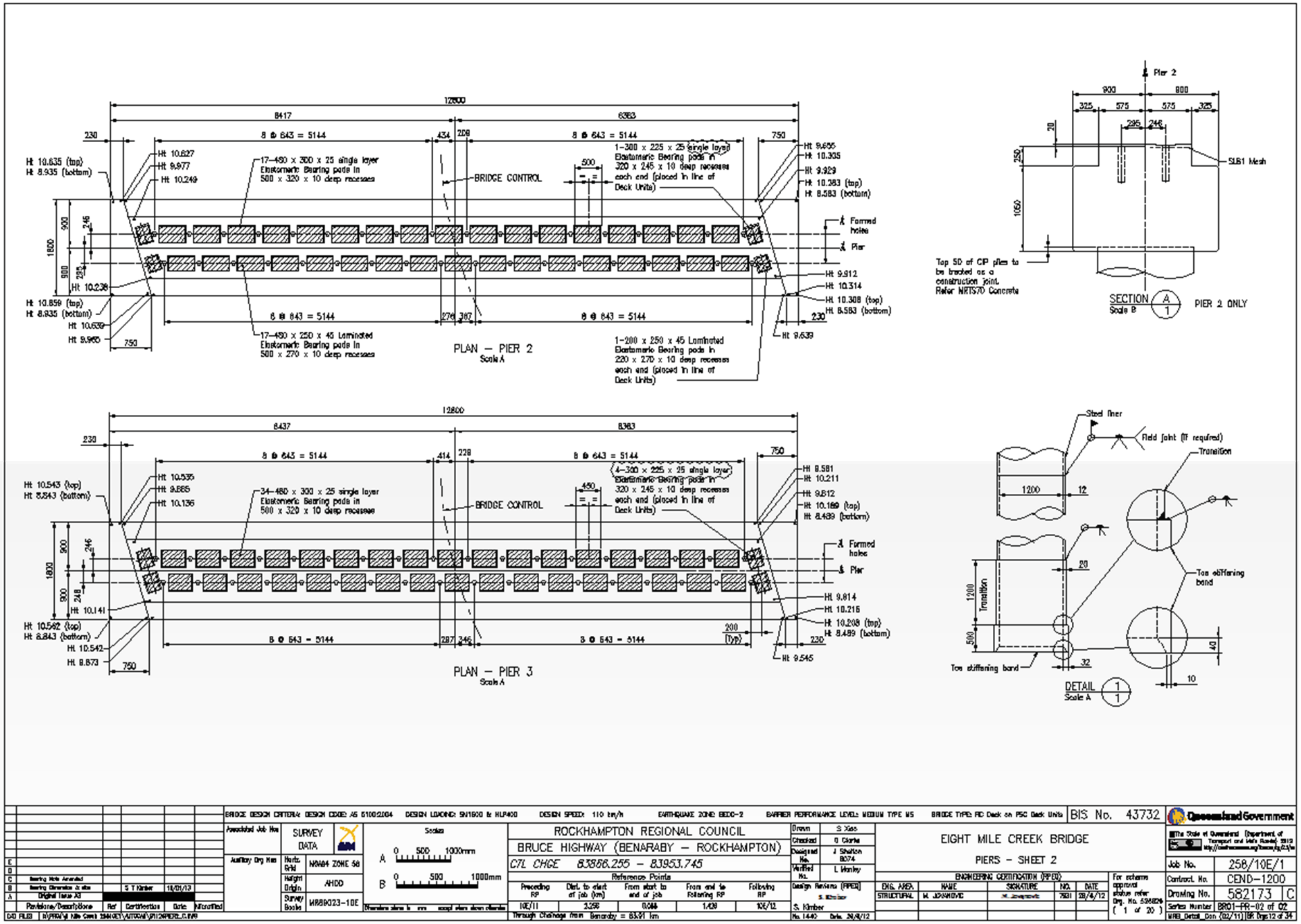
Appendix B - Example Pier Drawings – Sheet 6



Appendix B - Example Pier Drawings – Sheet 7



Appendix B - Example Pier Drawings – Sheet 8



Drafting and Design Presentation Standards
Volume 3: Structural Drafting Standards

Chapter 13: Provision for Bridge Jacking, Inspection and Maintenance

May 2013

Queensland Government

Chapter 13 Amendments

Revision register

<table>
<tr><th>Issue/Rev No.</th><th>Reference Section</th><th>Description of Revision</th><th>Authorised by</th><th>Date</th></tr>
<tr><td>1</td><td>–</td><td>First Issue.</td><td>Manager (Structural Drafting)</td><td>April 2011</td></tr>
<tr><td rowspan="3">2</td><td>–</td><td>Document name change.</td><td rowspan="3">Manager (Structural Drafting)</td><td rowspan="3">Nov 2011</td></tr>
<tr><td>13.3</td><td>Stainless steel marker plates to be Grade 316. Amend Figure 13.3-1 to show that threaded rod may replace the bolt.</td></tr>
<tr><td>13.4</td><td>Saw cut bitumen wherever it continues over a fixed or continuous joint. Deck unit holding down bolt recess depth increased to 55 mm. Slotted holding down bolt hole moved to 240 mm from end of deck unit. The distance from deck unit holding down bolt hole to the end of the deck unit increases on skewed bridges. Update all Figures.</td></tr>
<tr><td rowspan="4">3</td><td>13.3</td><td>Figure 13.3-1 Holding down bolt note revised.</td><td rowspan="4">Team Leader (Structural Drafting)</td><td rowspan="4">May 2013</td></tr>
<tr><td>13.4</td><td>Figures 13.4-1 to 13.4-7 incl. revised.</td></tr>
<tr><td>13.7</td><td>Abutment Protection – wording paragraph 3. Figures 13.7-2, to 13.7-5 incl. revised.</td></tr>
<tr><td>13.8</td><td>Figure 13.8-1 revised</td></tr>
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13 Provision for Bridge Jacking, Inspection and Maintenance

13.1 Glossary of terms

For a complete glossary of terms refer Chapter 1 – *Introduction.*

13.2 Figures and examples shown in this volume

The figures and examples shown in this volume are for presentation purposes only, and may contain some details that are now superseded. These details have been included for ease of reference, to illustrate typical solutions, and to show the required standard of drafting presentation. The details are not to be used without an engineering check and certification by a Structural RPEQ to confirm that the details are appropriate for the specific project.

13.3 Deck Unit Bridge Provision for Jacking

Deck Unit Bridges

Abutment and pier headstocks on a deck unit bridge must incorporate jacking shelves wherever there are elastomeric bearings. Because these bearings have a limited service life, provision must be made to jack the span and replace the bearings. The shelf will also be used to support temporary packers when the bearings are being installed.

Typically, the shelf shall be 250 mm deep and 325 mm wide for bridges with deck units. To stop the edge of the jacking shelf from breaking away during jacking, the jack must be located at least 175 mm from the outside of the headstock. The jacking shelf may need to be larger for other bridge types; that is, box girders.

Similarly, the bearing must sit at least 175 mm from the edge of the bearing shelf on a square bridge. On a skewed bridge this distance may be reduced because only one corner of the bearing is located closer than 175 mm. There jacking position must not be under a void in the deck unit.

Elastomeric bearings are used on a headstock in following instances:

- bridges with a concrete deck
- the expansion joint end of a span
- deck units longer than 20 m, even if there is no concrete deck and/or expansion joint.

Marker Plates (Stainless Steel Grade 316)

Stainless steel marker plates shall be placed above the deck unit holding down bolt nuts wherever the nuts have been designed to be removed prior to jacking. The marker plates shall be attached to the deck unit/deck with ‘Parchem Roadseal SL’ silicone or approved equivalent.

Polyethylene Sheet

At bridge piers without an expansion joint or a concrete deck, a 5 mm thick sheet of closed cell expanded polyethylene shall be placed between the ends of the deck units on adjacent spans. The remaining 45 mm of the 50 mm nominal gap shall be filled with 1:3 mix cement mortar. To prevent the mortar from spilling out at the bottom of the joint a strip of compressible filler shall be attached to the pier headstock with epoxy adhesive. The polyethylene sheet is used to allow for rotation of the deck units and to reduce friction when jacking because only one span of deck units is jacked at a time.

100 mm Diameter PVC conduit

Bridges with deck units and a concrete deck require that provision is made for a portion of the deck to be removed above the deck unit holding down bolts so that the bolts can be accessed. This is achieved by placing a 100 mm diameter PVC conduit above the bolt and filling it with N20/5 concrete. The contents of the conduit can then be easily removed before the bridge is jacked.

Bearings

At fixed and continuous joints the holding down bolts are designed to withstand all forces along the bridge (hence M30 Class 8.8 bolts are used). Large shear forces are applied to the bolts, so to prevent them from breaking, the gap between the top of the headstock and the bottom of the deck unit is limited to 15 mm. To prevent elastomeric bearings from moving, they are seated in a 10 mm deep recess. Therefore the bearing thickness is limited to 25 mm.

At expansion joints the holding down bolts are not subjected to the same shear forces. Therefore there is no upper limit to the bearing thickness.

Holding Down Bolt Size and Grout Type

Bridges without provision for jacking have their deck units held down with M24 Class 4.6 bolts bonded by 1:2 mix cement grout. Bridges with provision for jacking use M30 Class 8.8 holding down bolts bonded by ‘Parchem Conbextra GP’ cementitious grout or approved equivalent.

On bridges where provision for jacking is required on at least one pier or abutment, the M30 Class 8.8 bolts and ‘Parchem Conbextra GP’ grout shall be used over the entire bridge length to avoid confusion. To ensure that the ‘Parchem Conbextra GP’ grout sets to the required strength, it must be mixed to fluid consistency to the manufacturers specifications.

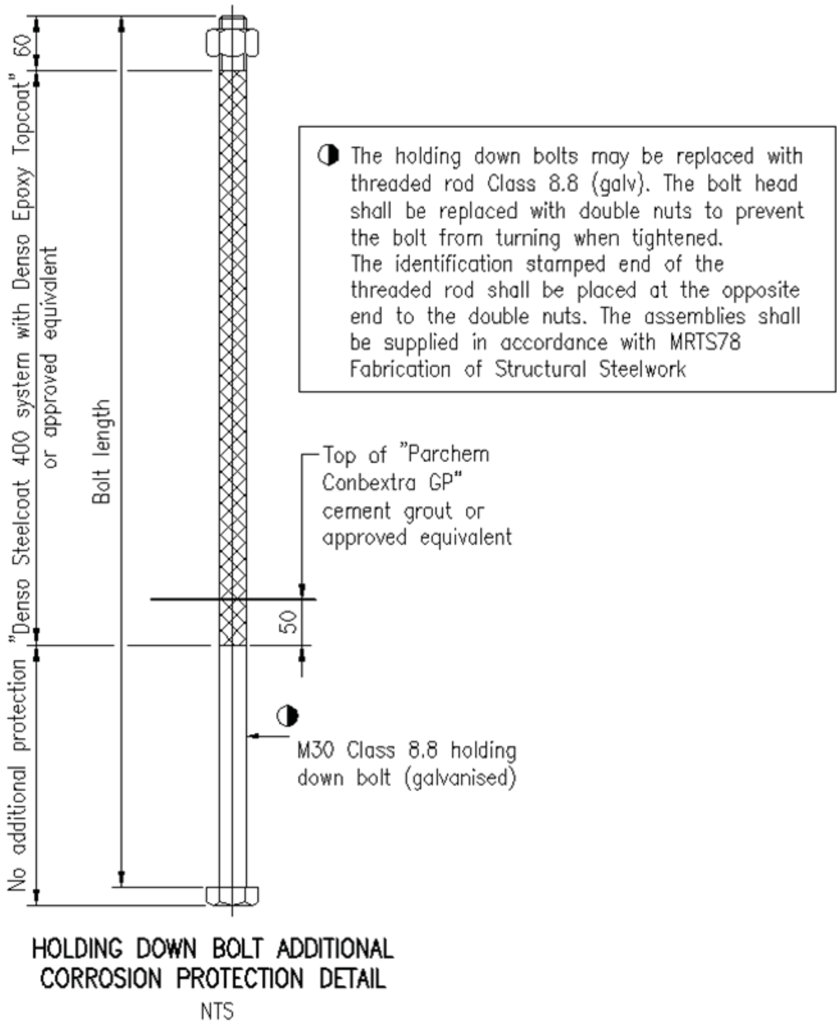
The bolts may be replaced with threaded rod. Refer Chapter 11 – *General Arrangements, Deck Unit Anchorage Details*.

Holding Down Bolt Corrosion Protection

Holding down bolts for deck units that are to be jacked at one or both ends shall be given additional corrosion protection because the full length of the bolt is not encased in grout. In addition to hot dip galvanising, the bolts shall be treated with the ‘Denso Steelcoat 400 system with Denso Epoxy Topcoat’ or approved equivalent. The additional protection shall start 50 mm from the top of the bolt and extend 50 mm into the ‘Parchem Conbextra GP’ grout which holds the bolt down. Refer Figure 13.3-1 *Holding Down Bolt Additional Corrosion Protection*.

Where the nut and washer at the top of bolt are designed to be removed before jacking, they shall be coated with grease before a silicone seal is placed around them.

Figure 13.3-1 Holding Down Bolt Additional Corrosion Protection



Silicone Seal

At fixed and continuous joints, a 50 mm deep silicone plug is installed at the top of the deck unit holding down bolt hole to stop water from ponding above the 'Parchem Conbextra GP' grout at the bottom of the deck unit holding down bolt hole. A fibre washer is installed to contain the silicone before it is placed. The washer shall be a 68 mm diameter x 0.8 mm thick non-asbestos fibre washer with a 32 mm diameter hole placed centrally.

At all joints the nut and washer for the holding down bolt are covered with grease before the holding down bolt hole recess is filled with silicone. The grease is applied to allow the nut and washer to be easily removed prior to jacking. The silicone is used to prevent moisture from seeping down through the concrete deck and/or DWS and ponding on the holding down bolt washer/expansion joint washer.

The silicone shall be 'Parchem Roadseal SL' or approved equivalent. On bridges without a concrete deck, the DWS will be applied directly onto the silicone, therefore the silicone must be heat resistant to 180ºC.

Deck Unit Bridges with a Concrete Deck without DWS

The method of locating all of the holding down bolts with a 100 mm diameter PVC conduit does not suit a bridge with a concrete deck without DWS because vehicular traffic will damage the concrete plug. Instead, only the outer deck units shall have their holding down bolt holes marked with the conduit. The intermediate holes can be located and by measuring from the outer holes. The concrete plug can then be removed so the holding down bolts can be accessed. Marker plates are not placed above the conduits in this instance.

Deck Unit Bridges with Cast Insitu Kerbs and without a Concrete Deck

The holding down bolt holes in the outer deck units will be covered by the cast insitu kerbs. The kerbs shall be broken back if the bridge needs to be jacked, and reinstated once the maintenance is complete. This shall be noted in the Bearing Replacement Procedure Notes, refer 13.8 *Bridge Jacking, Inspection and Maintenance Drawing*.

13.4 Deck Unit Bridge Joint Types

General Arrangement drawings show a view detailing the deck unit bridge joint details. The view is titled ANCHORAGE DETAILS. Refer Chapter 11 – *General Arrangement Drawings, 11.7 Detailed Design General Arrangement Drawings* for further explanation and to Chapter 11 – *General Arrangements, Figure 11.7.2 Deck Unit Anchorage Detail – Provision for Jacking* for an example of the details required.

There are several types and combinations of joint types. Additional details are as follows (note that these details shall be modified when the bearings are placed in front of the deck unit holding down bolt holes).

Fixed Joints – DWS on Deck Units >20m

At fixed joints the 'Parchem Conbextra GP' grout shall be placed in the headstock formed holes and the bottom 250 mm of the deck unit holding down bolt holes. The entire lengths of the holes are not filled because when the grout is removed at the time of jacking it will create unnecessary additional work. Refer Figure 13.4-1 *Fixed Abutment and Pier Joints – DWS on Deck Units >20 m*.

Expansion Joints – DWS on Deck Units

At expansion joints the 'Parchem Conbextra GP' grout is only placed in the headstock formed hole. Grout is not placed in the slotted deck unit holding down bolt holes because the holding down bolt must be free to slide along the slot. Refer Figure 13.4-1 *Fixed Abutment and Pier Joints – DWS on Deck Units >20 m*.

Fixed Abutment Joints with Bearings

When deck units are supported by bearings at fixed abutment joints, an XJS expansion joint (or approved equivalent) shall be provided in the DWS. Refer Chapter 17 – *Cast Insitu Kerbs and Decks, Appendix A Deck Design Sketches – Sheet 6*.

Combination of Fixed and Expansion Joints – DWS on Deck Units <20 m

A deck unit bridge without a concrete deck and with spans lengths 20 m or less will only have elastomeric bearings at expansion joints. This means that the deck units will only need to be jacked at the expansion joint end. At the fixed end, a jacking shelf is not needed, however, provision must still be made to disconnect the holding down bolts to allow the deck units to rotate as the expansion joint end is jacked. The deck units will be supported on 1:3 mix cement mortar and be grouted 250 mm into the deck unit holding down bolt holes. Refer Figure 13.4-3 *Expansion Abutment Joint and Fixed Pier Joints – DWS on Deck Units ≤20 m* and Figure 13.4-4 *Fixed Abutment Joint and Expansion Pier Joints – DWS on Deck Units ≤20 m*.

Similarly, if the bridge has an expansion/fixed pier the fixed side shall be fully grouted with ‘Parchem Conbextra GP’ for the full length of the pier headstock formed holes and the deck unit holding down bolt holes. Refer Figure 13.4-5 *Fixed Abutment Joint and Expansion/Fixed Pier Joint – DWS on Deck Units ≤20 m*.

Fixed and Continuous Joints – DWS on Concrete Deck on Deck Units

At continuous joints, the deck units on one span of the pier headstock shall be grouted 250 mm while the deck units on the adjacent span shall only be grouted into the pier headstock formed holes. Only one side is grouted so that the 50 mm nominal gap between the deck units can close up as the deck units are placed under load. The side of the pier headstock in which the deck units are grouted 250 mm shall be consistent along the entire bridge length. Refer Figure 13.4-6 *Fixed Abutment and Pier Joints – DWS and Concrete Deck on Deck Units*.

Expansion Joints – DWS on Concrete Deck on Deck Units

At expansion joints the ‘Parchem Conbextra GP’ grout is only placed in the headstock formed holes. Grout is not placed in the slotted deck unit holding down bolt holes because the holding down bolt must be free to slide along the slot. Refer Figure 13.4-7 *Expansion Abutment and Pier Joints – DWS and Concrete Deck on Deck Units*.

Figure 13.4-1 Fixed Abutment and Pier Joints – DWS on Deck Units >20 m

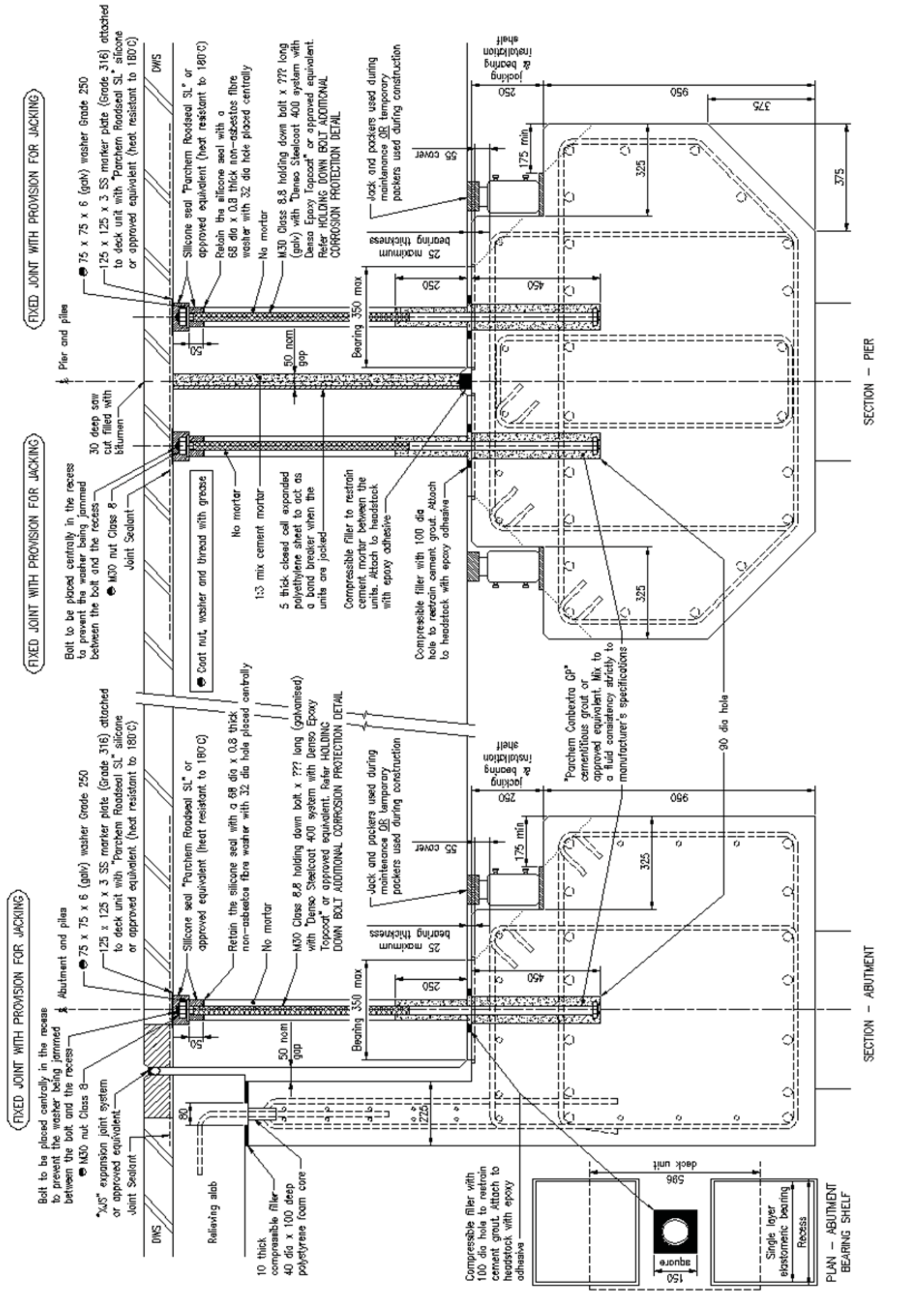


Figure 13.4-2 Expansion Abutment and Pier Joints – DWS on Deck Units

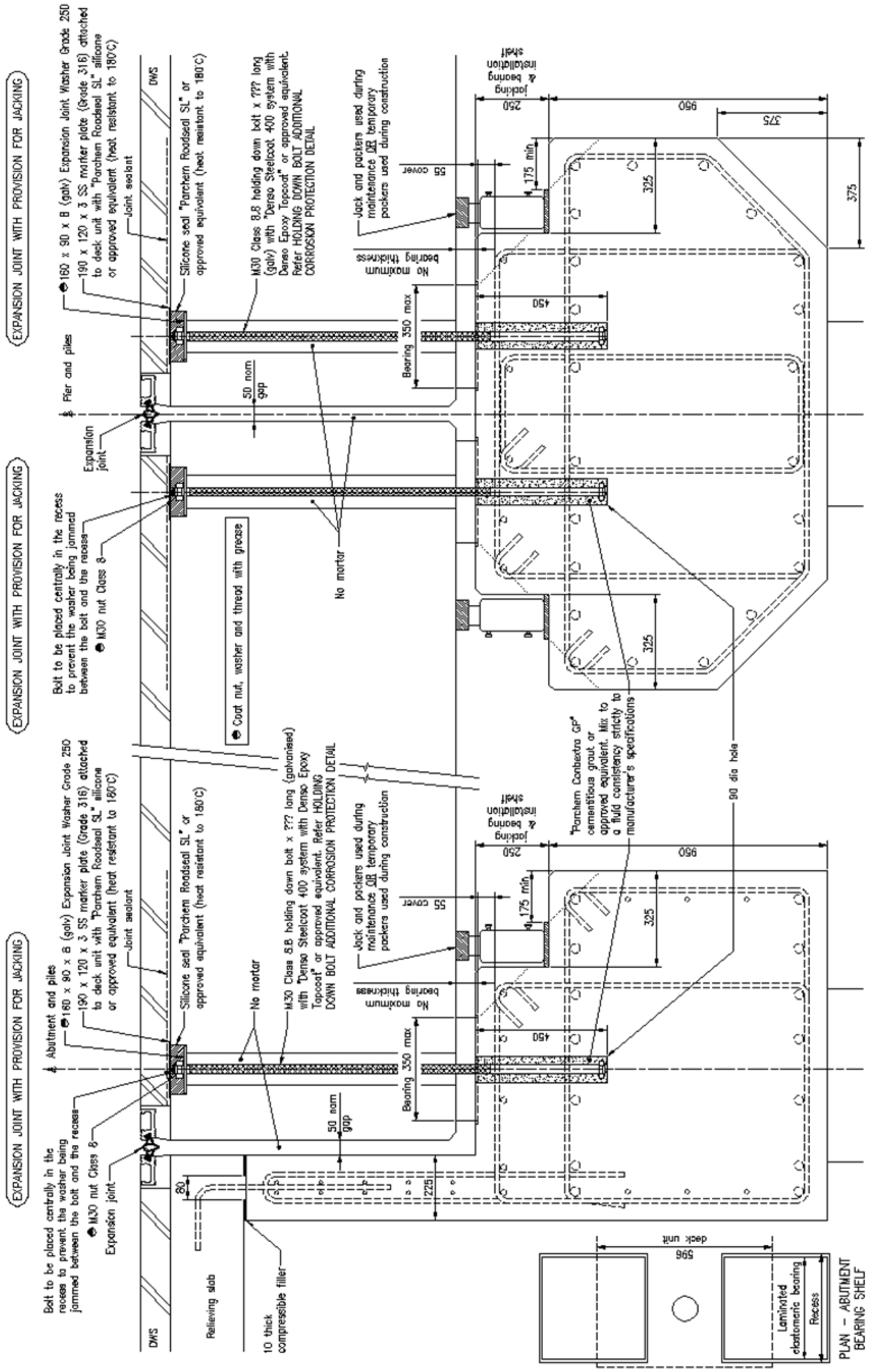


Figure 13.4-3 Expansion Abutment Joint and Fixed Pier Joints – DWS on Deck Units ≤20 m

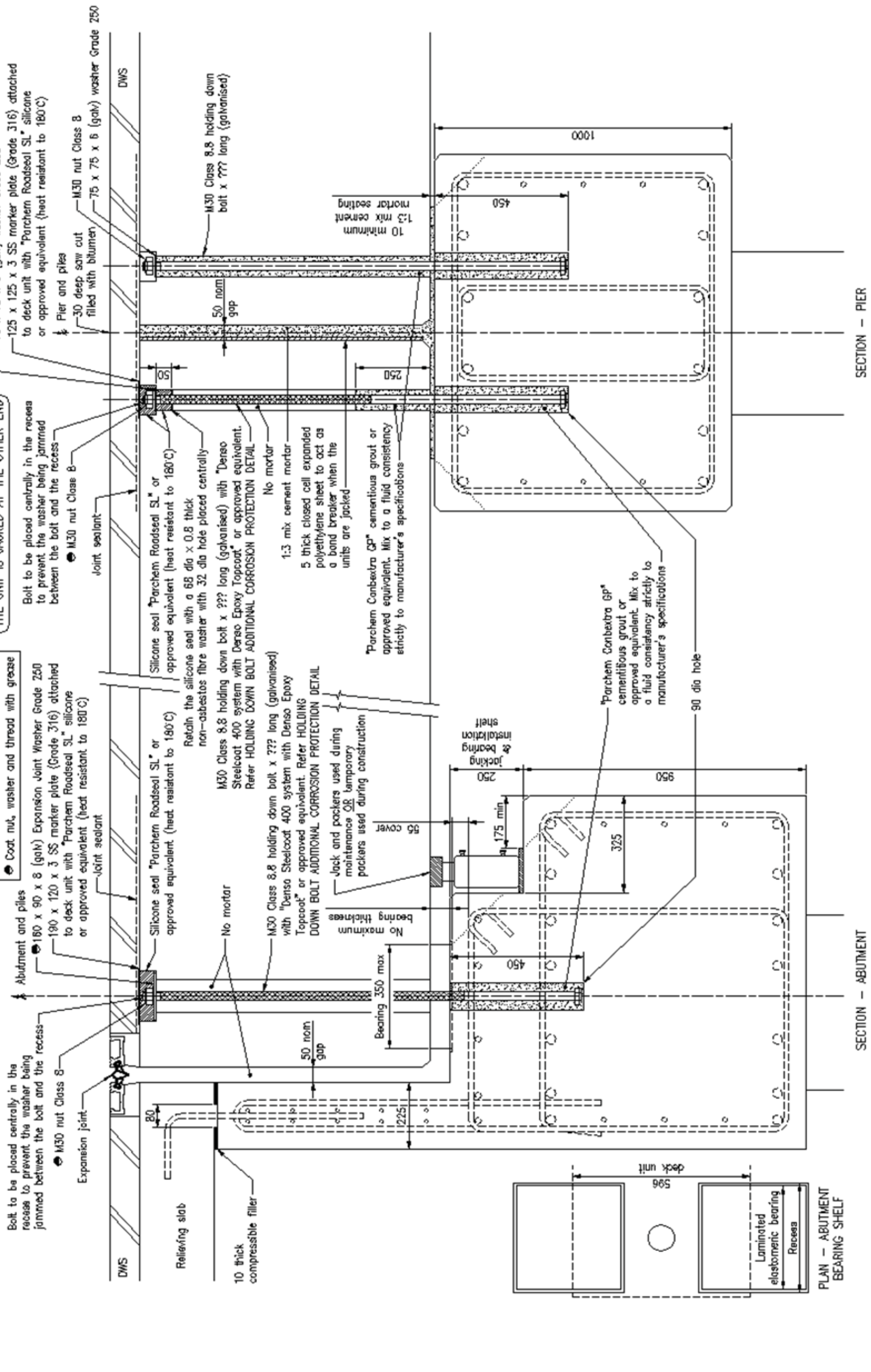


Figure 13.4-4 Fixed Abutment Joint and Expansion Pier Joints – DWS on Deck Units ≤20 m

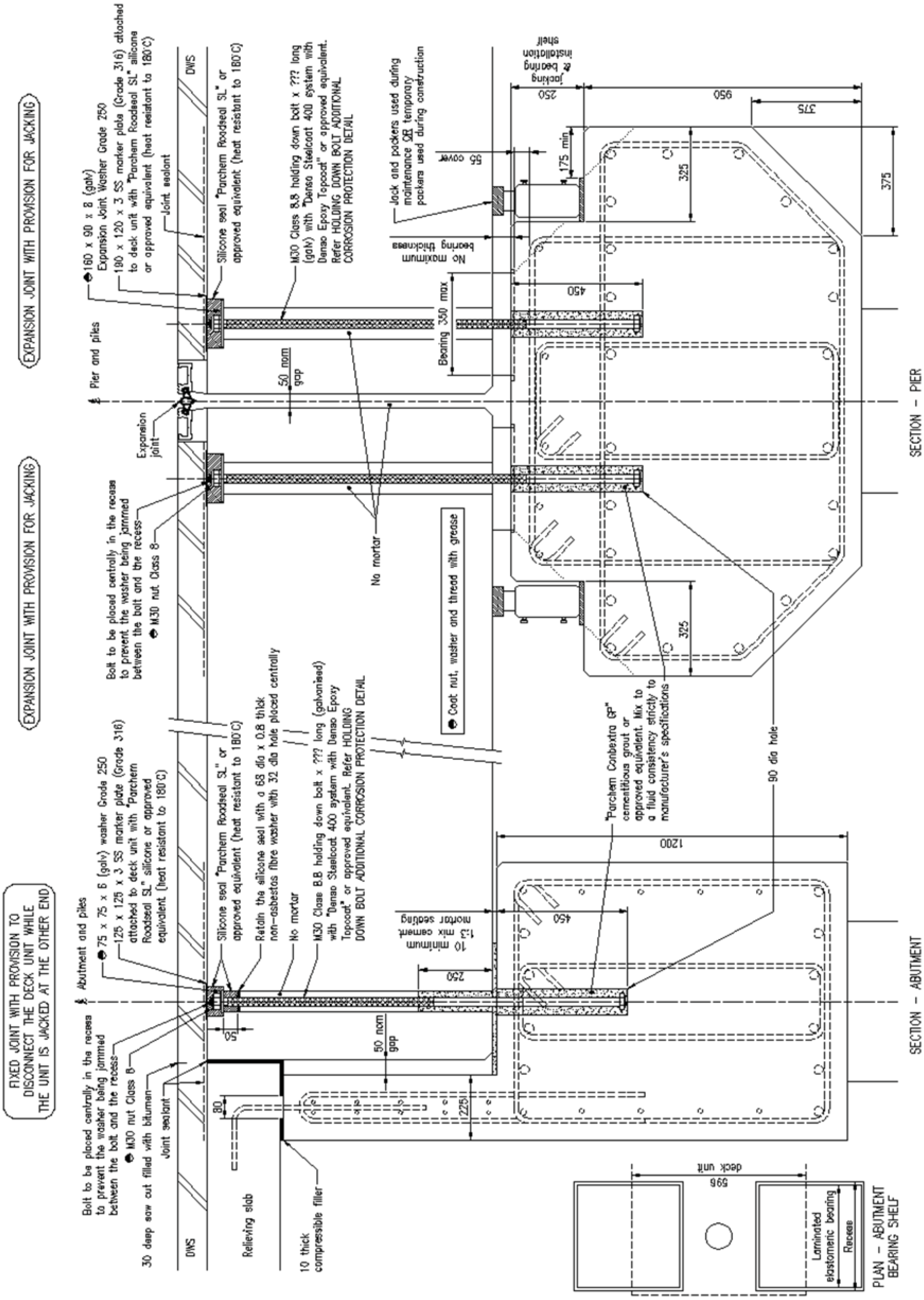


Figure 13.4-5 Fixed Abutment Joint and Expansion/Fixed Pier Joint – DWS on Deck Units ≤20 m

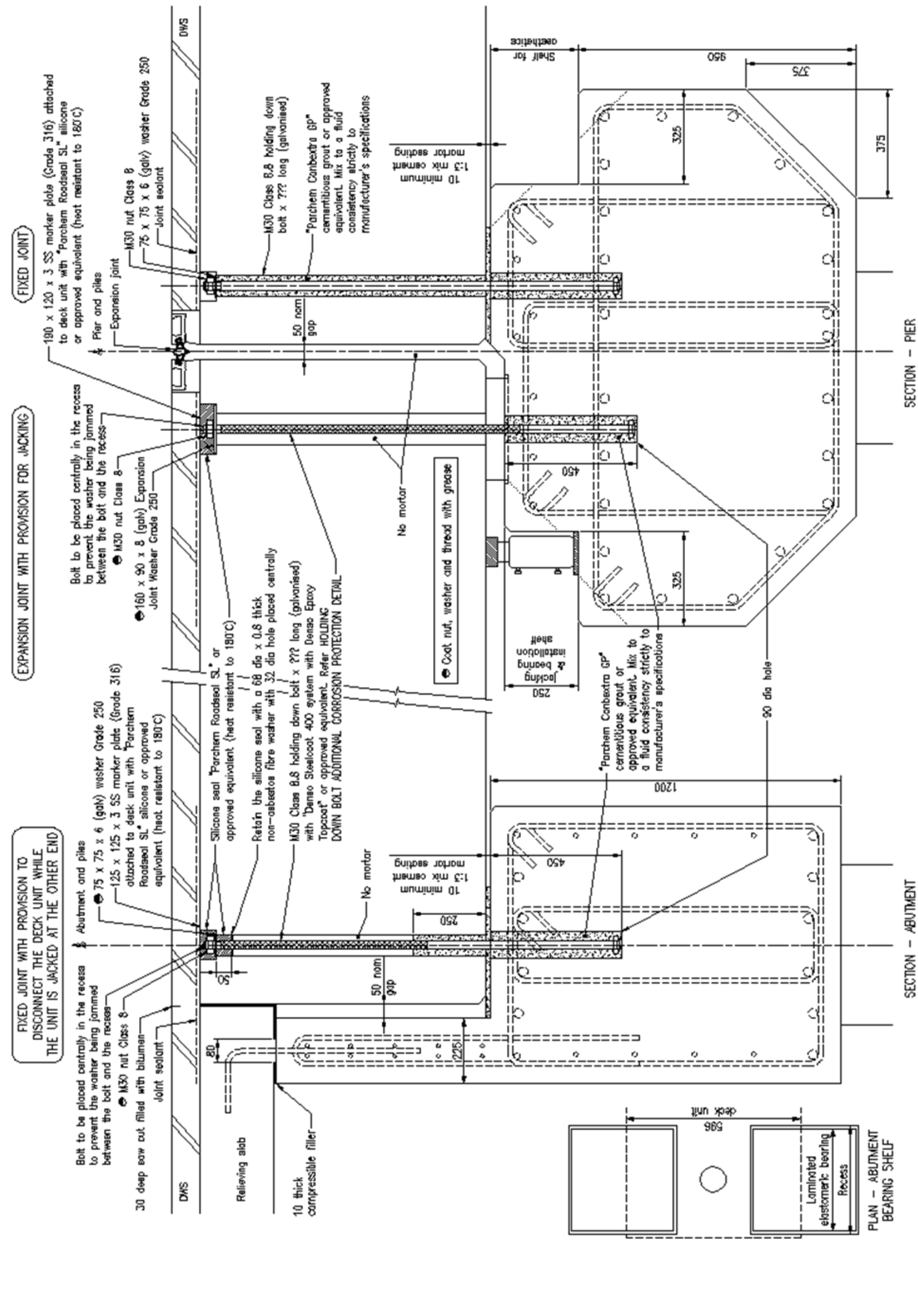


Figure 13.4-6 Fixed Abutment and Pier Joints – DWS and Concrete Deck on Deck Units

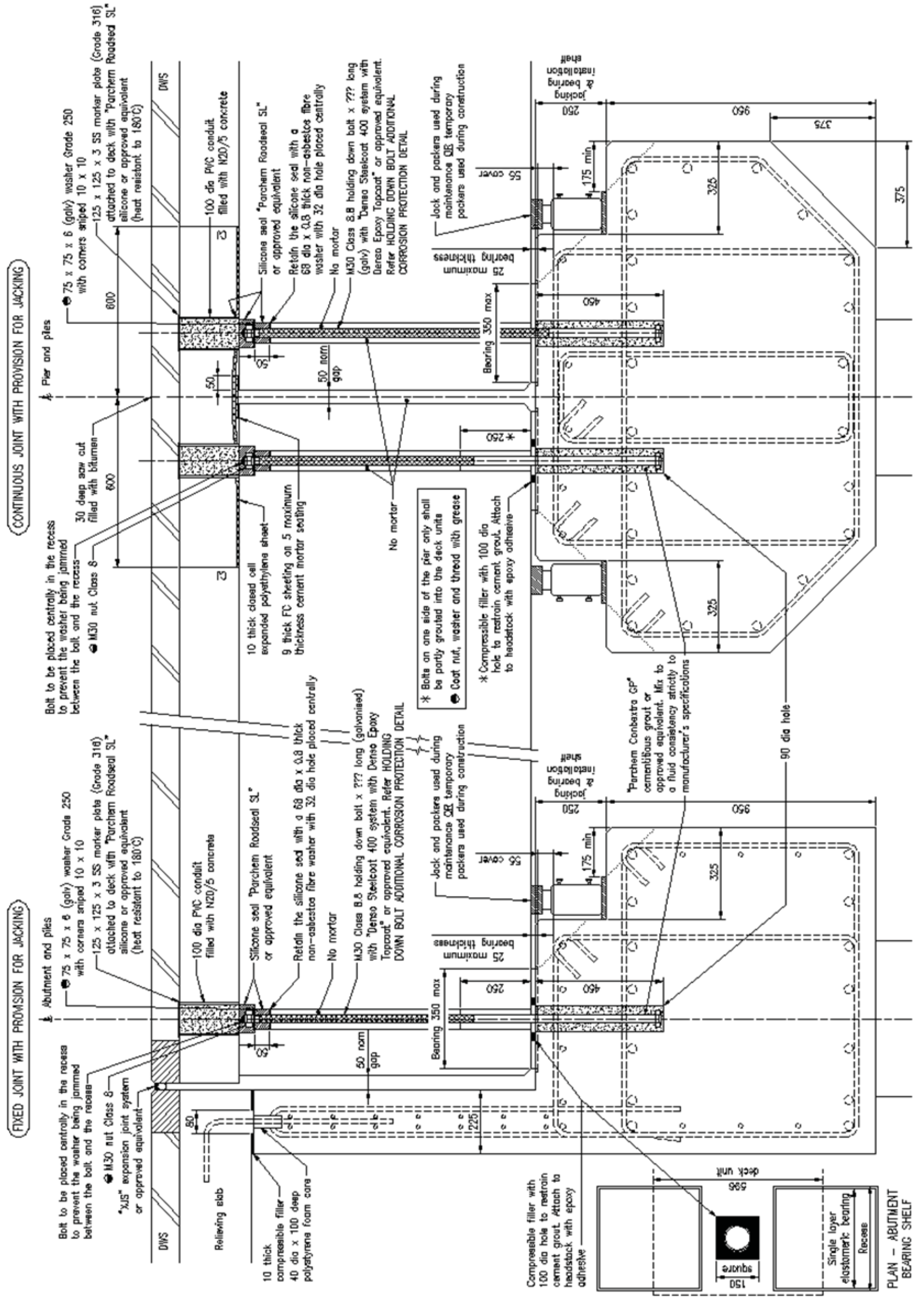
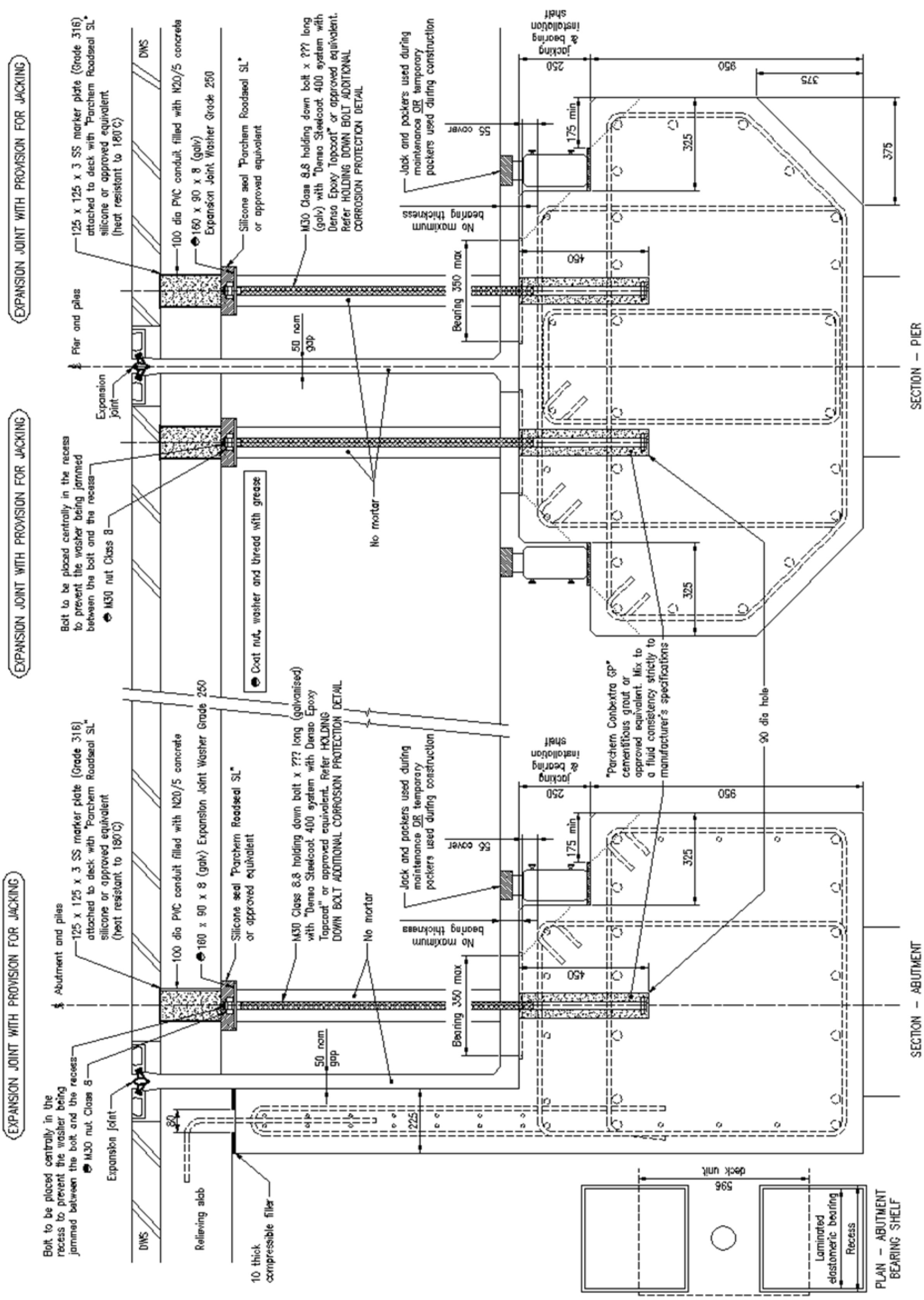


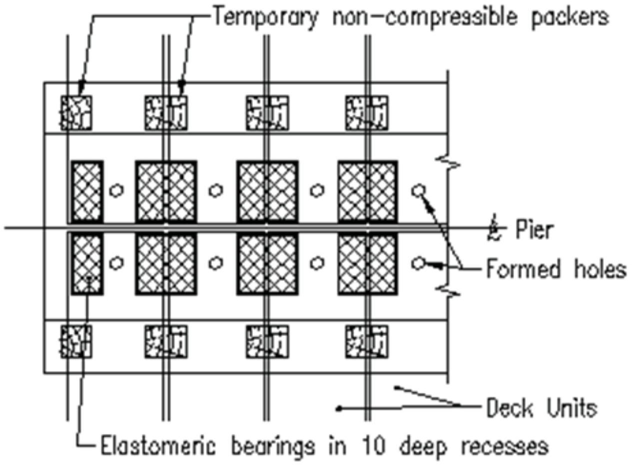
Figure 13.4-7 Expansion Abutment and Pier Joints – DWS and Concrete Deck on Deck Units



13.5 Deck Unit Erection Construction Procedure

A construction procedure for the bearing installation and deck unit erection shall be shown on the General Arrangement drawings. For an example of the required details, refer Figure 13.5-1 *Deck Unit Erection*. Note that the construction procedure shown may need to be modified to suit the specific bridge design.

Figure 13.5-1 Deck Unit Erection



CONSTRUCTION PROCEDURE

1.. Install non-compressible temporary packers on top of the headstock, positioned to support the deck units. Packers to be of sufficient strength to support the weight of the deck units, and of such a height under load that the soffit of the deck units will clear the top of the bearings by 1mm at the closest point.
2.. When compressible filler is required around the formed holes, attach it with epoxy adhesive.
3.. Immediately prior to installing the deck units, apply an approved epoxy to the top surface of the bearing. The epoxy shall have a cured compressive strength of not less than 60MPa. The thickness of the epoxy is determined by the hog/grade of the deck units. The thickness shall not exceed 5mm.
4.. The deck units shall then be lowered into position and supported on the packers. Any excess epoxy squeezed out shall be removed before it has set.
5.. If the epoxy sets before completion of this operation, the deck unit shall be lifted off and all contact surfaces cleaned before repeating the process.
6.. Put holding down bolts in place before grouting in the bolts to the required depth.
7.. Place the fibre washers and silicone in the top of the holding down bolt holes before installing the washers and nuts.
8.. After the epoxy has fully cured over a period of not less than 48 hours, the packers shall be removed without dislodging the deck unit

DECK UNIT ERECTION
PIERS SHOWN – ABUTMENTS SIMILAR
NTS

13.6 Girder Bridge Jacking

Girders are always located on bearings rather than cement mortar seating, therefore provision must be made for jacking to replace the bearings should the need arise. Usually girder bridges are designed with cross girders and the jacks shall be placed underneath them for lifting purposes. Therefore, jacking shelves are not needed.

13.7 Abutment Protection

The type of abutment protection shall be decided by the Design Engineer. Where the abutment protection is subject to flooding, assistance should be sought from a Hydraulics Engineer.

Workplace Health and Safety legislation requires that abutment protection be designed to allow safe access to the abutments for inspection and maintenance. When additional abutment protection is added to a bridge that is being widened, it may not be possible to comply with the Legislation, though every effort shall be made to do so.

Refer to TMR Standard Drawing 1536 which provides the selection criteria for various forms of abutment protection. A risk assessment shall determine which safety features are required to be incorporated into the abutment protection design.

For an explanation of the details required on the General Arrangement drawings refer Chapter 11 – *General Arrangement Drawings, Detailed Design General Arrangement Drawings*.

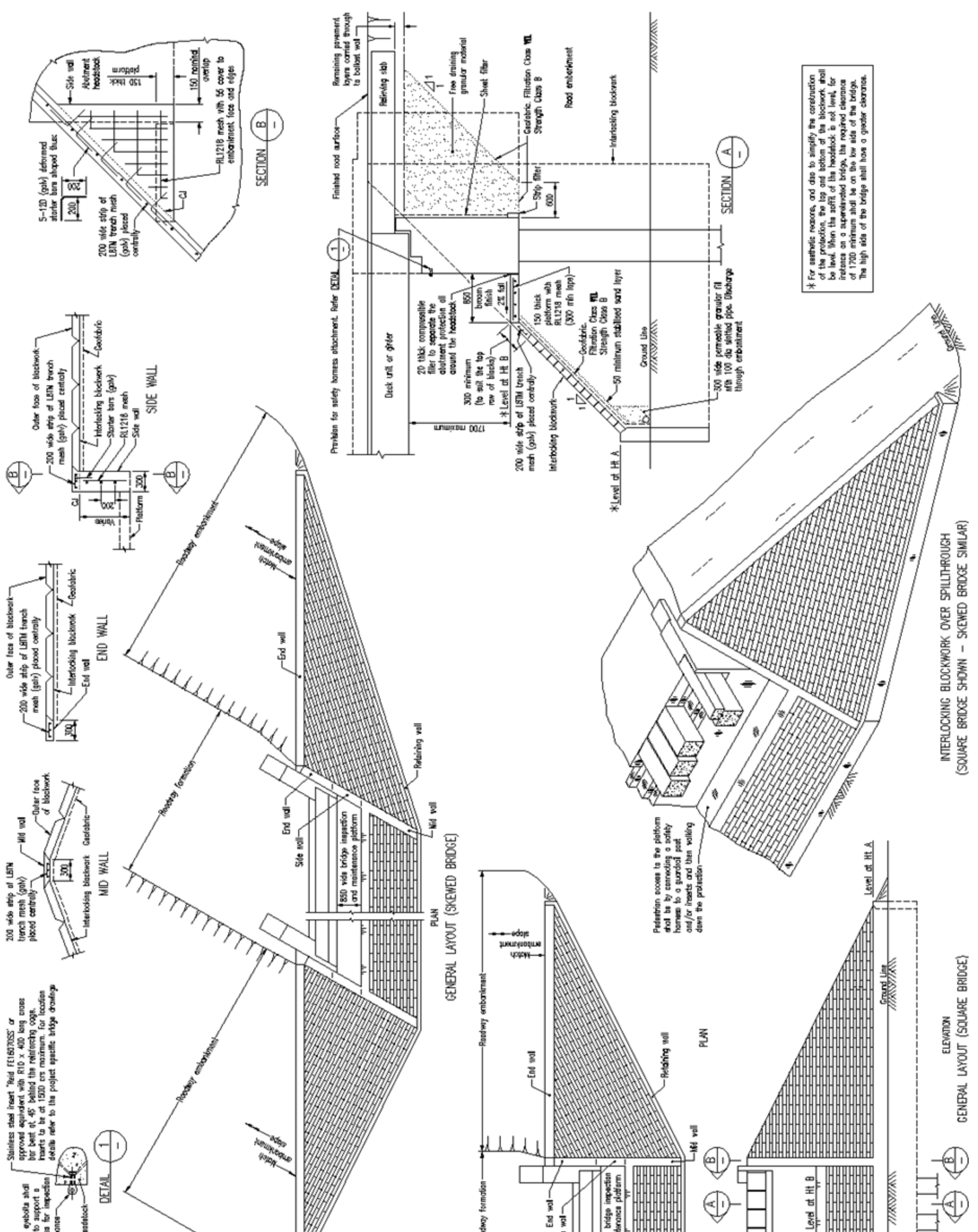
Interlocking Blockwork

Abutment Protection Type 6 – Interlocking Blockwork over Spillthrough, has traditionally been used for overpass bridges in residential areas where it has been placed on a one on one slope at the front of the embankment. Due to WH&S and stability requirements this slope shall be flattened to one on 1.5. Because overpass embankments are so tall, the one on 1.5 slope adds considerable length to the bridge. Therefore, reinforced soil structures are generally preferred to blockwork.

For an example of blockwork details, refer Figure 13.7-1 *Example Interlocking Blockwork Details*. Note that the embankment slope at the front of the abutment is shown at one on one in the example, however the current design criteria requires one on 1.5. The retaining wall around the base of the blockwork shall be designed to accommodate the earth pressure, and the force from the blockwork.

An inspection and maintenance platform shall be provided 1700 mm below from the underside of the deck unit/girder. This distance will suit an average sized person. The platform shall be 850 mm wide and broom finished to improve traction when walking on the platform.

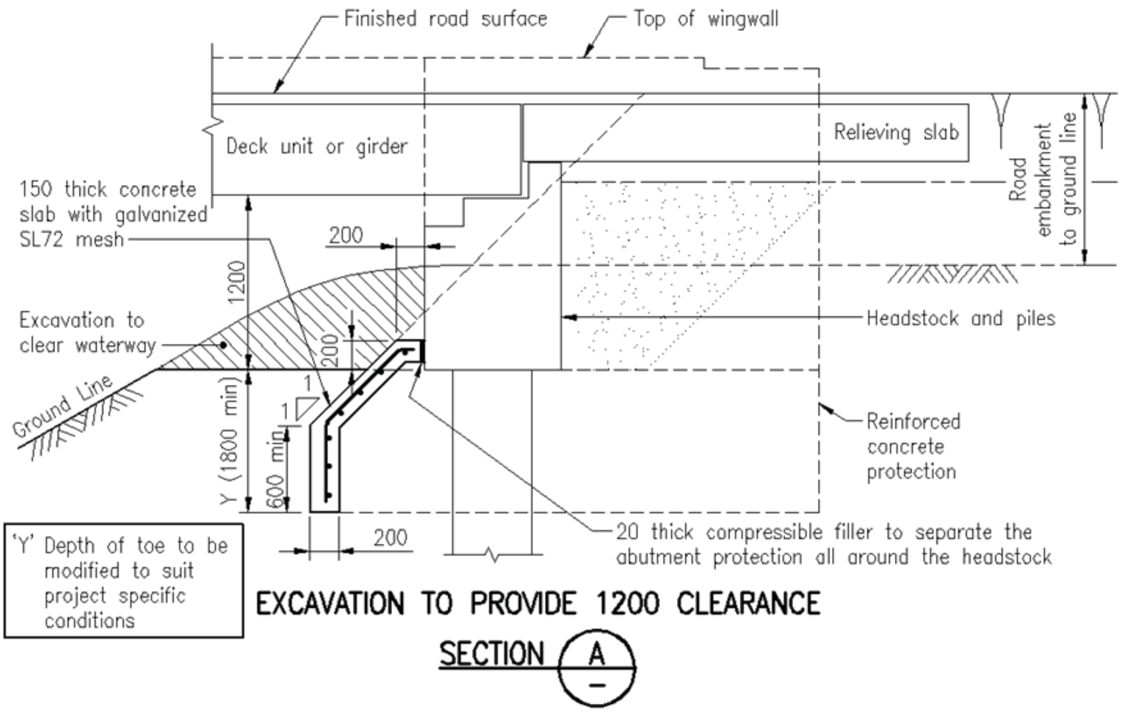
Figure 13.7-1 Example Interlocking Blockwork Details



Minimum Inspection Height of 1200 mm

When the soffit of the abutment headstock is below ground, a minimum of 1200 mm headroom shall be provided underneath the deck units/girders to allow practical inspection and maintenance of the abutments. To achieve this, the waterway shall be cleared to soffit height. On both sides of the bridge the excavation to clear waterway shall transition up to the natural ground line at one on four. Refer Figure 13.7-2 *Minimum Inspection Height of 1200 mm*. This figure is extracted from TMR Standard Drawings 1542.

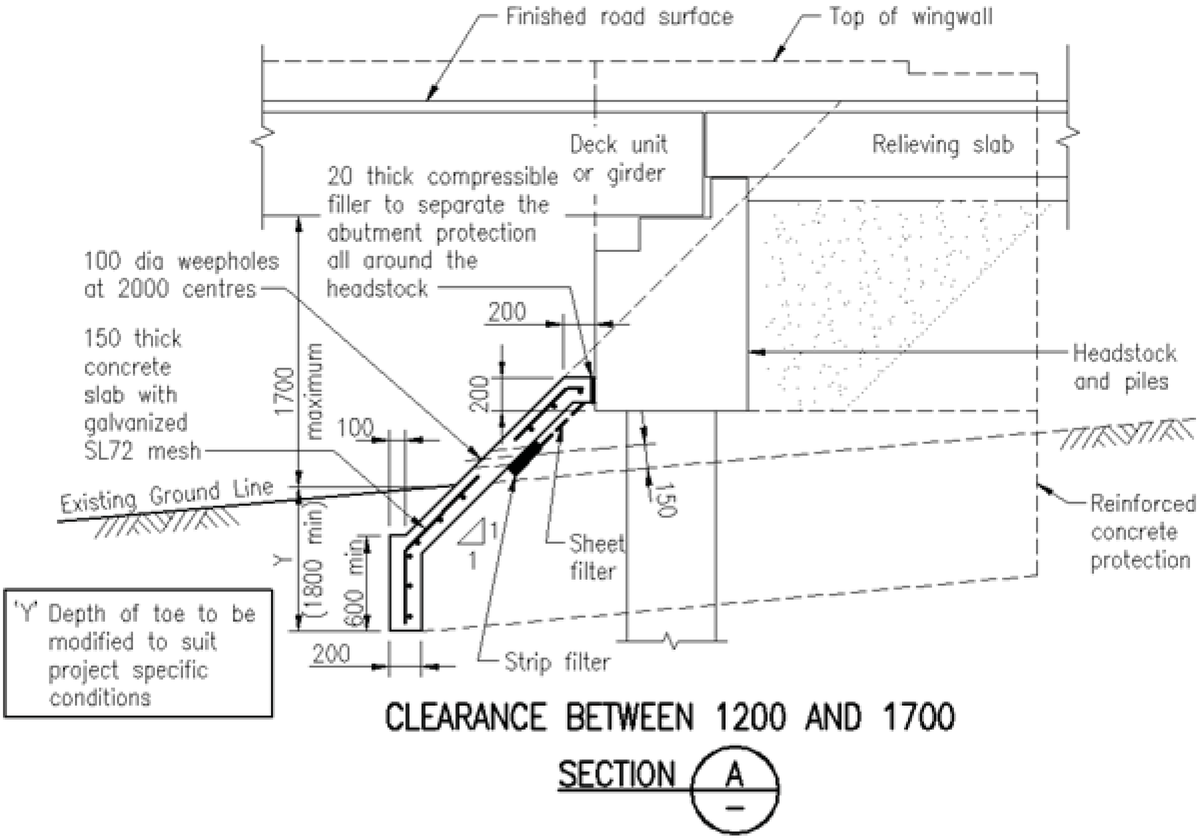
Figure 13.7-2 Minimum Inspection Height of 1200 mm



Inspection Height between 1200 mm and 1700 mm

When the distance from the underside of the deck unit/girder to the ground at the foot of the abutment protection spillthrough is between 1200 mm and 1700 mm, an inspection and maintenance platform shall not be provided. Refer Figure 13.7-3 *Inspection Height between 1200 mm and 1700 mm*. This figure is extracted from TMR Standard Drawings 1542.

Figure 13.7-3 Inspection Height between 1200 mm and 1700 mm

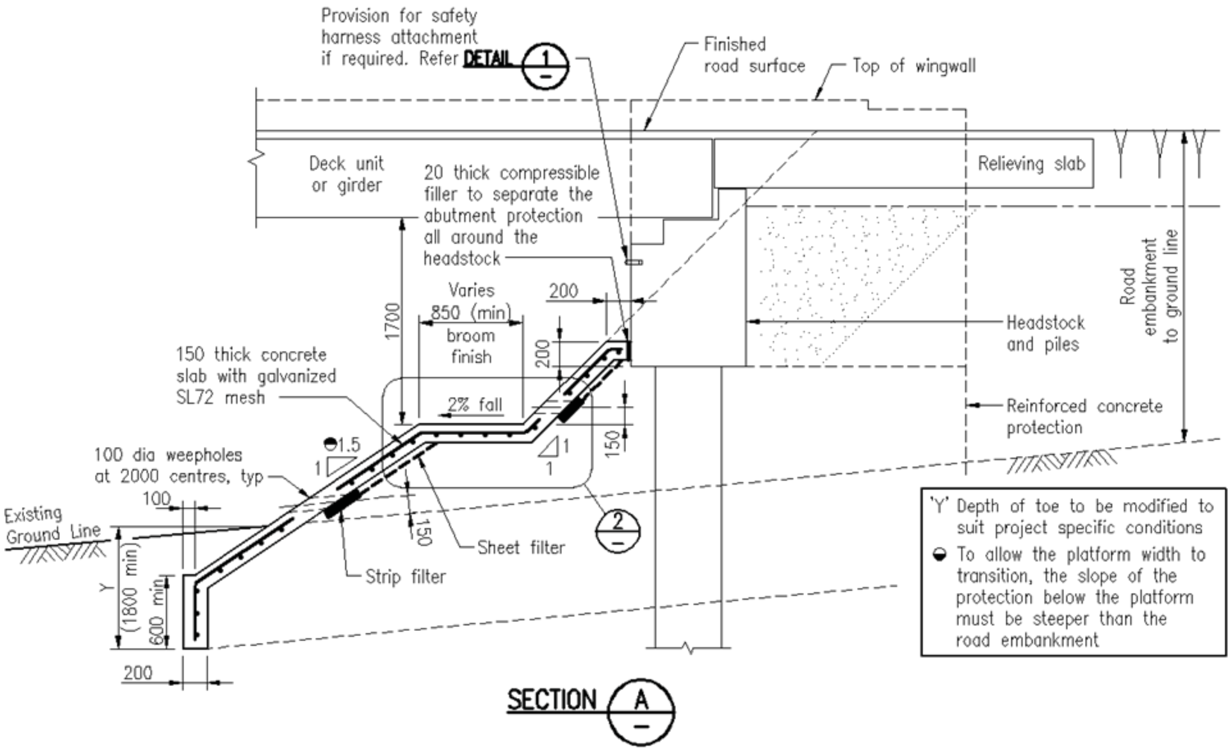


Maximum Inspection Height of 1700 mm

When the distance from the underside of the deck unit/girder to the ground at the foot of the abutment protection spillthrough is greater than 1700 mm, an inspection and maintenance platform shall be provided. This height will suit an average sized person. The platform shall be 850 mm wide. When the platform is constructed with concrete it shall be broom finished to improve traction when walking on the platform.

When an inspection and maintenance platform is provided, the slope of the abutment protection spillthrough below the platform shall be no steeper than one on 1.5. Refer Figure 13.7-4 *Maximum Inspection Height of 1700 mm*. This figure is extracted from TMR Standard Drawings 1543.

Figure 13.7-4 Maximum Inspection Height of 1700 mm

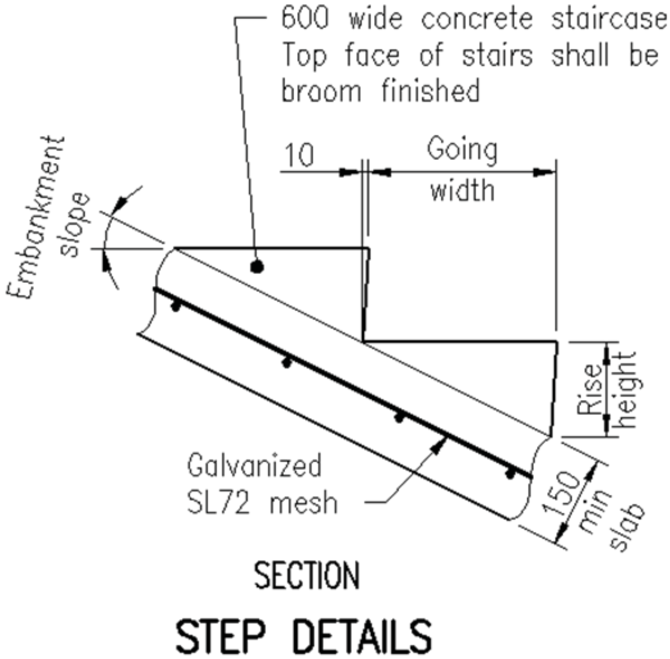


Staircase Access to the Inspection & Maintenance Platform

When the slope of the roadway embankment is steeper than one on two, a 600 mm wide stairs may be provided to allow safe access to the inspection and maintenance platform. The stairs may provide access from either above or below the platform.

The staircase slab shall be 150 mm thick minimum for standard abutment protection types 1 and 2 and 300 mm thick for type 4. Refer Figure 13.7-5 *Staircase details*. This figure is extracted from TMR Standard Drawings 1543.

Figure 13.7-5 Staircase details



STAIR DIMENSIONS

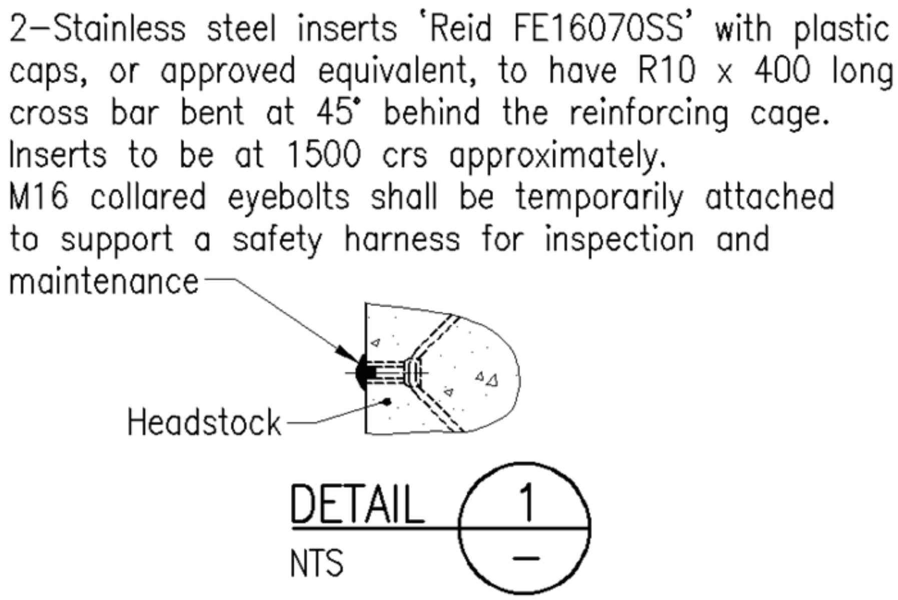
★ Embankment slope	Going width	Rise height
1 on 1 (45°)	215	215
1 on 1.5 (33.7°)	263	175
1 on 2 (26.6°)	300	150

★ Refer to AS 1657 for step details for alternate slopes

Inserts for Safety Harness Attachment

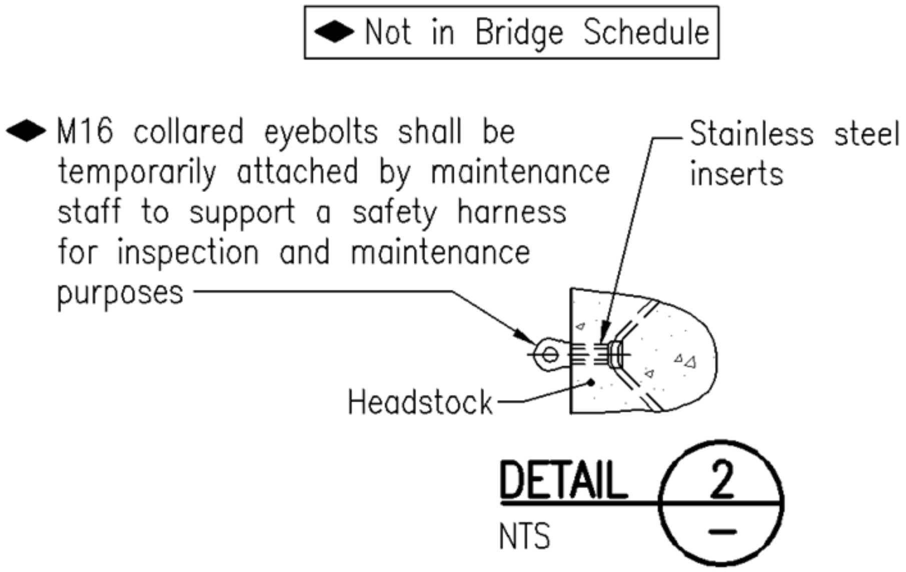
If it is likely a person would be injured by falling from the inspection and maintenance platform, inserts shall be cast into the headstock to allow for attachment of a safety harness. The inserts shall be spaced a maximum of 1500 mm. The details shown in Figure 13.7-6 *Insert Details at Abutments* shall be shown on the abutment drawings.

Figure 13.7-6 *Insert Details at Abutments*



The details shown in Figure 13.7-7 shall be shown on the inspection and maintenance drawing. It refers back to the abutment drawing for the insert details.

Figure 13.7-7 Eyebolt Details



13.8 Bridge Jacking, Inspection and Maintenance Drawing

A Design Report is required for every bridge design. This must include a section on future bridge inspection and maintenance. Whenever there is provision for future bridge jacking, an inspection and maintenance drawing shall be included in the set of bridge drawings. The following details are required on the drawing:

- Jack details including dimensions, manufacturer, model number, capacity and stroke
- Jack locations during jacking
- Details for how the bridge headstocks can be accessed for inspection and maintenance
- Design criteria for the lifting process
- Site preparation and access
- Bearing replacement procedure.

For examples refer Appendix A *Example Bridge Jacking, Inspection and Maintenance Drawings*.

Jack Details

Refer Figure 13.8-1 *Example Jack Details*.

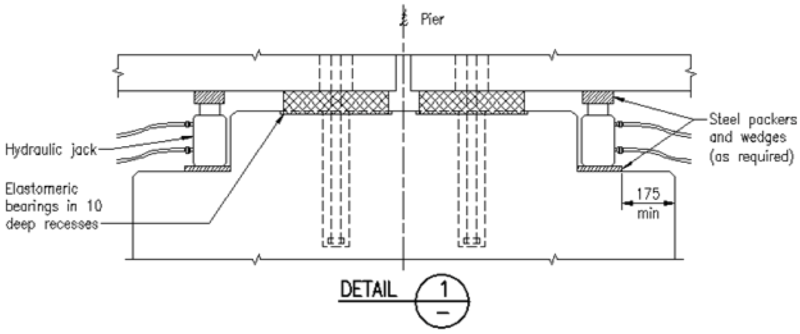
Figure 13.8-1 Example Jack Details

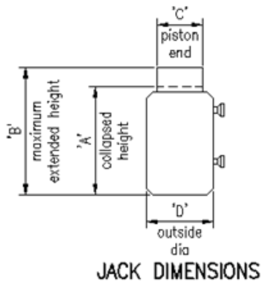
JACK DETAILS – CORRECT AT TIME OF DRAWING ISSUE

MANUFACTURER	MODEL No	◒Jack Capacity (tonnes)	Stroke (mm)	Dimensions 'A' (mm)	'B' (mm)	'C' (mm)	'D' (mm)
ENERPAC	CLRG–502 Double–Acting High Tonnage Jack	45	50	162	212	70	130

Alternative jacks may be substituted if approved by Department of Transport and Main Roads (Bridge and Marine Engineering Section).

◒Jack SWL shall be at least twice the actual load.

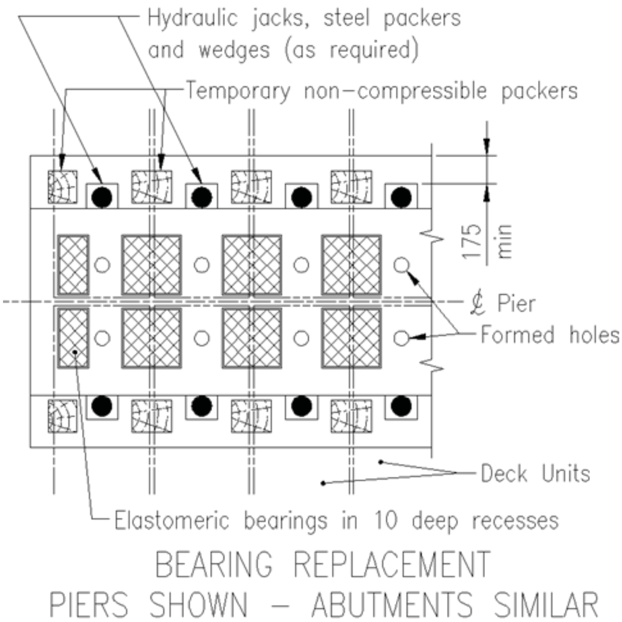




Jack Locations

Jacks must always be placed vertically. Steel packers and wedges are used to accommodate any slope on the bearing shelf and any hog/grade of the deck units. The drawing shall show the location of the jacks. Refer Figure 13.8-2 *Example Jack Location Details*.

Figure 13.8-2 Example Jack Location Details



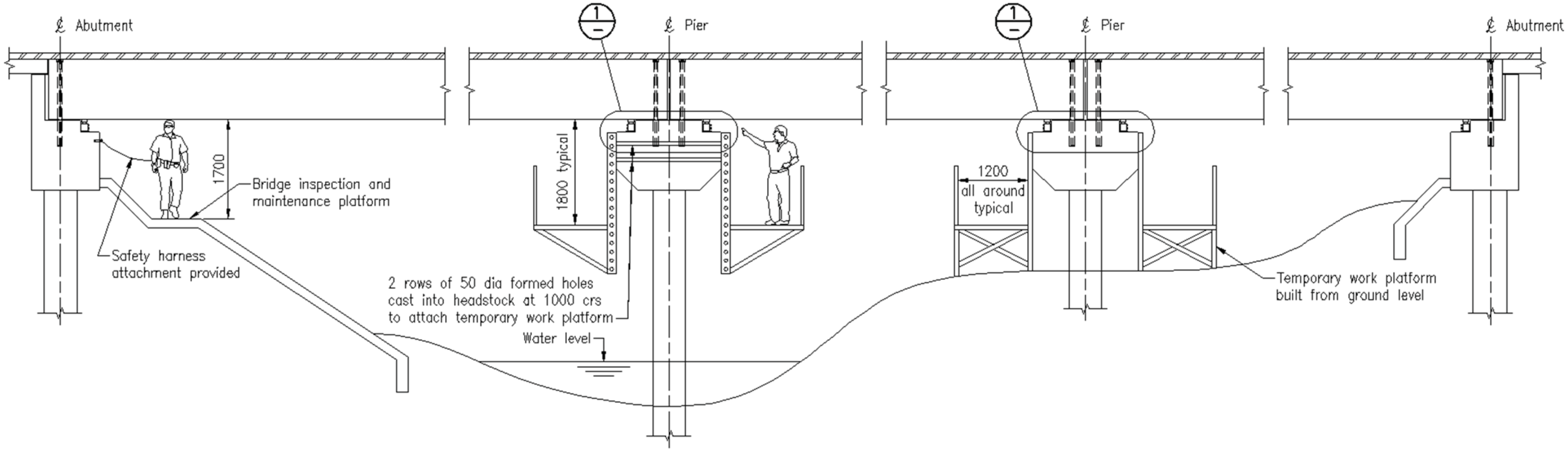
Bearing Replacement Procedure

The drawing shall explain the design assumptions for lifting, site preparation and access, and the bearing replacement procedure. For examples refer Appendix A *Example Bridge Jacking, Inspection and Maintenance Drawings*. Take care to reword the notes to suit the bridge in question.

Inspection and Maintenance Access

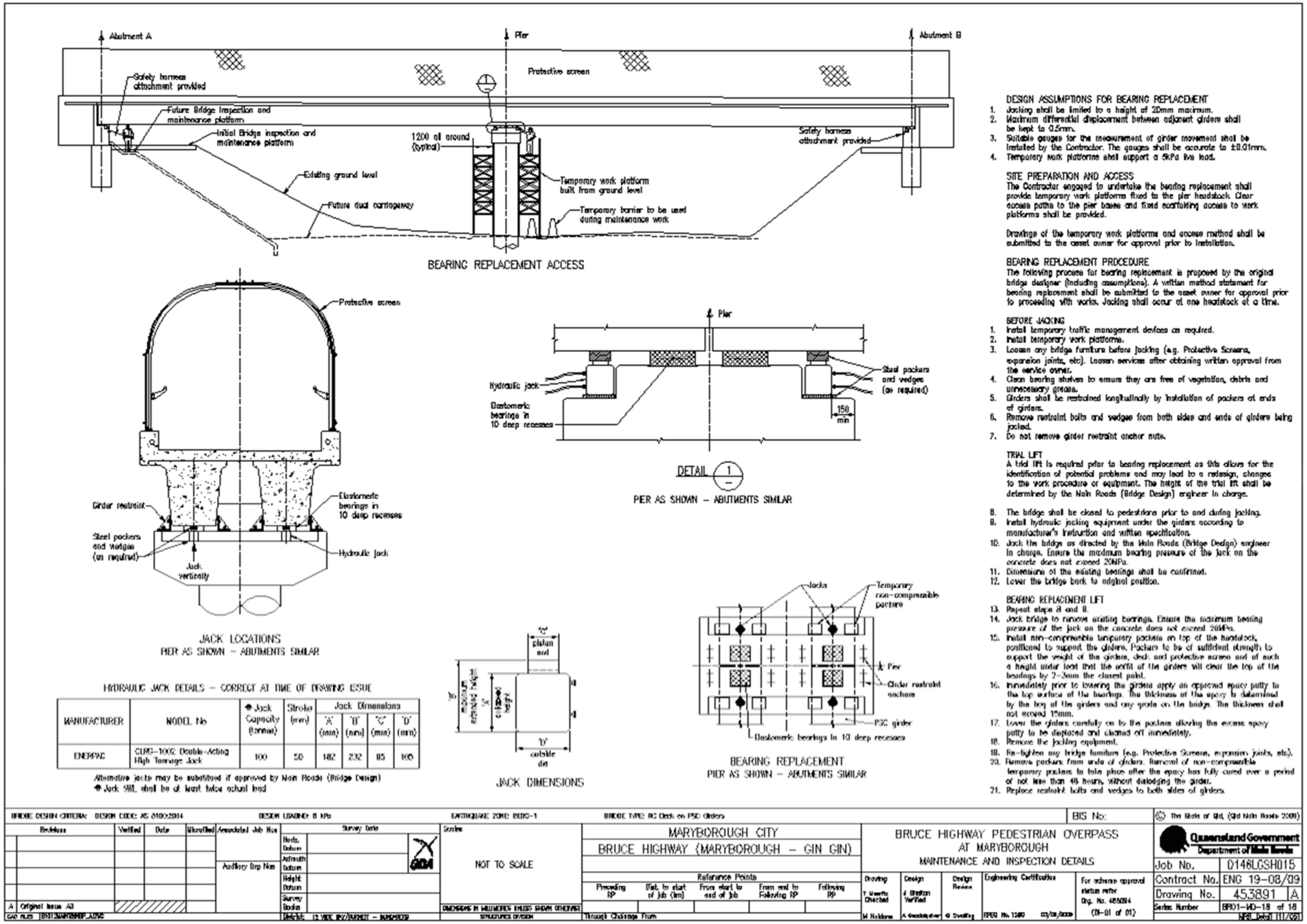
As explained in 13.7 *Abutment Protection*, a risk assessment shall determine which safety features are needed for inspection and maintenance to be done safely. The drawing shall show how access to the bridge can be done safely. Refer Figure 13.8-3 *Example Bearing Replacement Access Details*.

Figure 13.8-3 Example Bearing Replacement Access Details

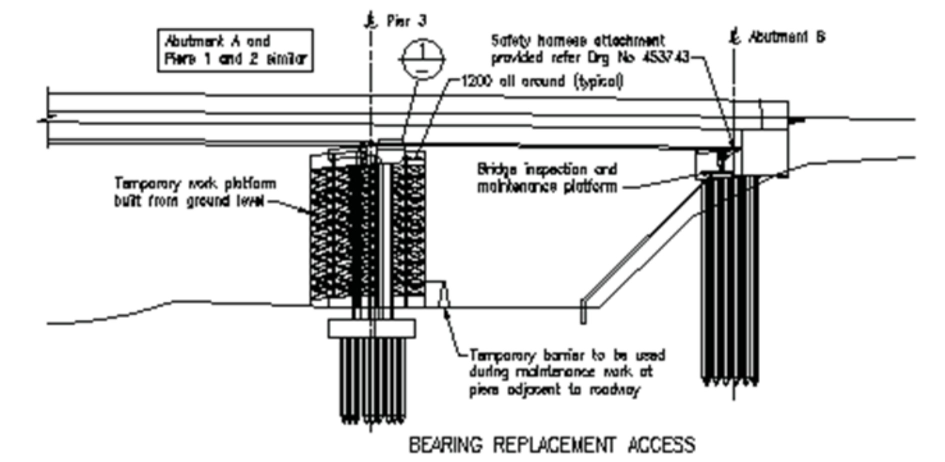


Appendix A – Example Bridge Jacking, Inspection and Maintenance Drawings

Appendix A – Example Bridge Jacking, Inspection and Maintenance Drawings – Sheet 1



Appendix A – Example Bridge Jacking, Inspection and Maintenance Drawings – Sheet 2

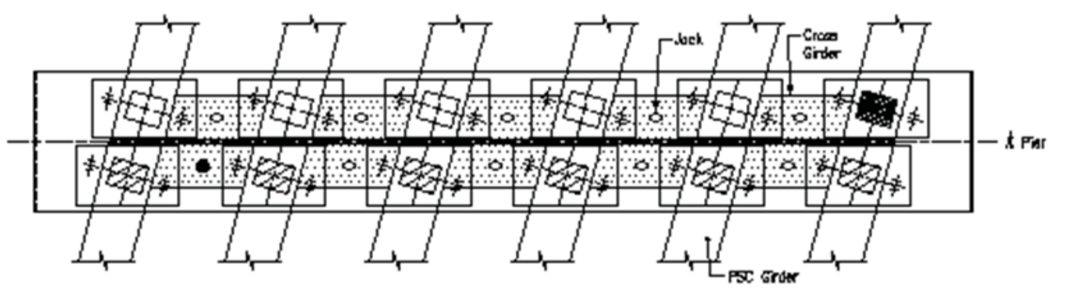


BEARING REPLACEMENT ACCESS

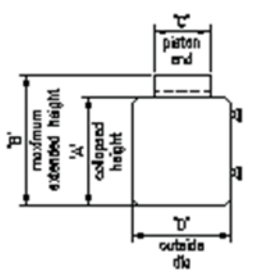
HYDRAULIC JACK DETAILS – CORRECT AT TIME OF DRAWING ISSUE

MANUFACTURER	MODEL No	*Jack Capacity (tonnes)	Stroke (mm)	Jack Dimensions 'A' (mm)	'B' (mm)	'C' (mm)	'D' (mm)
ENERPAC	40030SALR Single-Acting High Tonnage Jack fitted with tilt saddles in contact with the cross girder	411	30	190	220	270	380

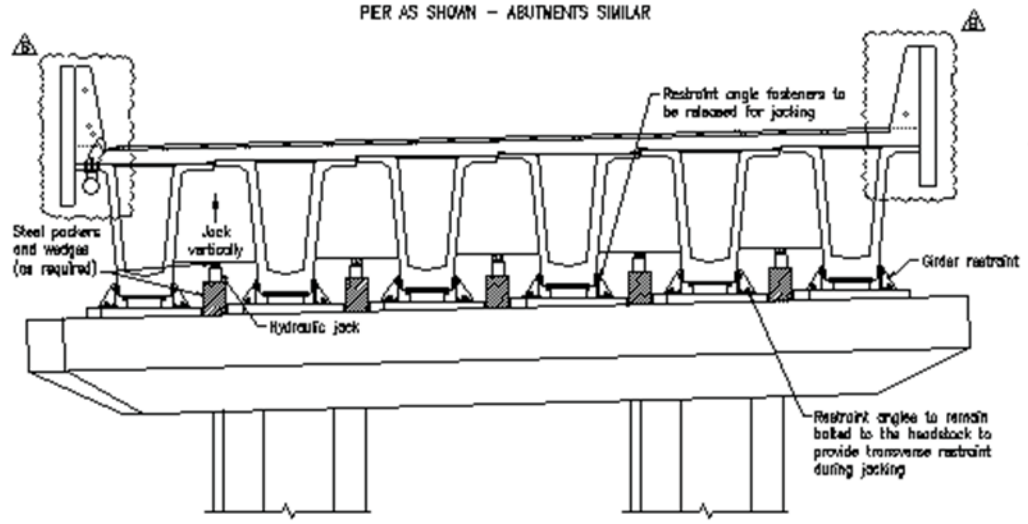
Alternative jacks may be substituted if approved by Main Roads (Bridge Design)
* Jack SWL shall be at least twice actual load



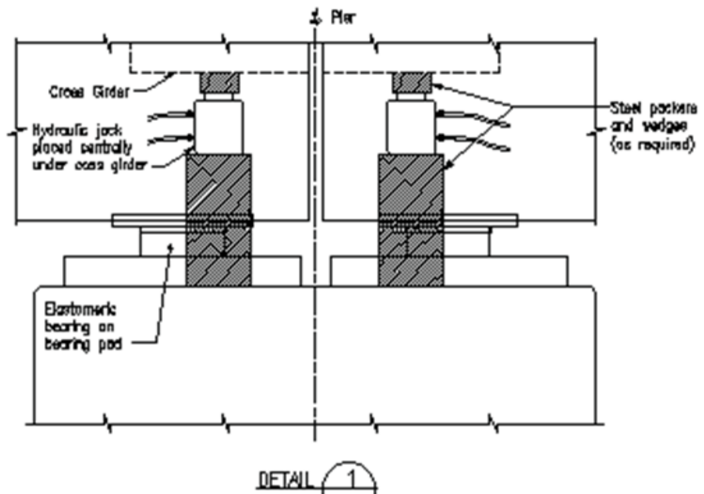
BEARING REPLACEMENT
PIER AS SHOWN – ABUTMENTS SIMILAR



JACK DIMENSIONS



JACK LOCATIONS
PIER AS SHOWN – ABUTMENTS SIMILAR



DETAIL 1
PIER AS SHOWN – ABUTMENTS SIMILAR

DESIGN ASSUMPTIONS

1. Jacking shall be limited to a height of 20mm maximum.
2. Maximum differential displacement between adjacent girders shall be kept to 0.5mm.
3. Suitable gauges for the measurement of girder movement shall be installed by the Contractor. The gauges shall be accurate to ±0.01mm.
4. Temporary work platforms shall support a 5kPa live load.
5. All girders at one end of the span are to be lifted simultaneously. Jacking shall only occur at one headstock at a time.
6. The X/S joint (or approved equivalent) in the DWS at the abutments is designed to stretch to twice it's width. This is enough to accommodate the small amount that the girders are jacked. However, it may be found that during the trial lift that the joint fails. If this is the case the joint shall be removed and then replaced once jacking is complete.

SITE PREPARATION AND ACCESS

The Contractor engaged to undertake the bearing replacement shall provide temporary work platforms fixed to the pier headstocks. Clear access paths to the pier bases and fixed scaffolding access to work platforms shall be provided.

Drawings of the temporary work platforms and access method shall be submitted to the asset owner for approval prior to installation.

BEARING REPLACEMENT PROCEDURE

The following process for bearing replacement is proposed by the original bridge designer (including assumptions). A written method statement for bearing replacement shall be submitted to the asset owner for approval prior to proceeding with works.

BEFORE JACKING

1. Install temporary traffic management devices as required.
2. Install temporary work platforms.
3. Loosen any bridge furniture before jacking where necessary (e.g. glands in expansion joints, cover plate etc). Loosen services after obtaining written approval from the service owner.
4. Clean bearing shelves to ensure they are free of vegetation, debris and unnecessary grease.
5. Girders shall be restrained longitudinally by installation of packers at ends of girders.
6. Remove restraint angle fasteners and wedges from both sides and ends of girders being jacked.
7. Do not remove restraint angle anchors.

TRIAL LIFT

A trial lift is required prior to bearing replacement as this allows for the identification of potential problems and may lead to a redesign, changes to the work procedure or equipment. The height of the trial lift shall be determined by the Main Roads (Bridge Design) engineer in charge.

8. The bridge shall be closed to traffic prior to and during jacking.
9. Install hydraulic jacking equipment under the girders according to manufacturer's instruction and written specification.
10. Jack the bridge as directed by the Main Roads (Bridge Design) engineer in charge. Ensure the maximum bearing pressure of the jack on the concrete does not exceed 20MPa.
11. Dimensions of the existing bearings shall be confirmed.
12. Lower the bridge back to original position.

BEARING REPLACEMENT LIFT

13. Repeat steps 9 and 10.
14. Jack bridge to remove existing bearings. Ensure the maximum bearing pressure of the jack on the concrete does not exceed 20MPa.
15. Install non-compressible temporary packers on top of the headstock, positioned to support the girders. Packers to be of sufficient strength to support the weight of the girders & deck and of such a height under load that the soffit of the girders will clear the top of the new bearings by 2–3mm the closest point.
16. Immediately prior to lowering the girders apply an approved epoxy putty to the top surface of the bearings. The thickness of the epoxy is determined by the hog of the girders and any grade on the bridge. The thickness shall not exceed 15mm.
17. Lower the girders carefully on to the packers allowing the excess epoxy putty to be displaced and cleaned off immediately.
18. Remove the jacking equipment.
19. Re-tighten any bridge furniture (e.g. expansion joints, cover plate etc).
20. Remove packers from ends of girders. Removal of non-compressible temporary packers to take place after the epoxy has fully cured over a period of not less than 48 hours, without dislodging the girder.
21. Replace restraint angle fastners and wedges to both sides of girders.

BRIDGE DESIGN CRITERIA: DESIGN CODE: AS 5100:2004 DESIGN LOADING: SM1600 and HLP400 DESIGN SPEED: 110 km/h EARTHQUAKE ZONE: BEDC-1 BARRIER PERFORMANCE LEVEL: Medium BRIDGE TYPE: RC Deck on PSC Girders BIS No: 41713

Revisions		Certified	Date	Microfilmed
B	Parapet Redesign			
A	Issue For Construction			

Associated Job Nos
Auxiliary Drg Nos
CAD FILES

Survey Data: Horiz. Datum MGA 94 ZONE 55; Height Datum AHD (D); Survey Books FB836 – 87863
District: Northern Region – Townsville

Scales: NOT TO SCALE
DIMENSIONS IN MILLIMETRES UNLESS SHOWN OTHERWISE
STRUCTURES DIVISION

TOWNSVILLE CITY
BRUCE HIGHWAY (TOWNSVILLE – INGHAM)
CH 758.695 – CH 867.765

Reference Points				
Preceding RP	Dist. to start of Job (km)	From start to end of Job	From end to Following RP	Following RP
10M/1C	5.212	0.11	5.533	10M/2A

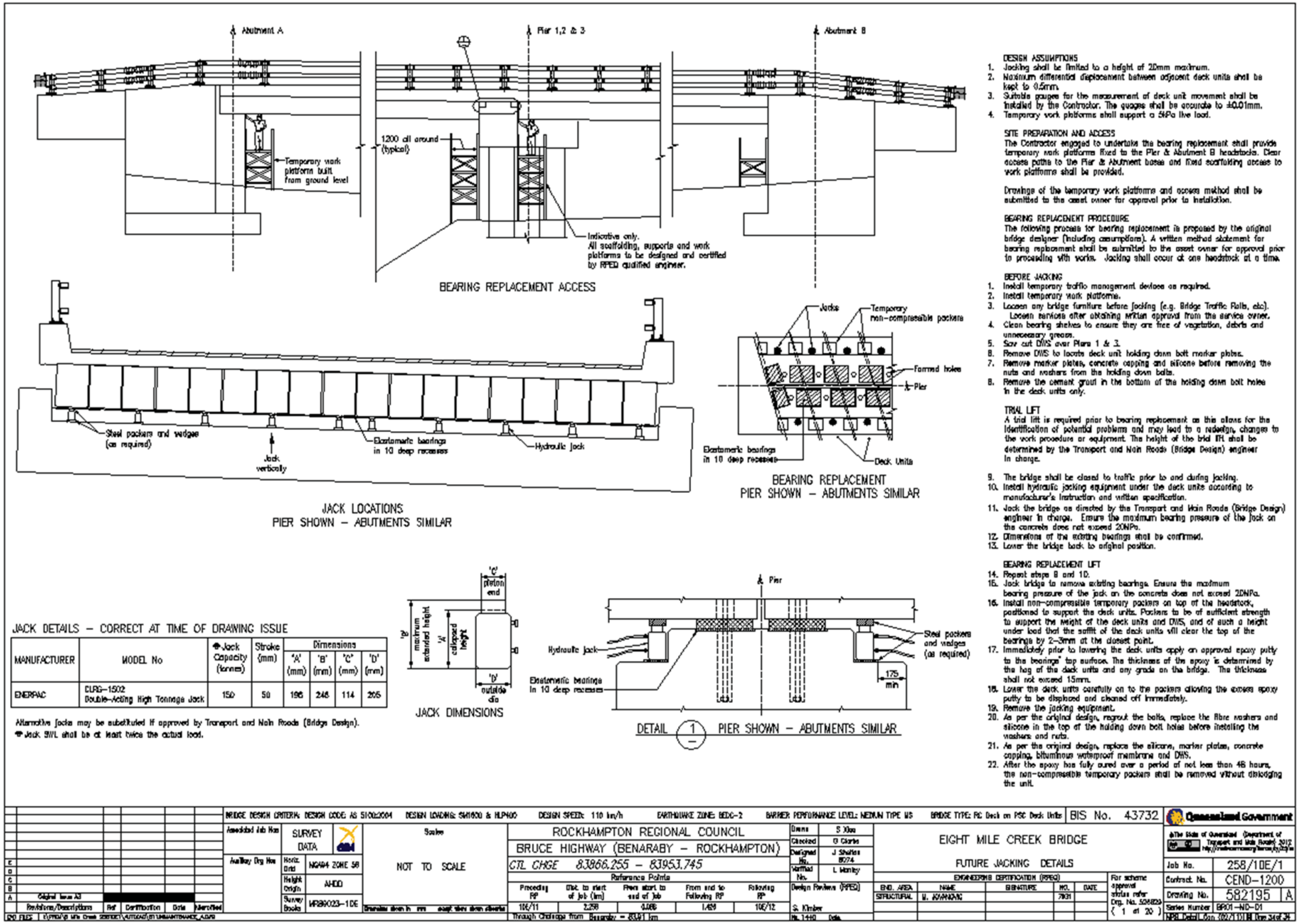
Through Chainage From Intersection of 10N/10L/14A 9.084 km

UNIVERSITY CREEK BRIDGE DUPLICATION
MAINTENANCE AND INSPECTION DETAILS

Drawing: R Gibson; Checked: S Flanagan
Design: J Shelton; Verified: P Pyasena
Design Review: N Holdsworth
Engineering Certification: K V Jacobs, RPEQ No. 9904, 22/4/10
For scheme approval status refer Drg. No.

Queensland Government
Department of Transport and Main Roads
Job No. 268/10M/2
Contract No. NTHD-913
Drawing No. 453768 B
Series Number BR02-MD-29 of 33

Appendix A – Example Bridge Jacking, Inspection and Maintenance Drawings – Sheet 3



Drafting and Design Presentation Standards
Volume 3: Structural Drafting Standards

Chapter 14: Prestressed Concrete Girders

March 2018

Queensland Government

Chapter 14 Amendments

Revision register

Issue/Rev No.	Reference Section	Description of Revision	Authorised by	Date
1	–	First Issue.	Manager (Structural Drafting)	Apr 2011
2	–	Document name change.	Manager (Structural Drafting)	Nov 2011
	14.5	The 30 mm dia drain hole shall not be positioned vertically between strands. Restraint angle fasteners shall be located above the bottom two rows of strands. Strands shall have 60 mm min cover to voids.		
	14.6	Restraint angle details vary depending on the forces they are designed to accommodate.		
	14.8	Figures amended to shown current standard reinforcement details. Fastener move upwards between 2nd and 3rd row of strands.		
	14.10	Add details on alternate cross girder design. Holes may be required if the bridge is subject to flooding.		
	14.12	Lifting Loops section added.		
	14.13	Girder erection sequence added.		
	Appendix A	1200 mm deep girder removed. 1500 mm and 1800 mm deep girders updated.		
	Appendix B	Example drawings replaced.		
3	All sections	General revisions and the inclusion of new Transport and Main Roads approved Wide Flange I-Girders.	Team Leader (Structural Drafting)	Feb 2018
	14.3.1	Figure 14.3.1 Closed Top Flange T-Girders marked ‘Not Permitted’.		
	14.4	Girder drawings to include all the information required by casting yards.		
	14.5	Figures 14.5-4, 14.5-5 and 14.5-7 amended. Reference to Attachment Plate and minimum dimensions.		
	14.6	Figures 14.6-1, 14.6-2, 14.6-3 and 14.6-5.		

Issue/Rev No.	Reference Section	Description of Revision	Authorised by	Date
	14.7	Figure 14.7-1.		
	14.9	Notes added regarding the stability of girders.		
	Appendix B	Sample T-Roff girder drawings - Sheet 10. Two 10A bars deleted from end grid (1st and 3rd bar from the bottom deleted).		

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14 Prestressed Concrete Girders

14.1 Glossary of terms

For a complete glossary of terms refer Chapter 1 – *Introduction.*

14.2 Figures and examples shown in this volume

The figures and examples shown in this volume are for presentation purposes only, and may contain some details that are now superseded. These details have been included for ease of reference, to illustrate typical solutions, and to show the required standard of drafting presentation. The details are not to be used without an engineering check and certification by a Structural RPEQ to confirm that the details are appropriate for the specific project.

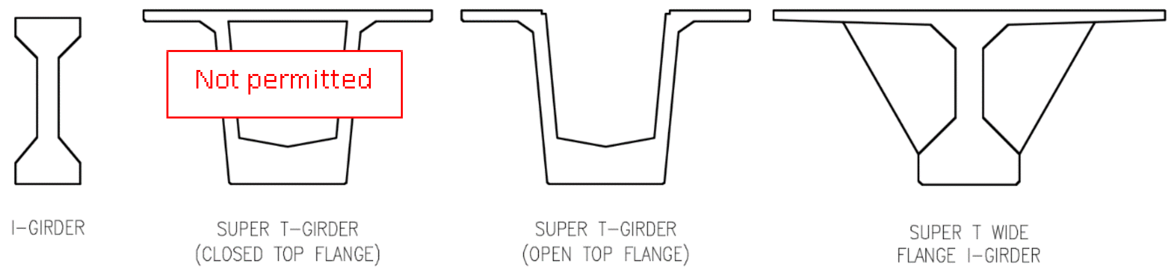
14.3 General

This chapter discusses the typical arrangement of PSC girders. PSC Super T-Girders are currently the most prevalent girder type for spans in the order of 25 – 36 m. Alternative 'Wide Flange I-Girders' now have type approval for designs where spans may be up to 46 m. Wider flanges for this girder type may also be used (shorter spans) to reduce the required number of girders. Many details shown in this chapter specifically are relevant for Super T-Girders. Most of the general parameters are applicable to the Wide Flange I-Girders also, for example, half joints (not permitted), restraints, and so on. Project specific examples of these girders may be sourced from the Lucinda Drive project on the Port Drive (Port of Brisbane) project. A design guide for the Transport and Main Roads approved 'Wide Flange I-Girders' is also available from approved suppliers as listed in the Proprietary Design Index for Bridges and Other Structures.

For Super T-Girders steel tub void formers are to be used, producing an open void which facilitates ease of inspection. Girders with closed voids are not acceptable due to casting issues related to the accurate restraint of void formers and the difficulty of verifying casting and compaction.

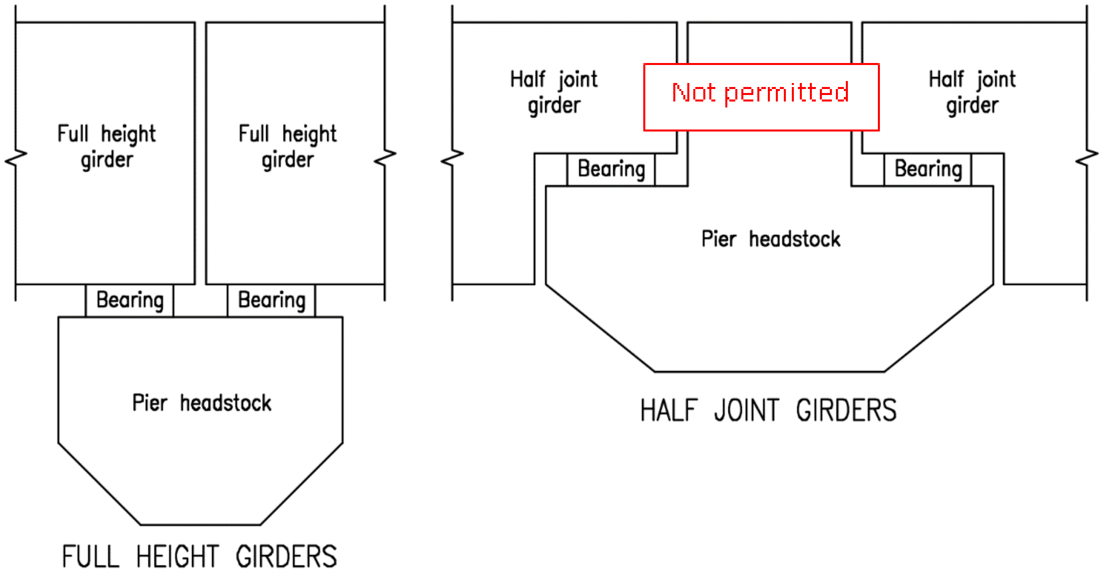
PSC girders are typically used for spans greater than 25 m long where they become more economical to use than PSC deck units. Refer example drawings in Appendix B - *Example Super T-Girder Drawings*.

Figure 14.3(a) - Girder types



Girders with half joints (shown below), are not permitted on Transport and Main Roads designs due to the issues related to shear forces at the half joints and the level of reinforcing required to overcome shear in such a compact environment.

Figure 14.3(b) - Girder joints



14.4 Standard design details

Standard Super T-girder design sheets have been developed in Structures and Marine Engineering Branch and are used as the standard for design and presentation in the production of departmental bridge drawings. For standard details for 1500 and 1800 mm deep super T-girders refer Appendix A *Super T-Girder Design Sketches*.

All departmental PSC girder drawings shall provide the casting yards with all the required project specific information in an easy to understand format on a succinct set of drawings, supplemented only by the general arrangements, general notes and specifications.

14.5 Super T-Girder profiles

T-Girder dimensions and void arrangements shall be in accordance with Chapter 4 of the *Design Criteria for Bridges and Other Structures*. Options are supplied for girder depths ranging from 1000 to 1825 mm deep.

Girder sectional properties for Super I-Girders will be project specific and within the constraints of the dedicated casting yard and subject to review by the department as per the normal design requirements of the *Design Criteria for Bridges and Other Structures*.

For girder mass calculations, the specific density of 2.7 tonnes/m^3 shall be used.

Super T-Girders - Flange widths

The outer profile of a girder must comply with AS 5100.5. Casting yard forms comply with this profile. The width of the girder flanges may vary to suit the width of the bridge deck.

Whenever possible, the flanges on outer girders are to be made the same width as those on the internal girders to keep the number of girder types to a minimum.

An example of where this is not usually possible is when a drain pipe hangs below the outer flange and this flange needs to be wider to accommodate the pipe and its expansion joints. Standard widths of girder flanges may vary from 1226 mm minimum to 2500 mm maximum.

On bridges with a horizontal curve, the outer flange of the outer girders, are to be curved to match the road alignment. When setting out the bridge, the Drafter shall ensure that the flanges are wide enough to fit holes for formwork anchors.

Super T-Girder voids

Voids shall be made from standard 5 m and 2.5 m long forms. The standard void sizes have been developed in coordination with the pre-casting industry and are designed to ensure the manufacture of PSC girders is efficient, simplified and cost effective.

Voids are separated longitudinally by a diaphragm of concrete 150 mm wide containing one set of steel reinforcement. The solid end blocks at each end of the girder will increase or decrease in size to accommodate the standard void lengths.

An end block length is measured along the centreline of the girder. On square or slightly skewed girders the end blocks may vary in length nominally from 2 m up to 3 m to avoid having a non-standard void length.

Refer to the *Design Criteria for Bridges and Other Structures* for acceptable void arrangements.

Super T-Girder void drainage

30 mm diameter drain holes are required between the voids and in the end blocks, to drain the voids prior to deck casting.

The 30 mm diameter drain holes shall not be located vertical between the strands, they must be horizontal between voids and continue horizontally through the end block of the girder each end.

If the bridge is subject to flooding, 100 mm diameter drain holes may be required at the base and top of the voids to allow the voids to fill with water to prevent the bridge from potential floatation.

Gaps between girders – All girder types

Standard practice is to space girders to allow a 30 mm gap between girder flanges, however this may vary slightly depending on the width of girder flanges and the width of bridge deck. During construction the gap is covered by approved high strength waterproof tape to prevent deck concrete from leaking between the girders.

Span lengths – All girder types

Span lengths from pier to pier are generally to be to the nearest metre, with a gap between girders of 50 mm. Thus a 27 m span utilises a girder length of 26950 mm.

In most cases end spans are to use girders with lengths matching the internal spans so the end span length is to be a resultant of the location of the bearings at the abutments.

Strands – All girder types

Strands are to have 60 mm cover to any voids and forms, minimum.

Gaps and inclined girder ends

A nominal gap of 50 mm is provided between the ends of girders on adjacent spans, and between the ends of girders and the abutment ballast wall. When girders are being placed on site they are lowered vertically into position. To provide adequate clearance it is important that the ends of the girders be vertical once placed on the structure.

Therefore, girders are to be designed to have nominally vertical ends after installation. The designer must make allowance for grades, vertical curves and rotation of the girder ends due to the effects of the 100 day design hogs so that the required vertical ends are achieved.

Worked example - bridge on a simple grade.

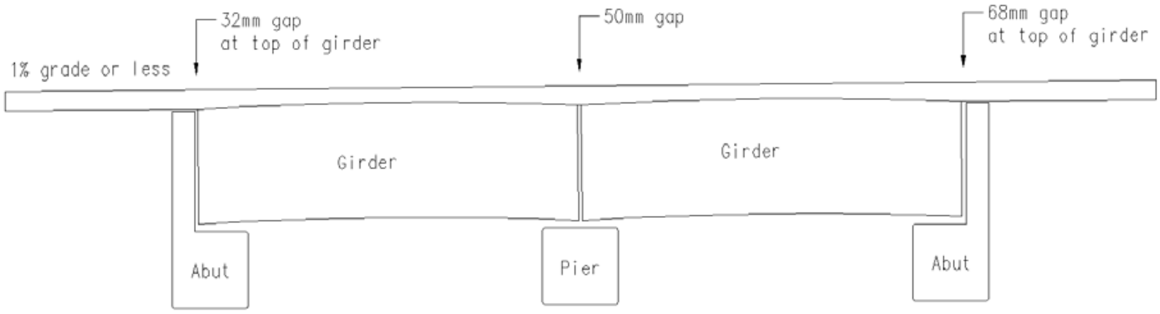
For a project with 1800 deep girders and a 1% grade: the gap between the top of the girder and the ballast wall will reduce at the low end of the bridge. At the lower abutment the gap from the ballast wall to the girder end will be 32 mm. At the high end of the bridge it will increase to 68 mm. These gaps are at the limit of what is acceptable, therefore, 1% is the steepest grade with which the girders ends can be made vertical (at 100 days after casting).

For grades greater than 1%, each end of the girder needs to be inclined to ensure that the ends will be vertical when the girder is installed.

For bridges on a vertical curve the end incline may vary on both ends of the girders on every span. These inclined dimensions may be rationalised to the nearest 5 mm to reduce the amount of variations.

Where deep girders are combined with grades and skews consideration should be given to increased clearance at the abutment ballast walls to accommodate discrepancies in the girder end kicks between designed end kicks and actual. Extra wide flanges may also create increased geometric challenges especially where a vertical curve is applied to the bridge deck. This must be taken into consideration by the designer.

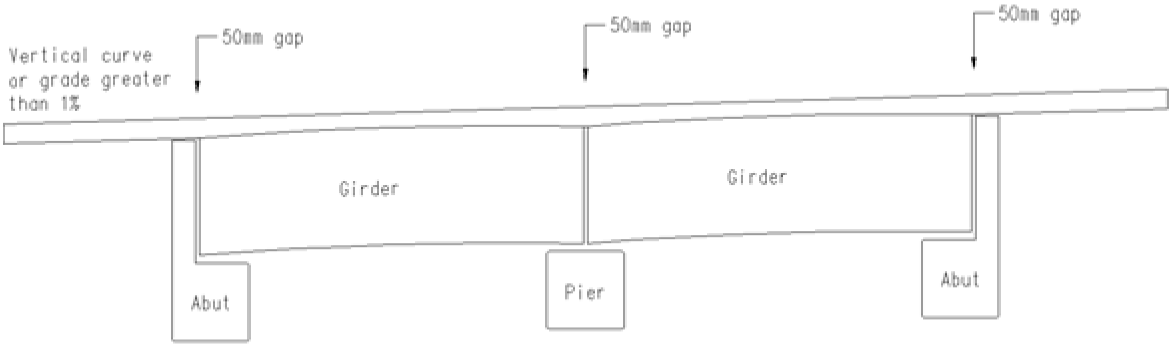
Figure 14.5(a) - Girder end incline guidelines



For bridges on a grade of 1% or less, the ends of the girders are not vertical, but are perpendicular to the bottom of the girder (after 100 days).

Note – The gaps shown are calculated using an 1800 mm deep girder on a 1% grade, the gaps will vary depending on the girder depth. The designer is to calculate the gaps and ensure sufficient clearance is achieved between the girder and the ballast wall.

Figure 14.5(b) - Girder end incline guidelines

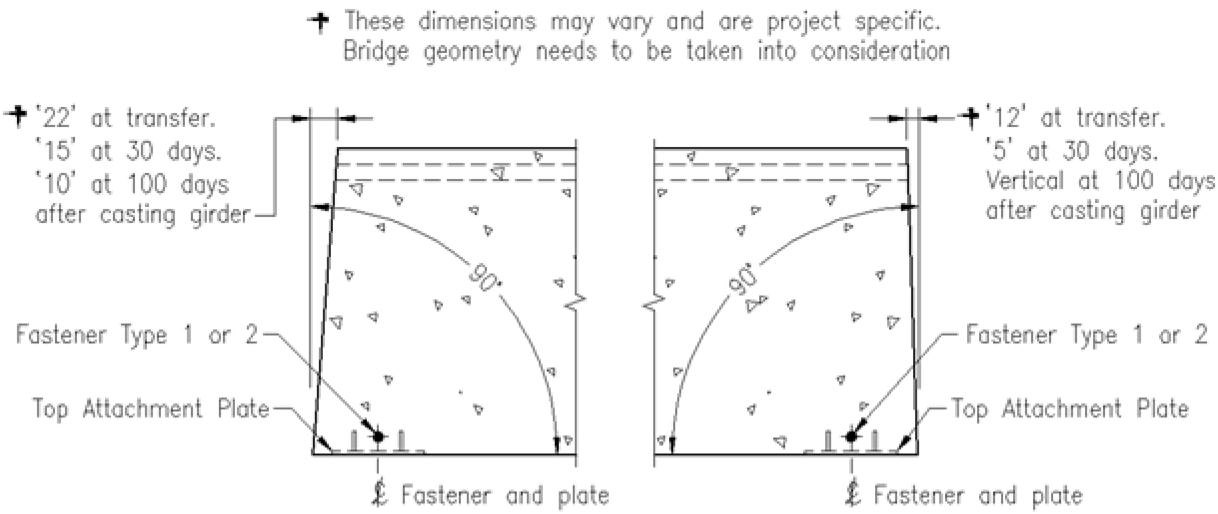


When end incline dimensions are shown on a drawing, three sets of distances are required. These are the distances at transfer, at 30 days, and at 100 days after casting. The transfer figure tells the casting yard what offsets the girder ends must have immediately after it has been cast and is leaving the form.

The casting yard will calculate and make an allowance for the amount of incline required in the form to achieve the designed incline at transfer.

About 30 days after casting, the girder may leave the casting yard, therefore an incline distance is provided to let the precast inspector check that the girder is hogging as designed. The incline distance at 100 days is the amount that the girder end is inclined when it is erected on the bridge. Refer *Figure 14.5(c) - Girder end incline details.*

Figure 14.5(c) - Girder end incline details



Girder anchorage details

Girders and or decks may be anchored by a number of systems.

The department accepts RPEQ certified designs for either:

1. Restraint angles connecting the girders to the headstocks, or
2. Restraint blocks with dowels into cross girders. The dowel caps placed in the cross girders are designed to restrain transversely and manage either expansion or fixed longitudinal restraints.

Pot bearings shall be used, as appropriate, for the larger loads and movements associated with longer spans and or wider flange girders.

A construction sequence for the bearing installation and girder erection is required to detail the proposed sequence and method of bearing and girder installation including the epoxy mortar.

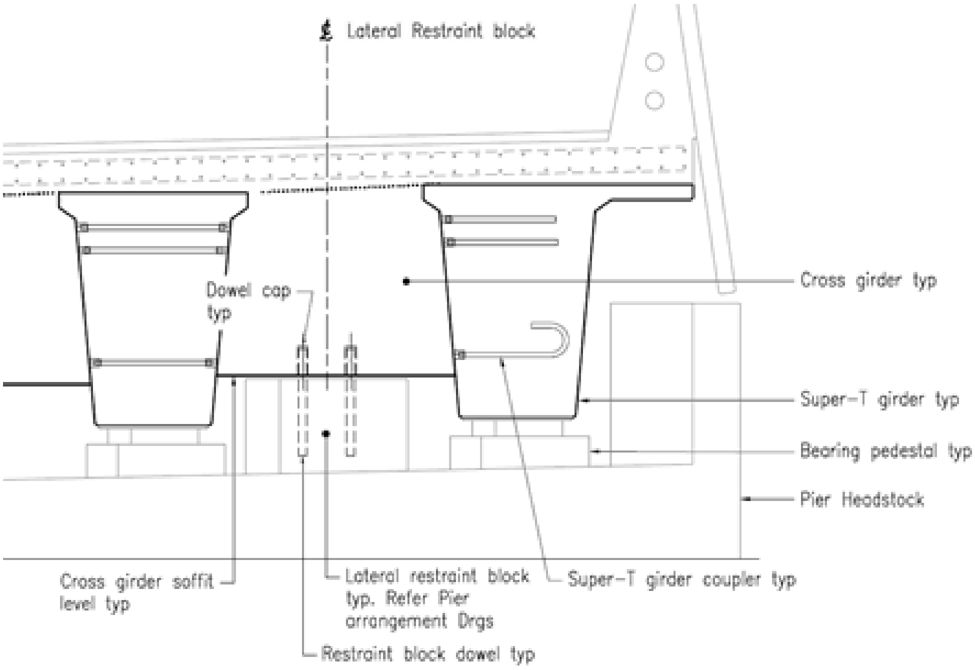
Restraint blocks

Where restraint blocks are used the number and sizes of dowels and restraint blocks are to be determined by the designer to accommodate the required loads. Typically it is expected that cross girders will be deeper than the restraint blocks and dowels will be cast into the restraint blocks deeper than they project into the cross girders. No proprietary products for dowels are approved for use in restraint blocks.

Sufficient details are to be shown for orientation, sizing, reinforcing, dowel caps, dowels, locations and correct installation dimensions and orientation.

Restraint blocks are to be supplied on both ends of each span so that the deck infill pour is not engaged to carry larger loads than otherwise required.

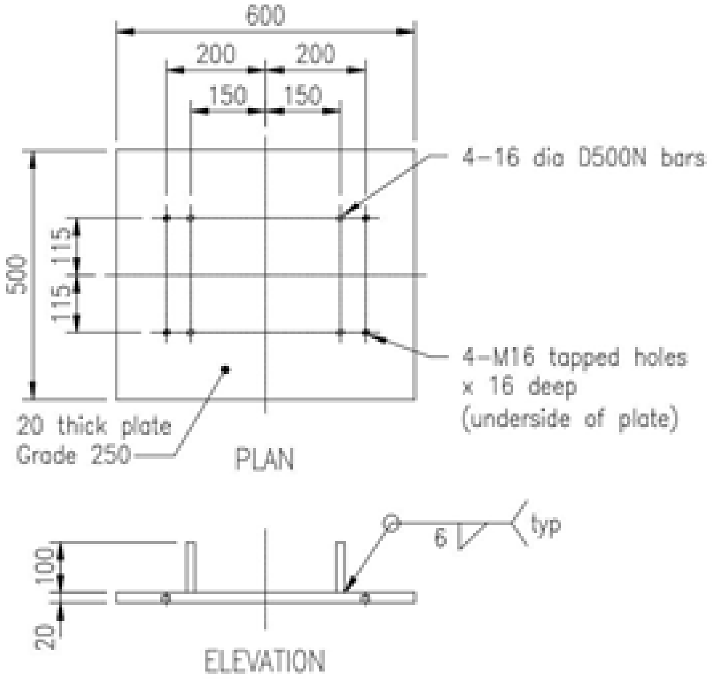
Figure 14.5(d) - Typical restraint block



Top attachment plates

A top attachment plate is cast into the underside of the girder and a bearing restraint plate is then screwed to this before the girder is lifted onto the bridge. The top attachment plate shall be larger in length and width than the bearing restraint plate to ensure plates fully engage after casting. The plate is to be 600 mm minimum width. Four dowel bars welded to the plate hold it in place in the girder.

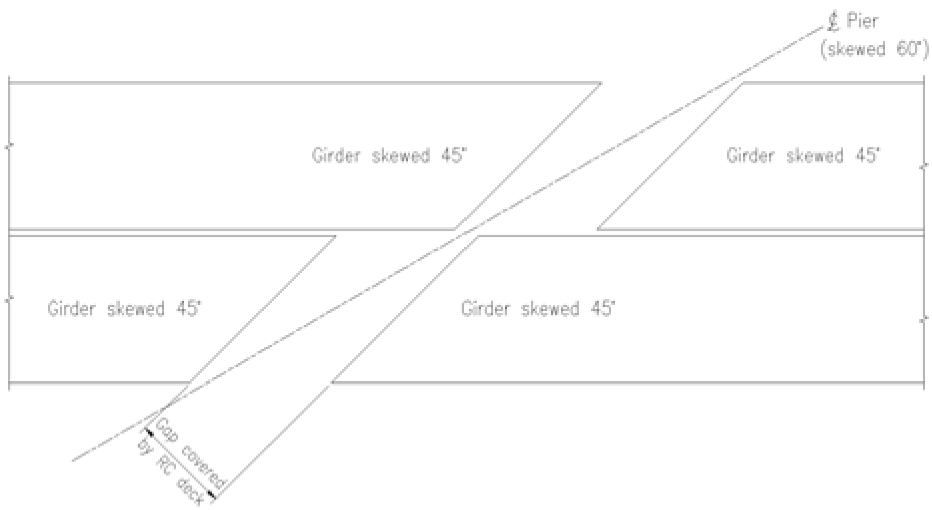
Figure 14.5(e) - Top attachment plate



Skew

Girders should not be skewed more than 45º. When the road and bridge geometry is being designed, every effort should be made to avoid skews larger than this. Due to constraints, skews larger than 45º are sometimes unavoidable. The department does not have a policy or standard details on how girders / decks skewed more than 45º are to be designed. One possible option is to increase the gap between girders of adjacent spans and cover the gap with a reinforced concrete deck. Refer Figure 14.5(f) - *Bridges skewed > 45º*.

Figure 14.5(f) - Bridges skewed > 45º

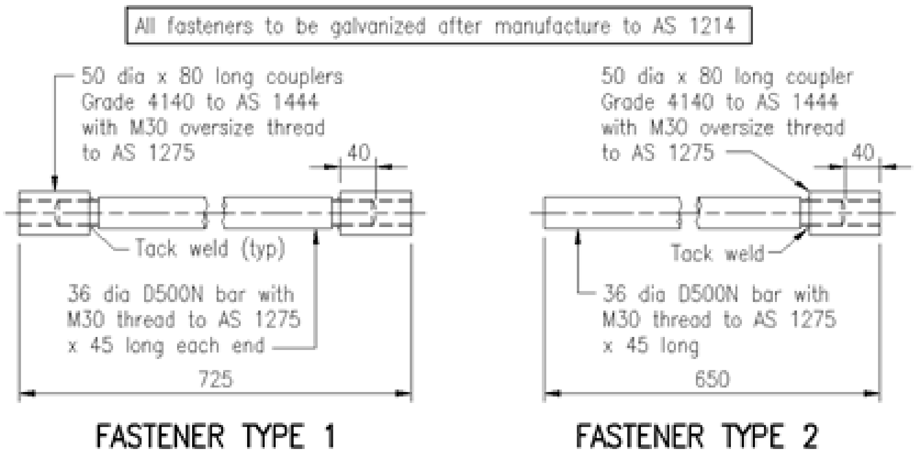


Fasteners

Fasteners are cast into the girder to allow cross girder reinforcement to be attached. These fasteners must be galvanised even though they are encased with cross girder concrete. This is to prevent corrosion caused by steam curing during casting.

Where fasteners are used for restraint brackets the fasteners shall be located above the bottom two rows of strands. To prevent the fasteners being hidden beneath the surface of the concrete a note on the girder drawings shall read '*Fasteners shall be exposed prior to delivery to site*'. For an example of the details required on the girder drawings, refer Figure 14.5(g) - *Girder fasteners*.

Figure 14.5(g) - Girder fasteners

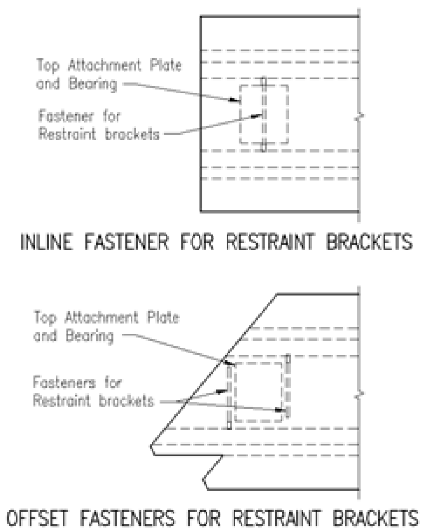


A detailed view (minimum scale of 1:10 on an A1 drawing) shall show how the fasteners, top attachment plate and reinforcing steel fit together in the end block.

Fasteners in skewed girders

On bridges with skews >10º, the restraint bracket fasteners may need to be offset to prevent the headstock widths becoming un-proportionally wide. Chapter 12 – *Abutments and Piers, 12.8 Girder bridge headstock layout* explains the method required to determine if the fasteners need to be offset. Refer Figure 14.5(h) - *Fasteners for restraint brackets*.

Figure 14.5(h) - Fasteners for restraint brackets



14.6 Miscellaneous girder components

Casting yards that manufacture girders require drawings that succinctly detail the components that are cast into the girders i.e. the top attachment plate and the fasteners. Details for the following girder related items are to be shown on the *Miscellaneous Details* drawing.

Bearing restraint plates

Girders supported on elastomeric bearings require a bearing restraint plate above each bearing to stop the bearing moving from its designed position. Because the vertical load from the girder must be applied evenly across the bearing, the plate is tapered to nullify the effect of the girder hogging. The minimum thickness of the plate is 16 mm. For an example of the required bearing restraint plate details refer *Figure 14.6(b) - Bearing restraint plates*. These details shall not be shown on the girder drawing because the casting yard manufacturing the girders will not be fabricating the steelwork. Rather, the details shall be shown on the *Miscellaneous Details* drawing, refer Chapter 18 - *Expansion joints and miscellaneous details.*

If a bridge has different types of plates, a layout diagram is required to show the orientation of the plates, refer *Figure 14.6(a) - Layout diagram for bearing restraint plates*.

Figure 14.6(a) - Layout diagram for bearing restraint plates

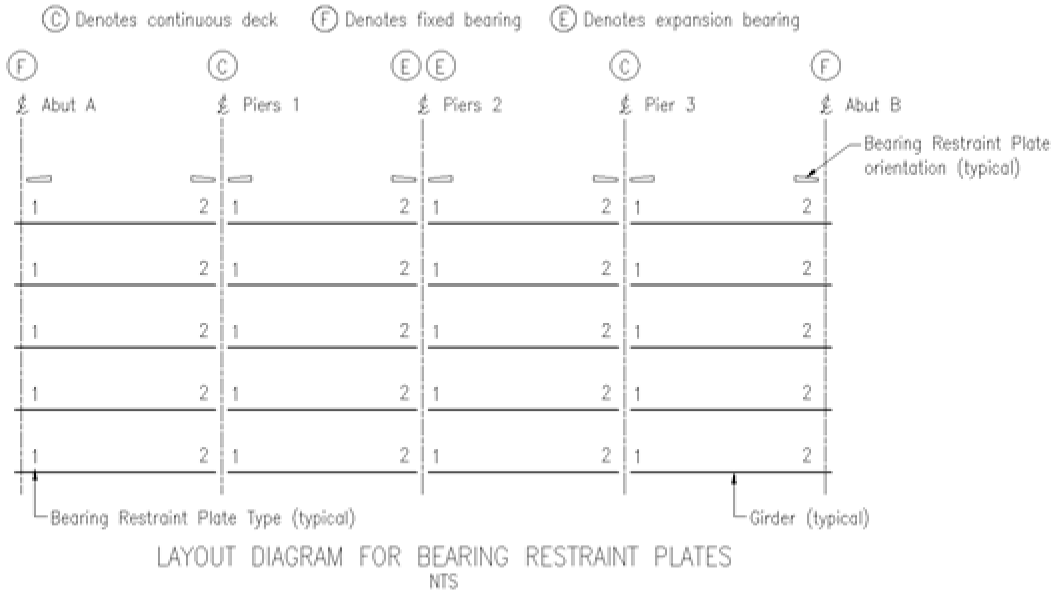
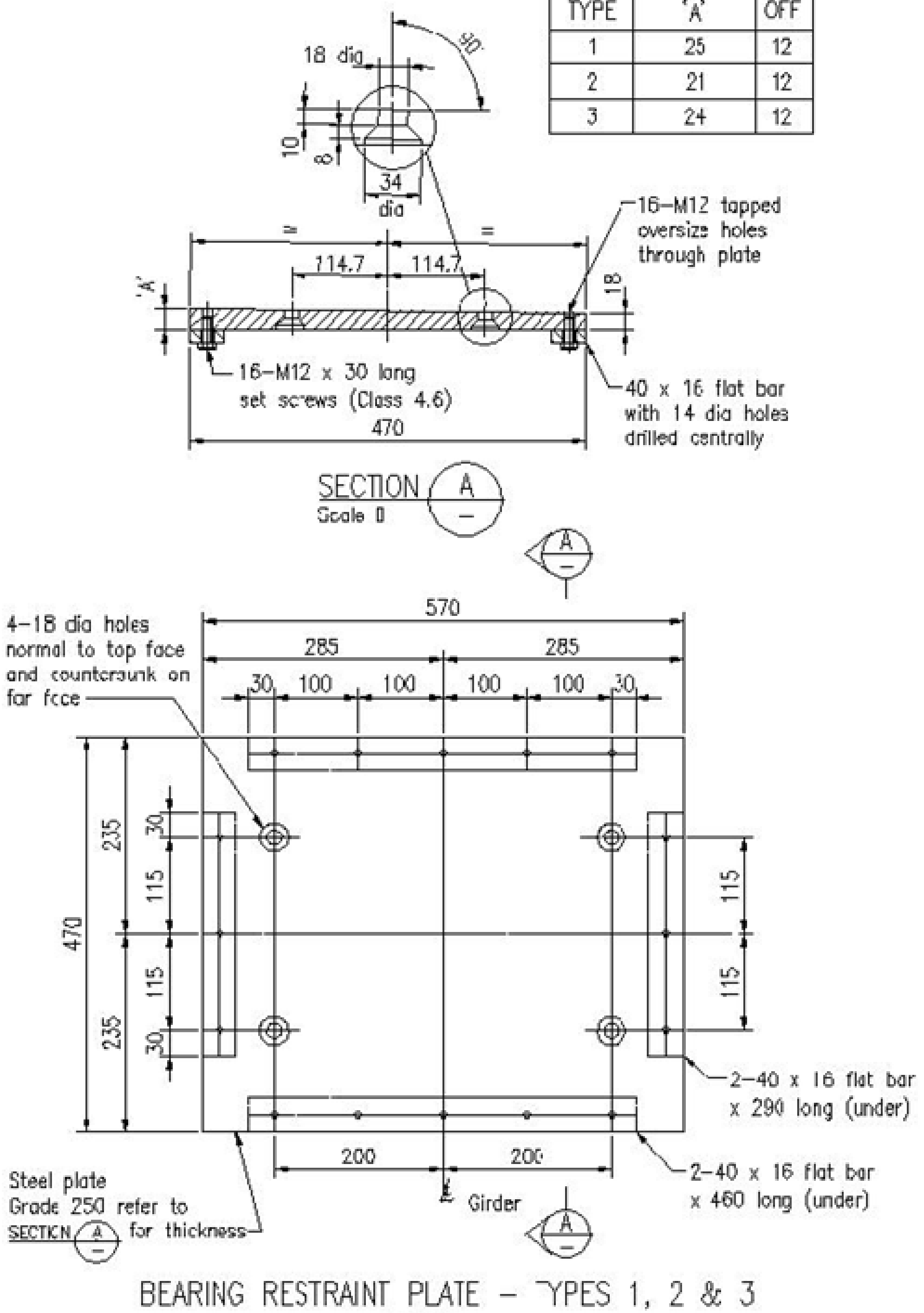


Figure 14.6(b) - Bearing restraint plates

BEARING RESTRAINT PLATES

PLATE TYPE	THICKNESS 'A'	No OFF
1	25	12
2	21	12
3	24	12



14.7 Reinforcement

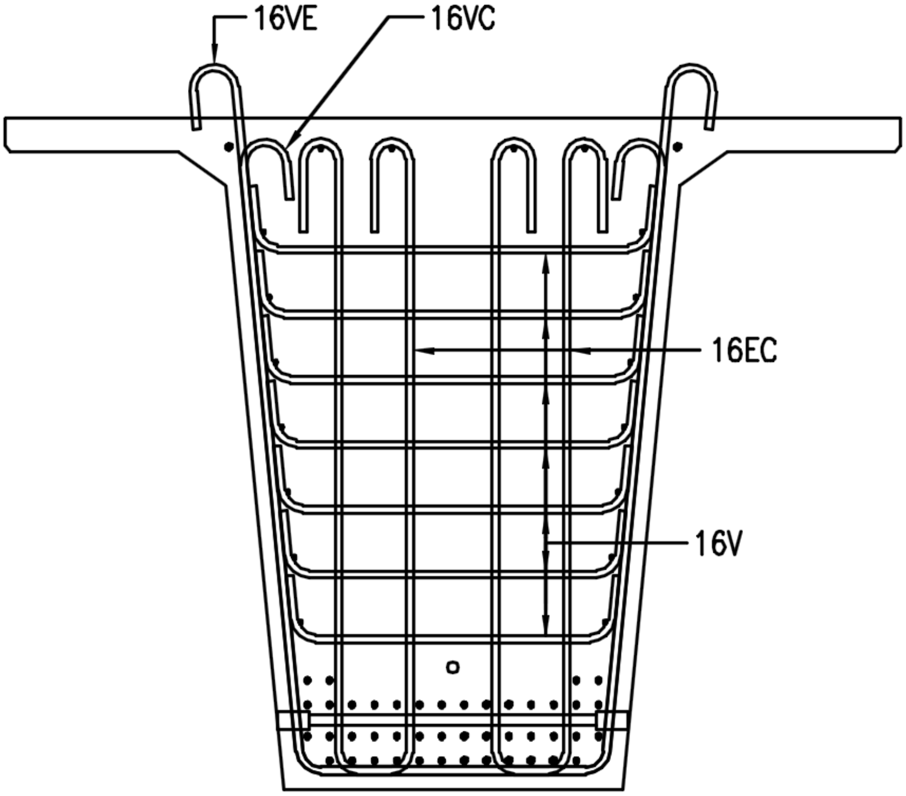
For reinforcing details regarding proprietary Wide Flange I Girders refer to the technical manual produced by the girder supplier. The remaining details in this chapter apply to Super T-Girders.

Most Super T-Girder reinforcing details have been standardised and are shown on the departmental standard design sheets. The Design Engineer should use these details and only calculate the reinforcement set spacing and wall thickness of the girders.

Reinforcing set spacing

Typically there is congestion in the end block due to closely spaced reinforcing. The absolute minimum spacing for reinforcing in the end blocks is 90 mm. In the end blocks the 16V bars shall be placed inside the 16VE and 16VC bars to provide extra clearance between sets. Refer *Figure 14.7(a) - Typical reinforcing set – end blocks.*

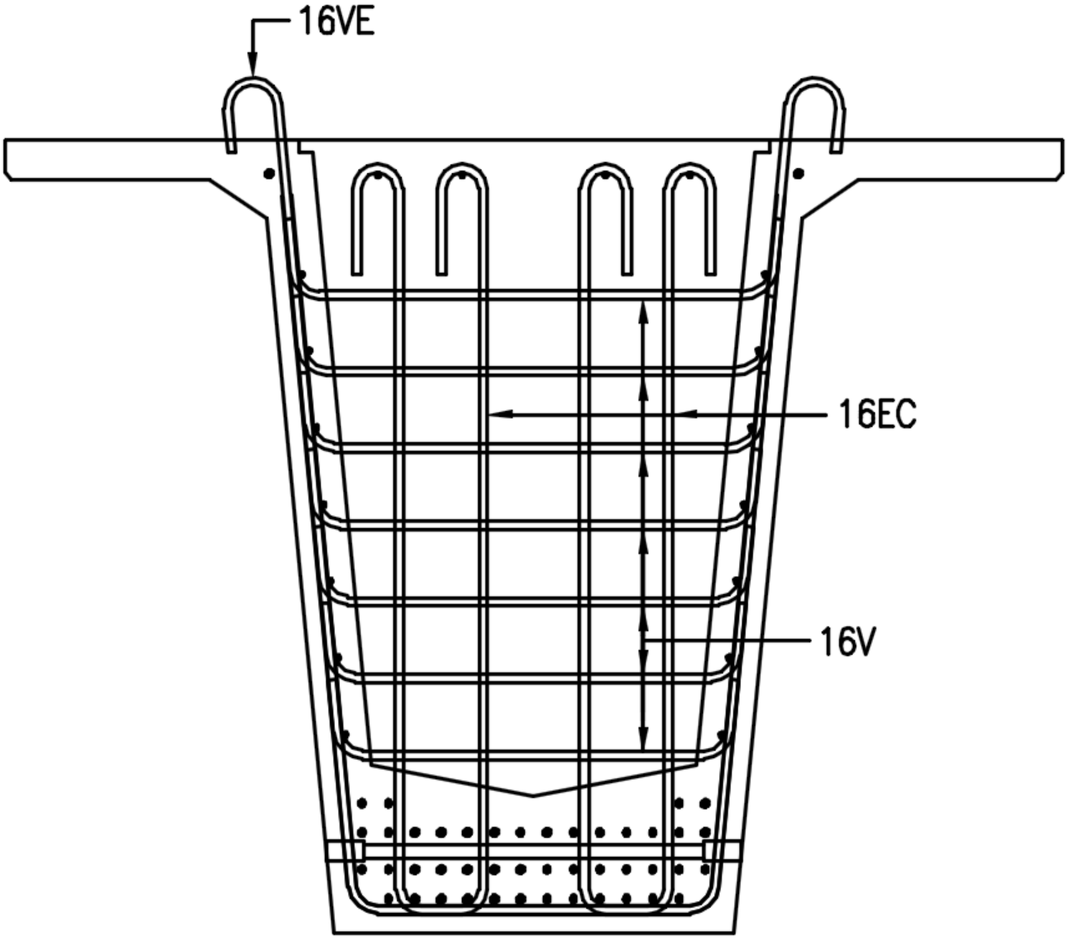
Figure 14.7(a) - Typical reinforcing set - end blocks



Note: The 16V bars sit inside the 16VE bars so that the set is only two bars wide (16EC + 16VE + 16VC) and not three (16EC + 16V + 16VE or 16VC).

Along the voided section of 1500 mm deep girders where the walls are typically 100 mm thick, the 16VE and 16V bars are located side by side to maintain cover to the void. Refer Figure 14.7(b).

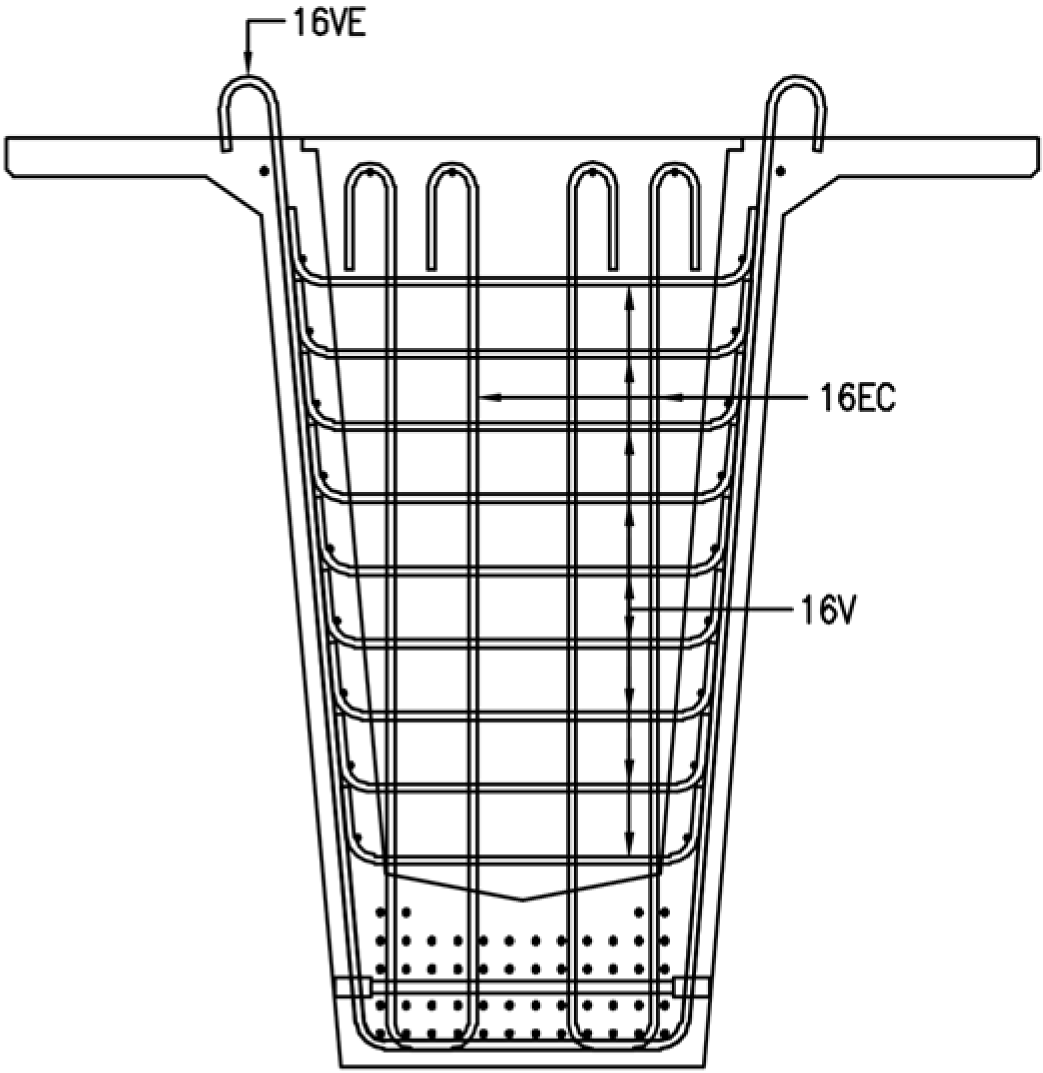
Figure 14.7(b) - Typical reinforcing set in diaphragms and around voids (1500 deep girders)



Note: The 16V bars sit beside the 16VE and 16EC bars so that the 12A longitudinal bars have sufficient cover to the void. The reinforcing set is three bars wide, however the sets are not spaced as closely as they may be in the end block.

Because the walls of 1800 mm deep girders are typically 120 mm thick, maintaining cover is not a problem. Therefore the 16V bars shall be placed inside the 16VE bars. Refer *Figure 14.7(b) - Typical reinforcing set in diaphragms and around voids (1500 deep girders)*.

Figure 14.7(c) - Typical reinforcing set in diaphragms and around voids (1800 deep girders)



Note: The 16V bars sit inside the 16VE and 16EC bars so that the set is only two bars wide (16EC and 16VE) and not three (16EC and 16V and 16VE).

Skewed girders

Some casting yards prefer to tack weld the fasteners into the form and lower the prefabricated reinforcement cage into the form.

To enable them to do this the reinforcement must be parallel to the fastener at the bottom of the cage.

Refer *Figure 14.7(d) - Girder Reinforcement around Fastener (1)* and *Figure 14.7(e) - Girder Reinforcement around Fastener (2)* for an example of how the reinforcing steel may be set out.

Figure 14.7(d) - Girder reinforcement around fastener (1)

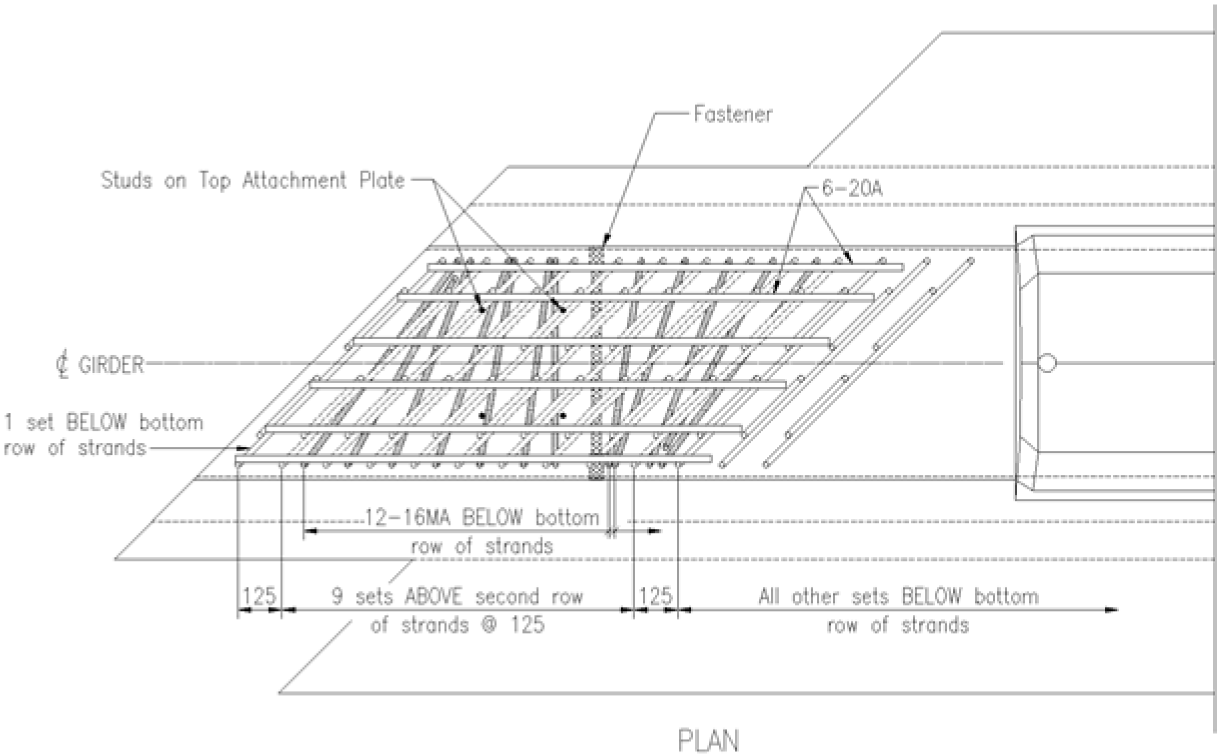
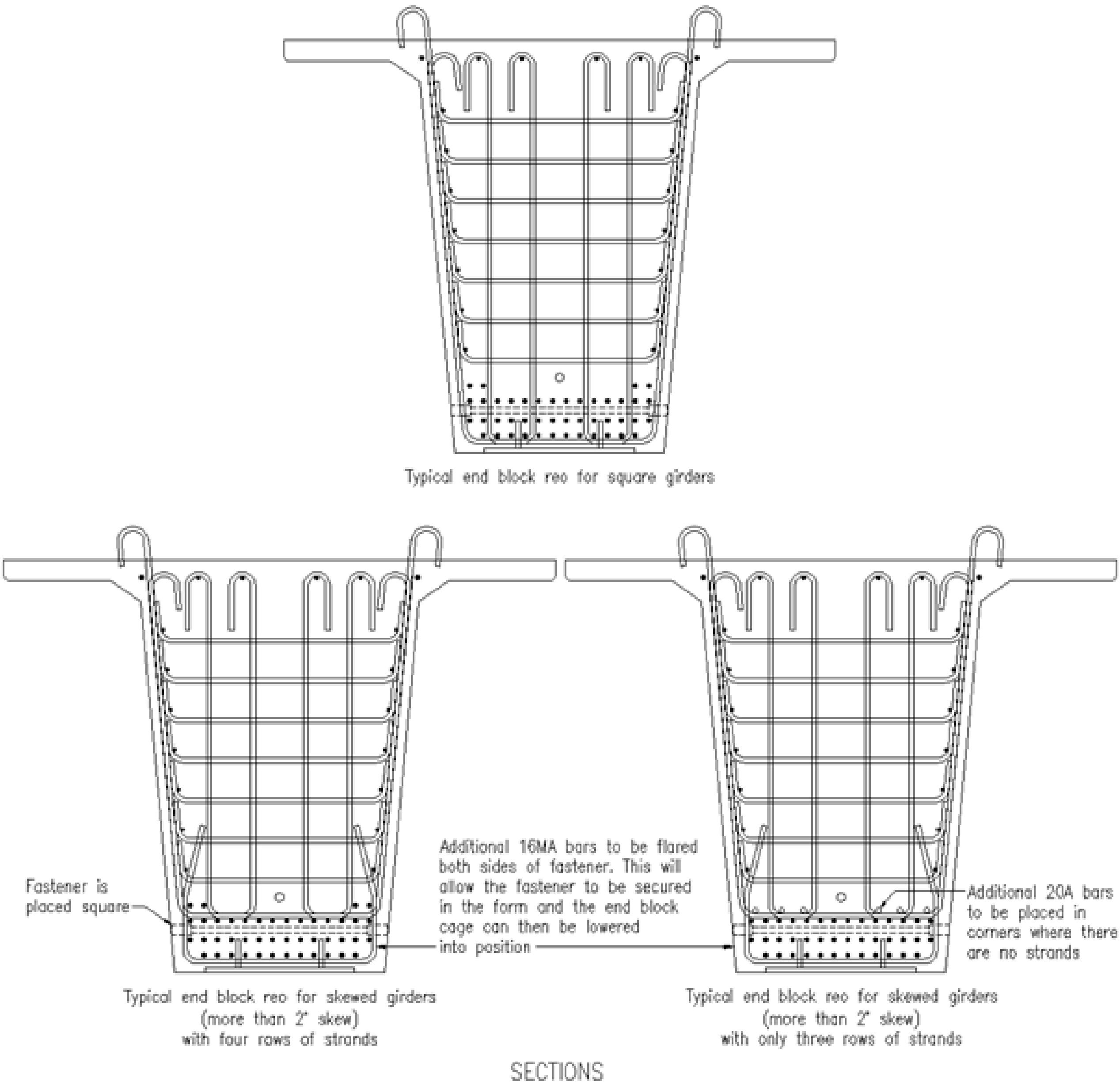


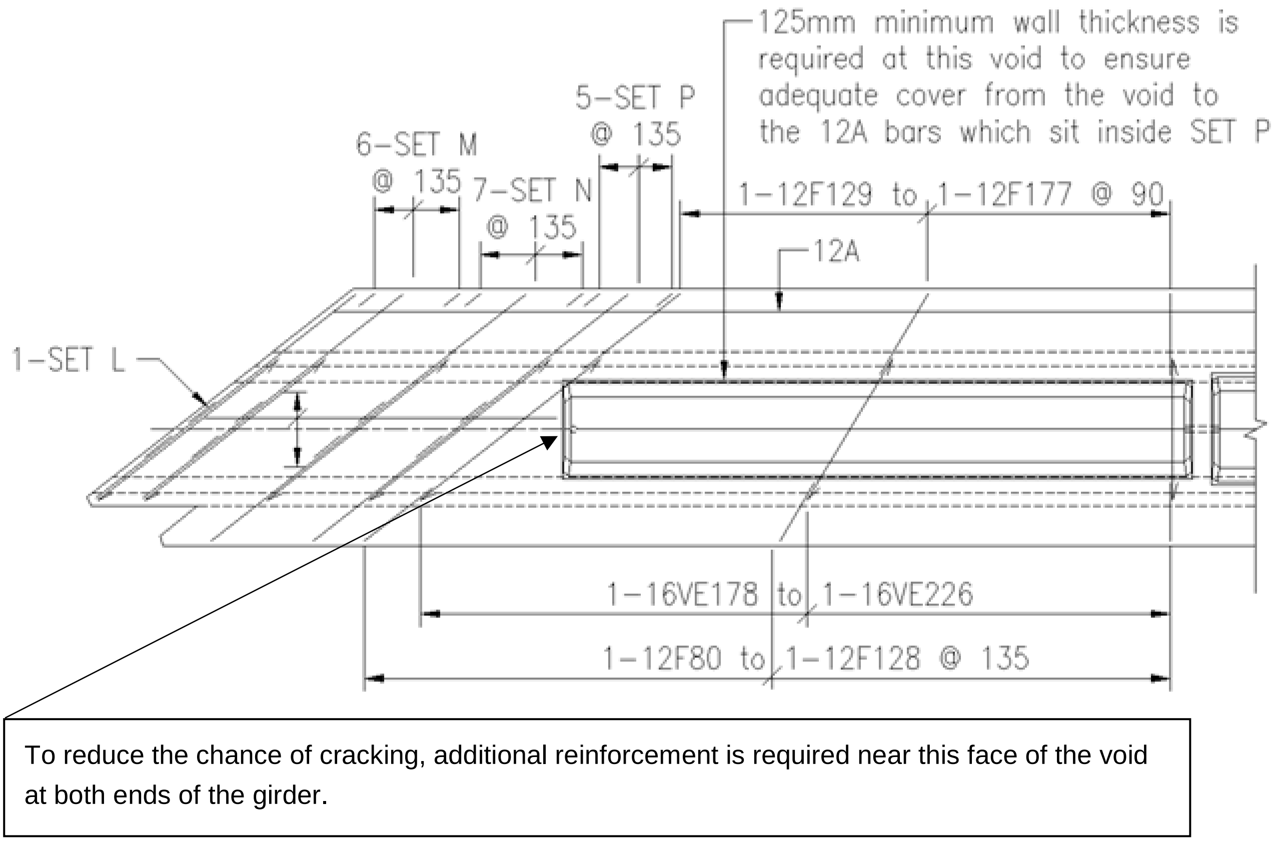
Figure 14.7(e) - Girder reinforcement around fastener (2)



Fanned reinforcement

In skewed girders the reinforcement is fanned about the voids at each end of the girders. Refer *Figure 14.7(f) - Variable bars*. Because the reinforcing sets in the end block encroach into the wall of the girder at the adjacent void, the wall thickness of this void must be at least 125 mm thick to maintain cover to the 12A bars.

Figure 14.7(f) - Variable bars



14.8 Drilling holes into girders

Drilling holes into girders is not permitted. The following text shall be shown on the general arrangement drawing beside the section deck detail 'DRILLING INTO THE GIRDERS IS NOT PERMITTED. ALL FERRULES / ATTACHMENTS MUST BE CAST-IN'.

14.9 Cross girders

All girder bridges are to have cross girders cast at the ends of each span.

Some of the benefits of cross girders are as follows:

- to strengthen the structure
- to provide a location for the temporary packers required during bearing installation
- to provide jacking points for bridge maintenance, and
- to provide stability of the girders prior to and during casting and curing of the deck.

For Wide Flange I-Girders extra considerations will be required for girder stability prior to casting and curing of the deck. Potentially this may have impacts on the casting of the girders where cast in ferrules are required as was the case on the Lucinda Drive, Port of Brisbane project.

It is good practice to space girders as far apart as possible to reduce reinforcement congestion in the cross girders, and to facilitate easier inspection and maintenance of the bearings. This may require reducing the number of girders by increasing the girder depth.

At fixed and expansion joints the cross girder reinforcement bonds into the concrete deck. At continuous deck joints the cross girder reinforcement cannot do this as the deck is de-bonded with sheets of closed cell expanded polyethylene. For an example of the typical details required, refer *Figure 14.9(a) - Typical cross girder design*.

The ends of the girders may be cut out to allow the top reinforcing steel to continue over the girder. The main advantages of this design are that it reduces / eliminates the laps in the top cross girder reinforcement and also the top girder couplers that this reinforcement would typically screw into. The main disadvantages are that construction and detailing of the girders drawings are both more complicated. Refer *Figure 14.9(b) - Alternate cross girder design*.

The reinforcement details and the width and depth of cross girders are project specific and are largely dependent on the span length and girder width. The examples shown may have less reinforcement that is required to comply with current standards.

If the bridge is subject to flooding, holes may be required near the top of the cross girders so that as the bridge is submerged, air between the girders can be released to prevent the bridge from potentially floating away.

Figure 14.9(a) - Typical cross girder design

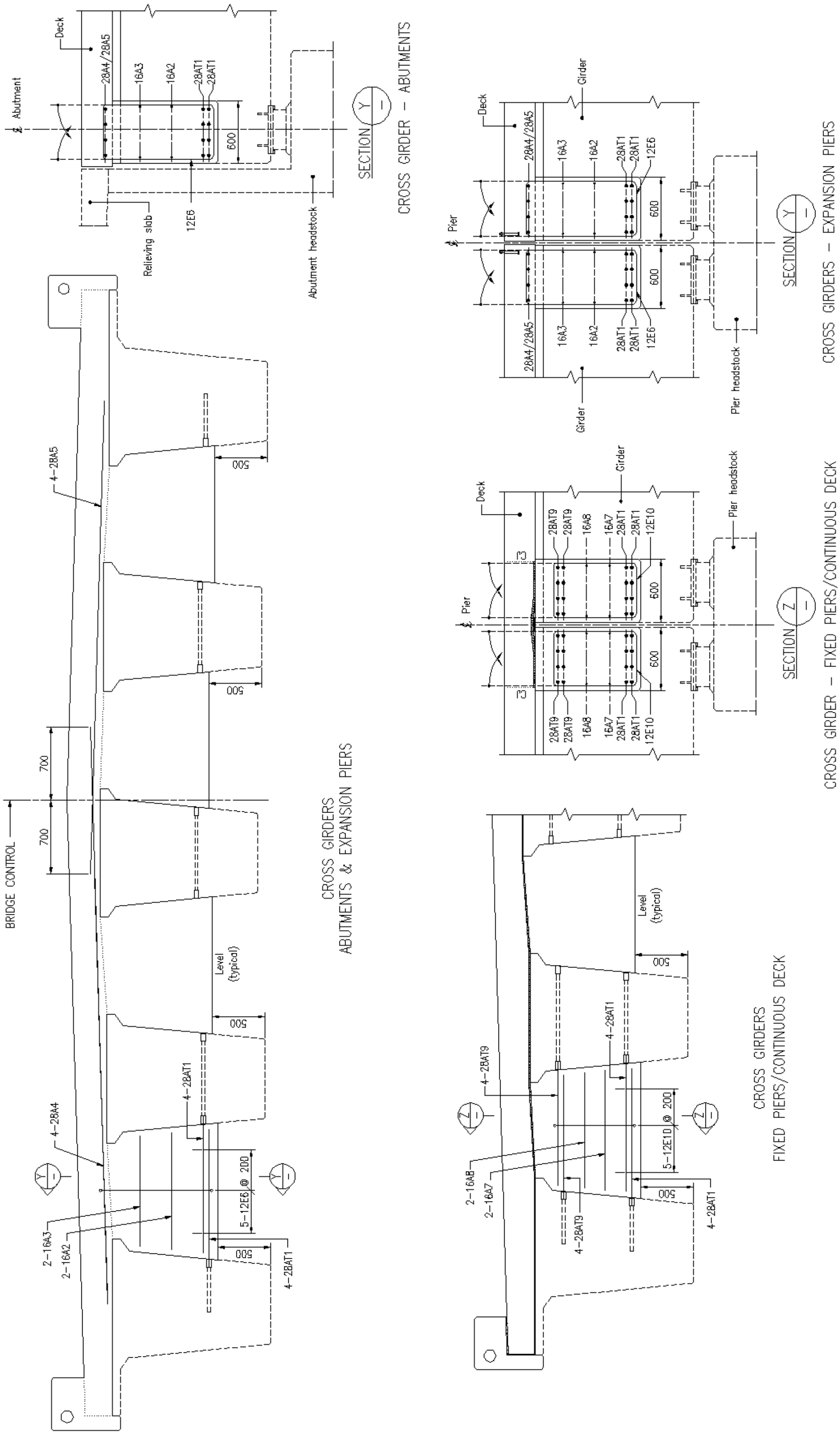
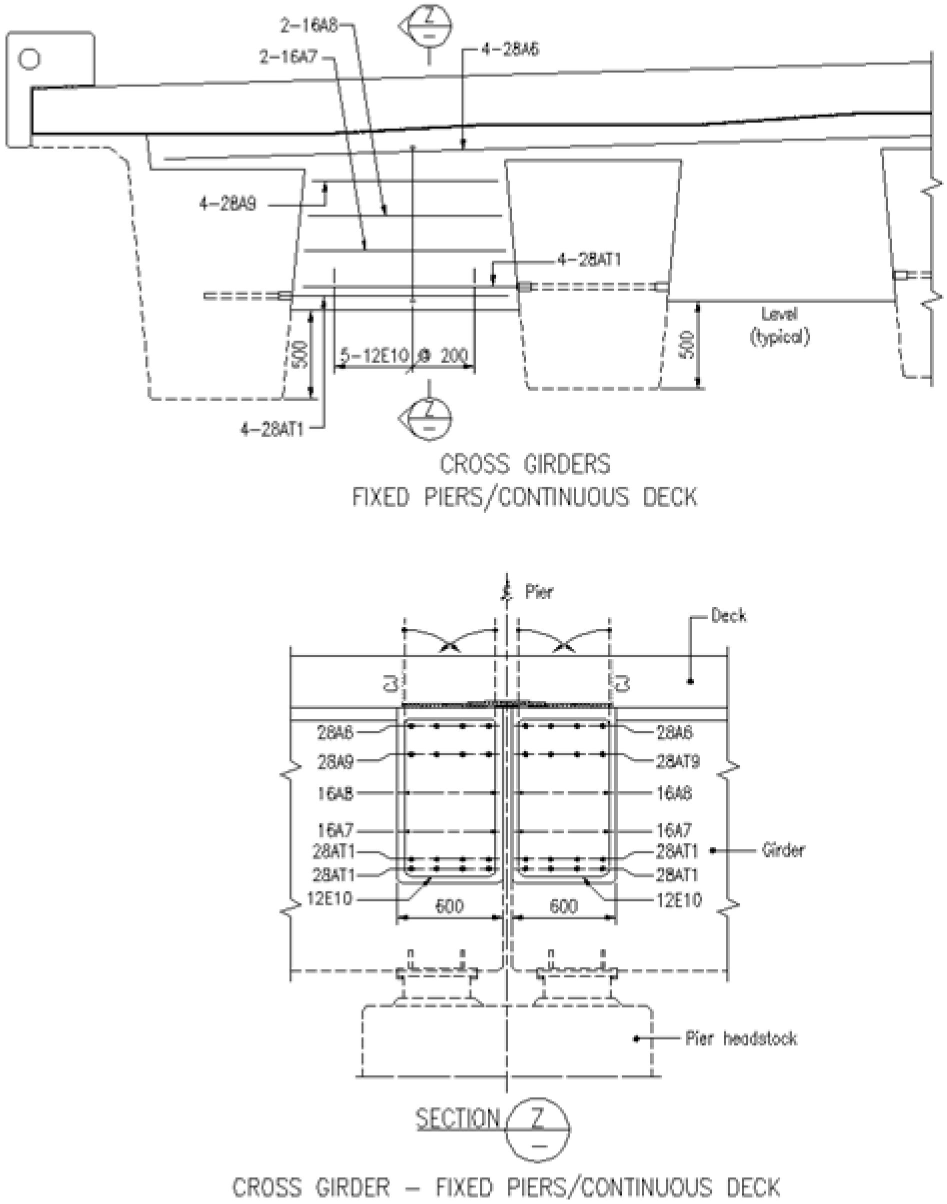


Figure 14.9(b) - Alternate cross girder design



14.10 Holes in girder flanges for road drainage

The department's typical deck drainage design for a girder bridge is to use a steel drain pipes to carry the water to the end(s) of the bridge. Refer Chapter 18 - *Expansion Joints and Miscellaneous Details, Appendix C - Example Drain Drawings*.

The water is drained from the deck with 150 mm diameter PVC scuppers that pass through 200 mm diameter holes in the girder flange. Refer *Figure 14.10(a) - Plan view of hole layout* and *Figure 14.10(b) - 200 mm diameter holes in girder flange for scuppers*.

Figure 14.10(a) - Plan view of hole layout

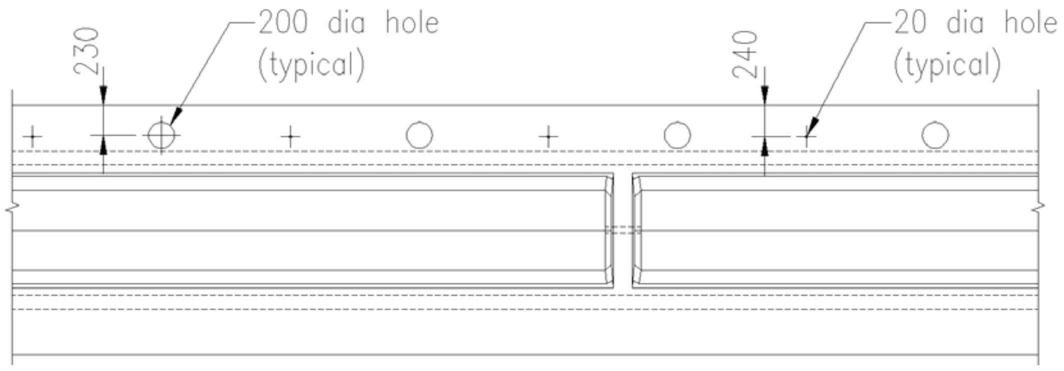
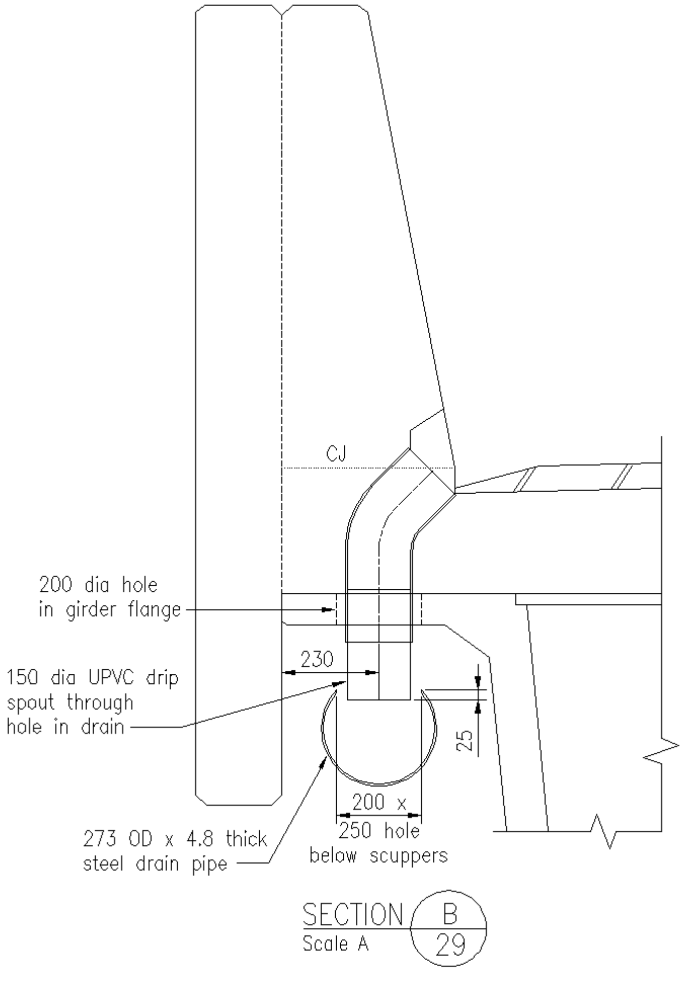
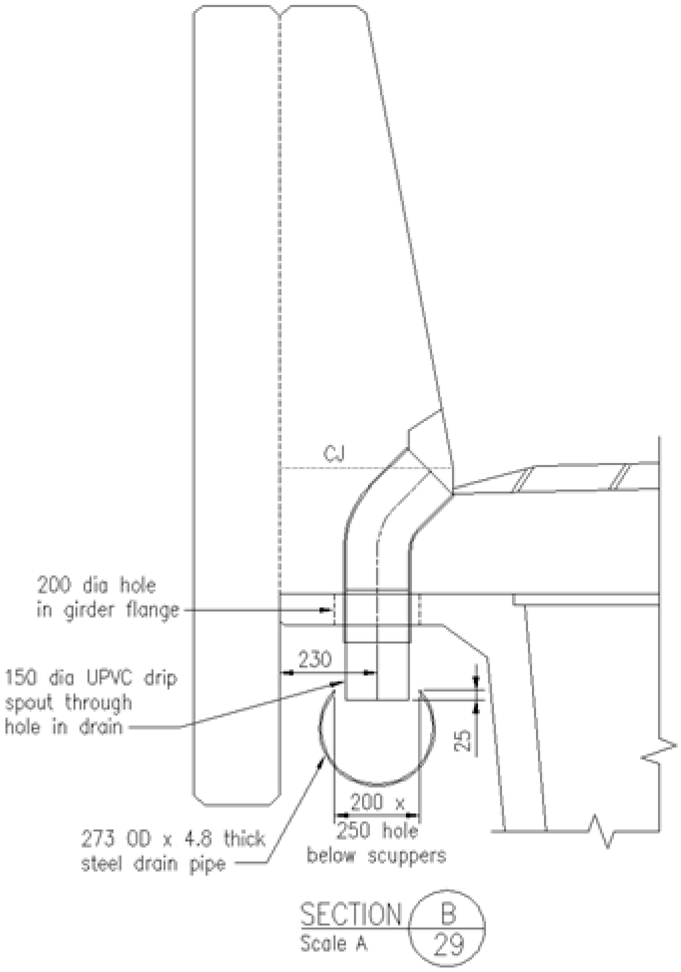


Figure 14.10(b) - 200 mm diameter holes in girder flange for scuppers



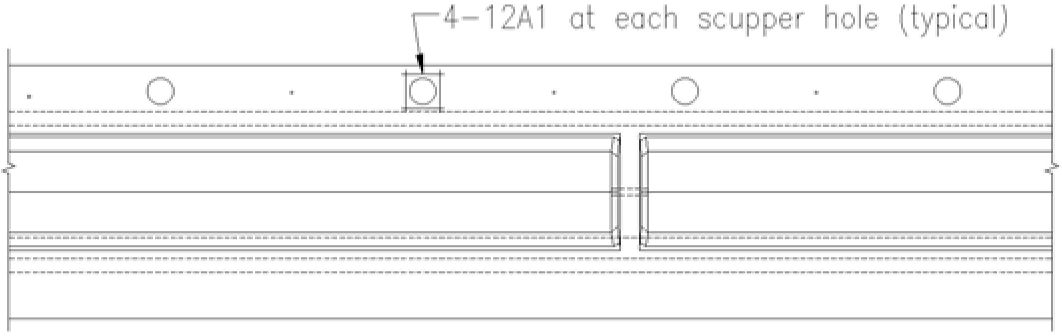
The drain pipe is supported by a steel drain bracket which passes through 20 mm diameter holes in the girder flange. Refer *Figure 14.10(a) - Plan view of hole layout* and *Figure 14.10(c) - 200 mm diameter holes in girder flange drain bracket*.

Figure 14.10(c) - 200 mm diameter holes in girder flange drain bracket



To reduce the chance of cracking around the 200 mm diameter holes, four trimmer bars shall be placed around each hole. Refer *Figure 14.10(d) - Trimmer reinforcement bars*.

Figure 14.10(d) - Trimmer reinforcement bars



14.11 Lifting loops

Lifting loops shall have a factor of safety of 5. The department does not have standard lifting loop details. The details are dependant on the mass of the girder.

The following examples are from a 77 tonne girder, refer *Figure 14.11(a) - Lifting diagram* and *Figure 14.11(b) - Lifting loop details*.

Figure 14.11(a) - Lifting diagram

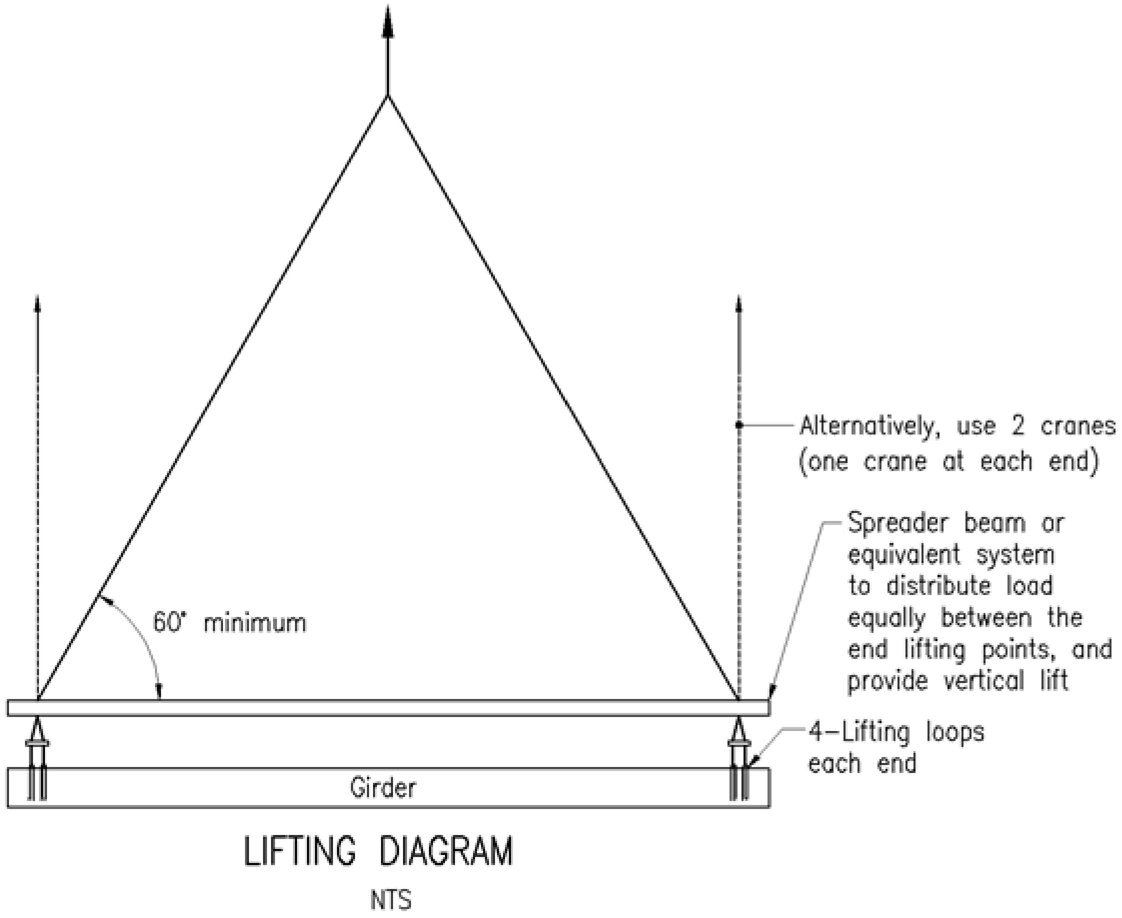
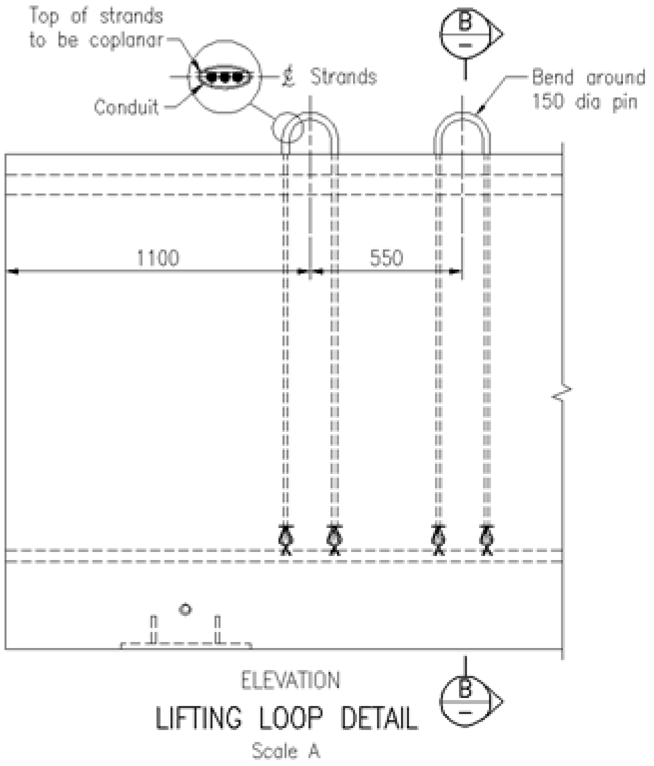
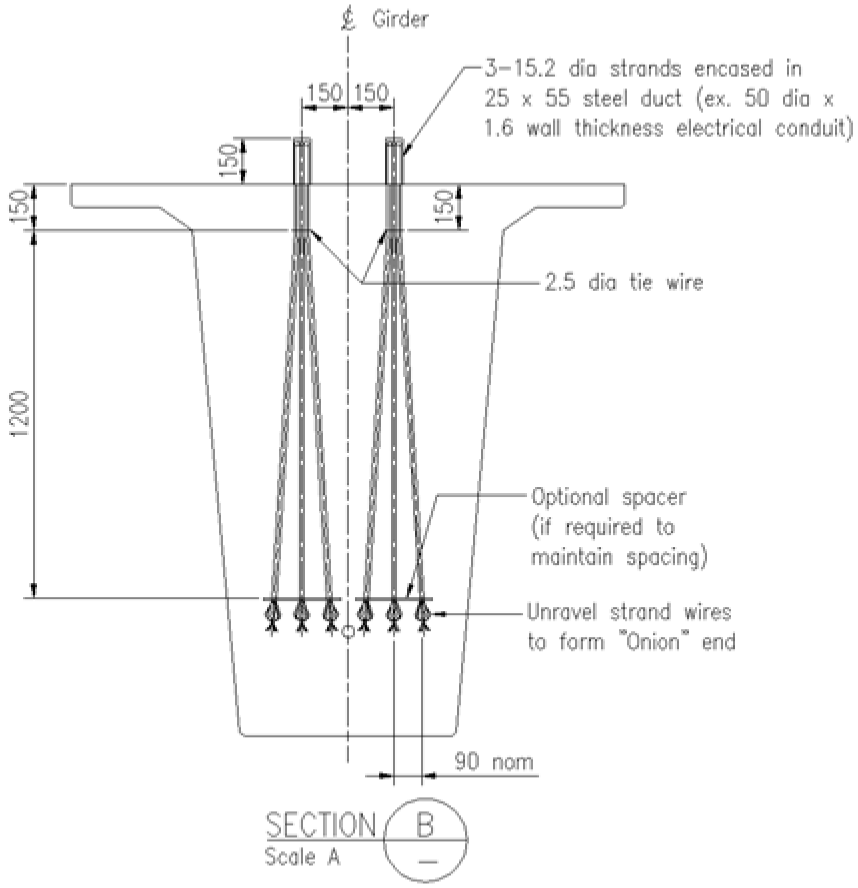


Figure 14.11(b) - Lifting loop details





14.12 Girder erection sequence

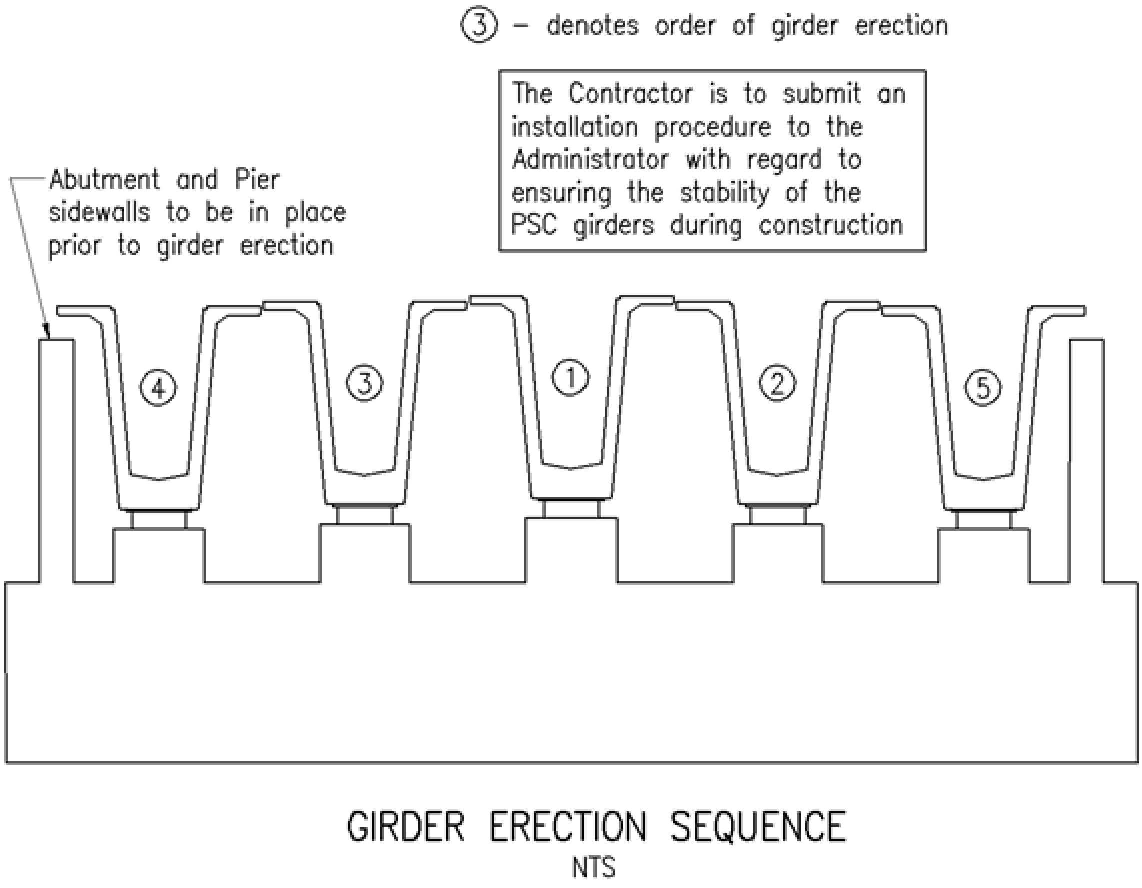
One of the greatest safety risks during bridge construction is an unsecured girder toppling over, and worst still, falling off the bridge altogether. By erecting the girders from the centre of the bridge first and then working outwards, the risk of a girder falling off the bridge is reduced.

If headstock sidewalls are required, they shall be constructed before the girders are erected. These walls improve aesthetics and safety. The walls shall be strong enough to resist impact loads during installation of the girders.

The Contractor is responsible for ensuring the stability of the girders during construction. This usually involves temporary bracing between the girders, or temporary propping of the girders.

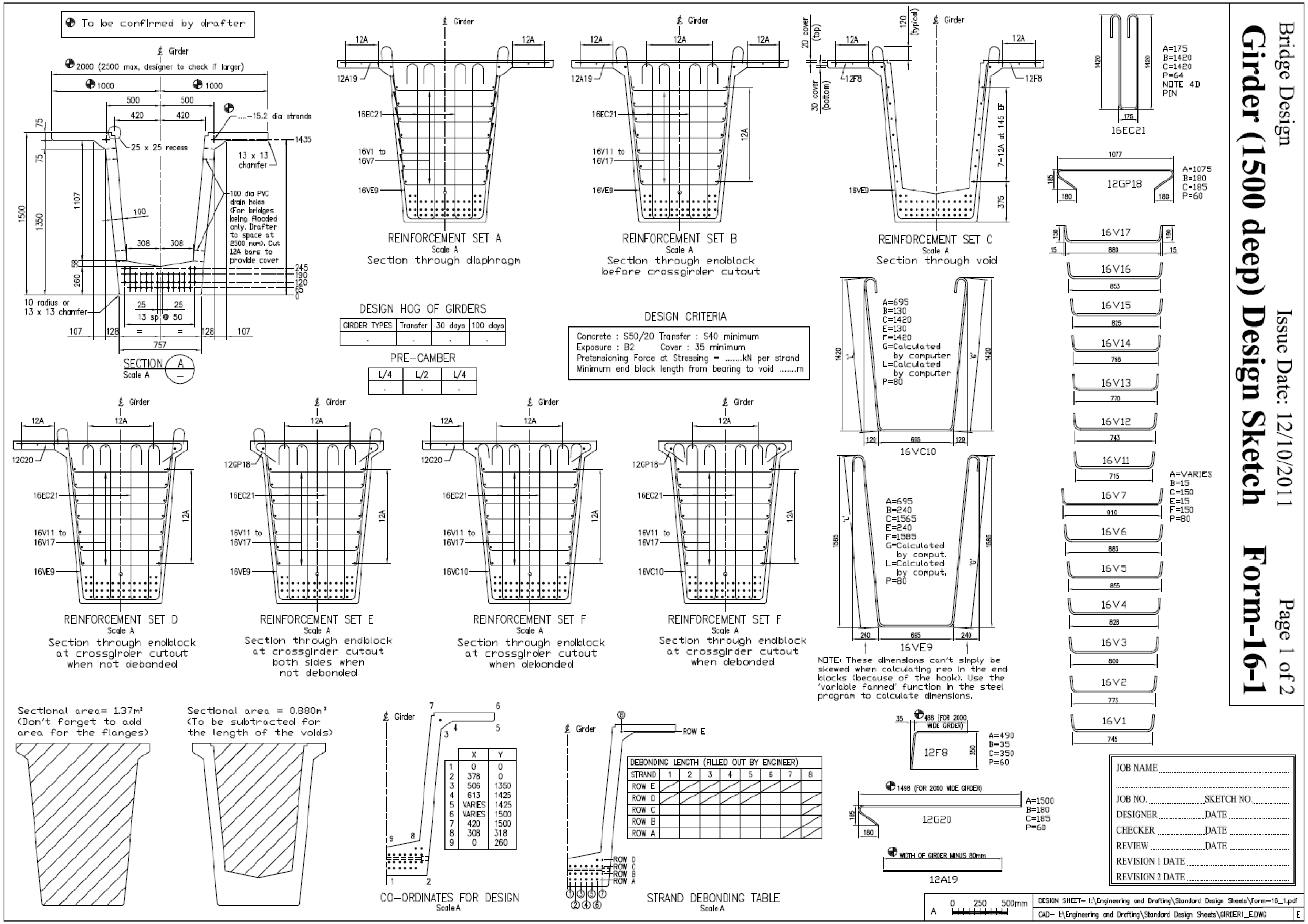
For an example of the required details, refer Figure 14.12(a) *Girder erection sequence detail*.

Figure 14.12(a) - Girder erection sequence detail

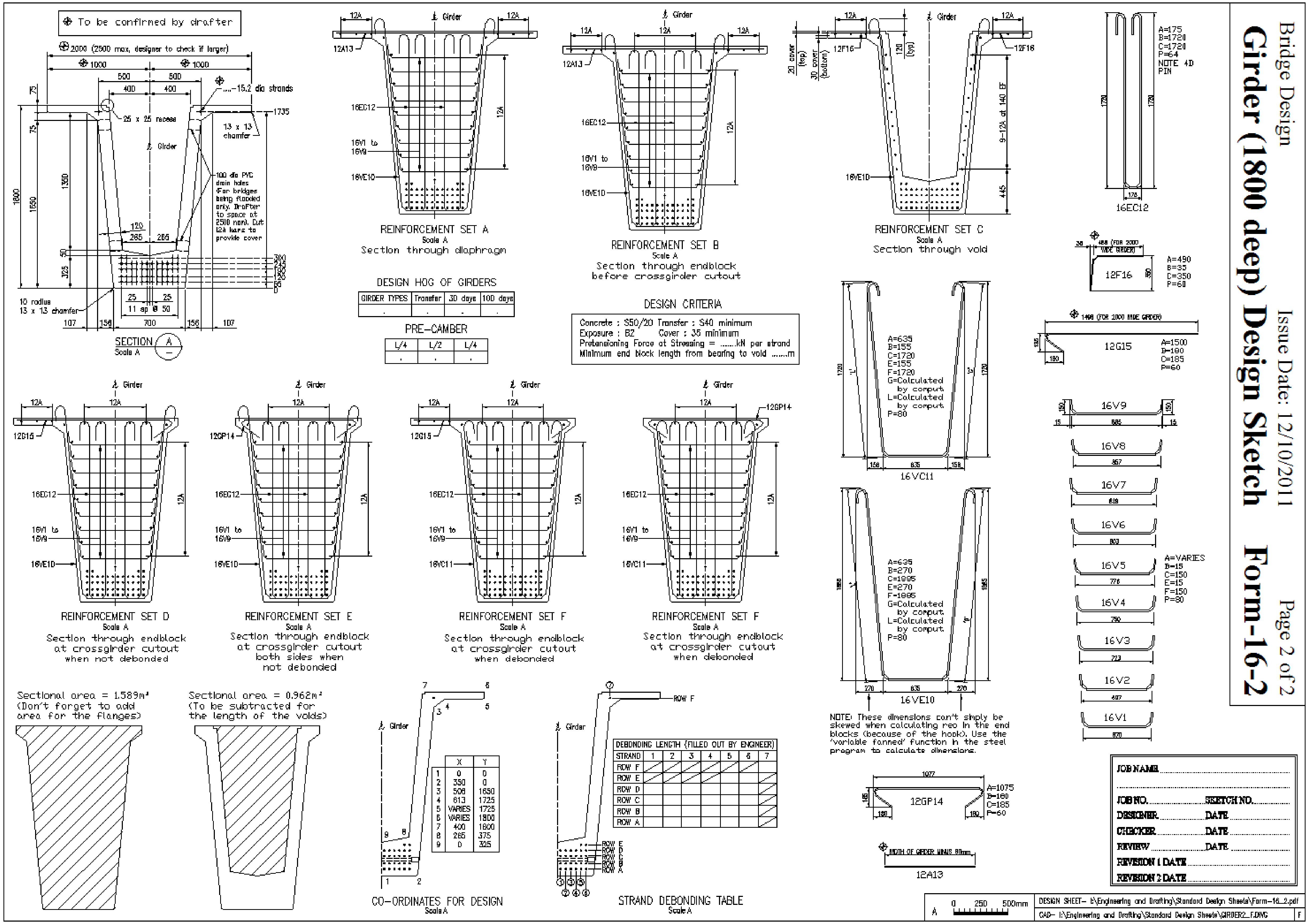


Appendix A – Super T-Girder design sketches

Appendix A – Super T-Girder Design Sketches – Sheet 1



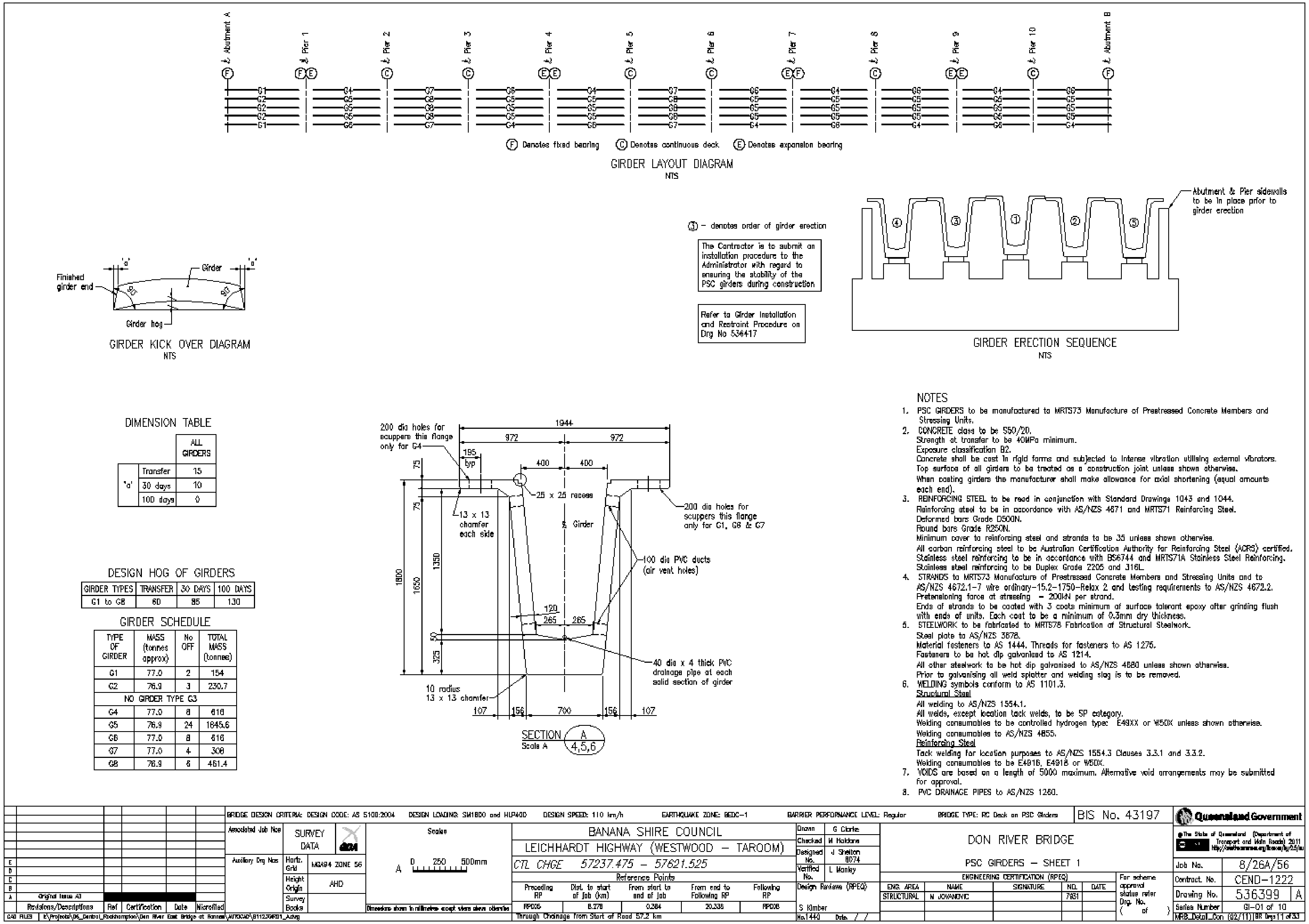
Appendix A – Super T-Girder Design Sketches – Sheet 2



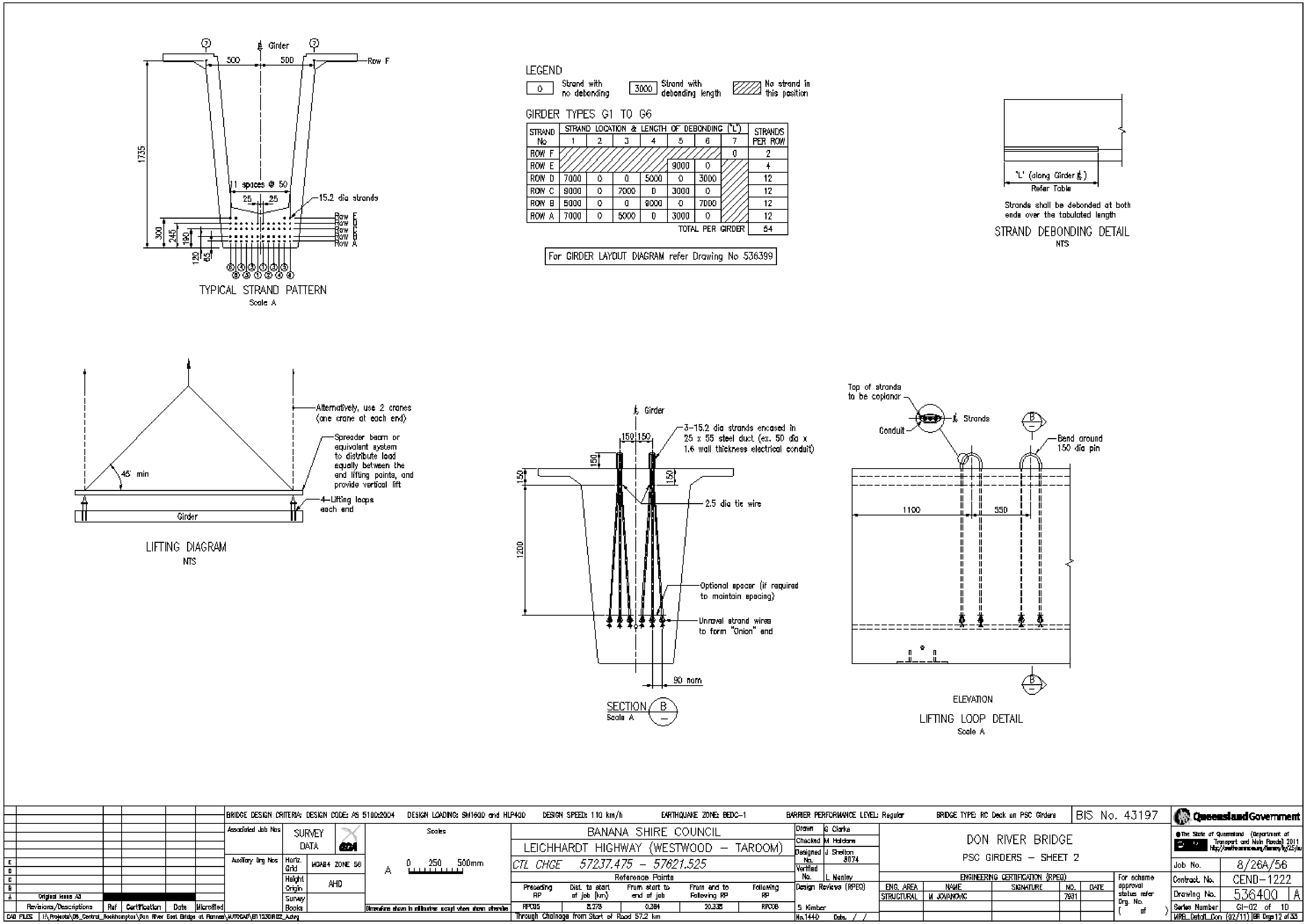
	X	Y
1	0	0
2	350	0
3	506	1650
4	613	1725
5	VARIES	1725
6	VARIES	1800
7	400	1800
8	265	375
9	0	325

Appendix B – Example Super T-Girder Drawings

Appendix B – Example Super T-Girder Drawings – Sheet 1



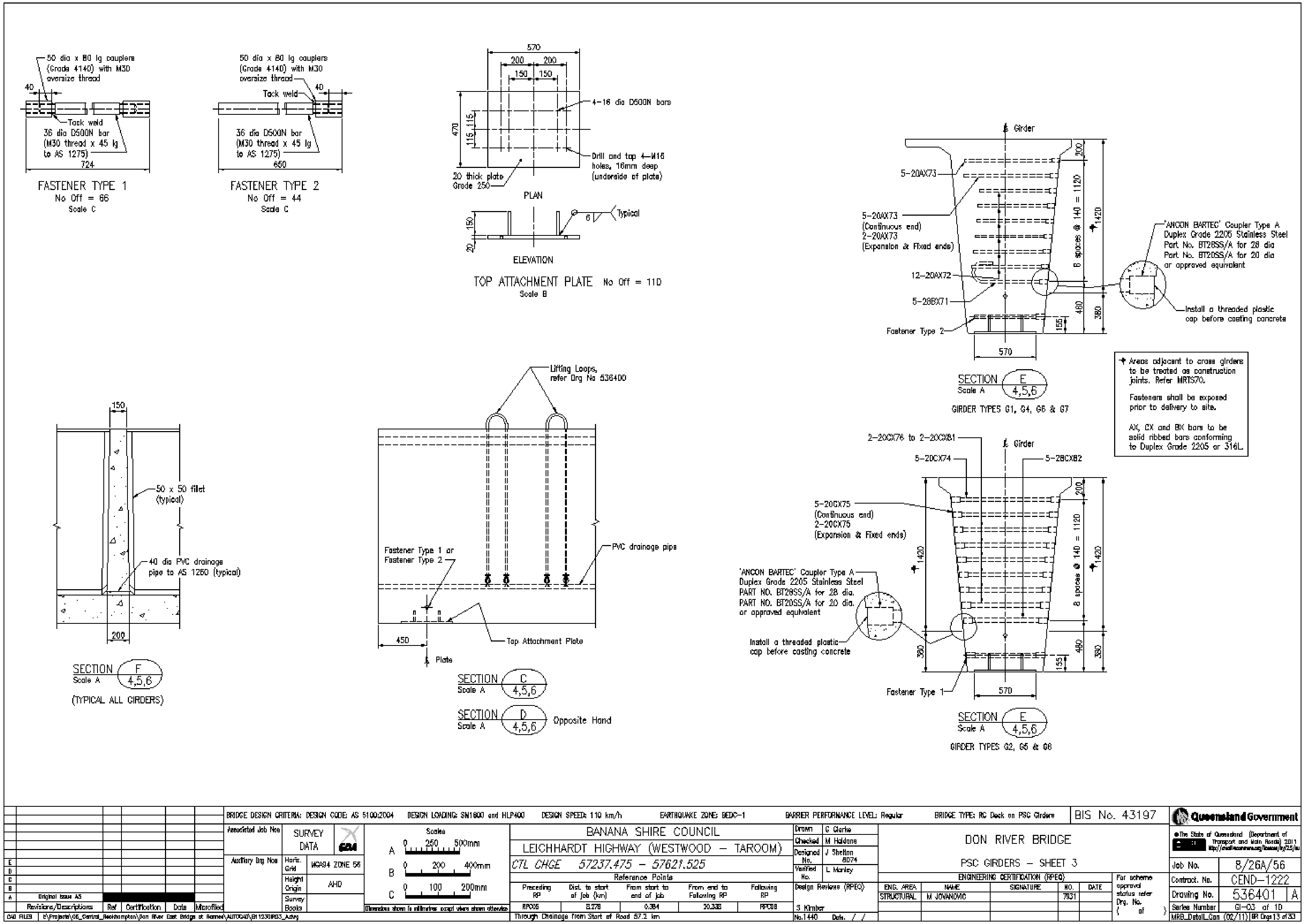
Appendix B – Example Super T-girder Drawings – Sheet 2



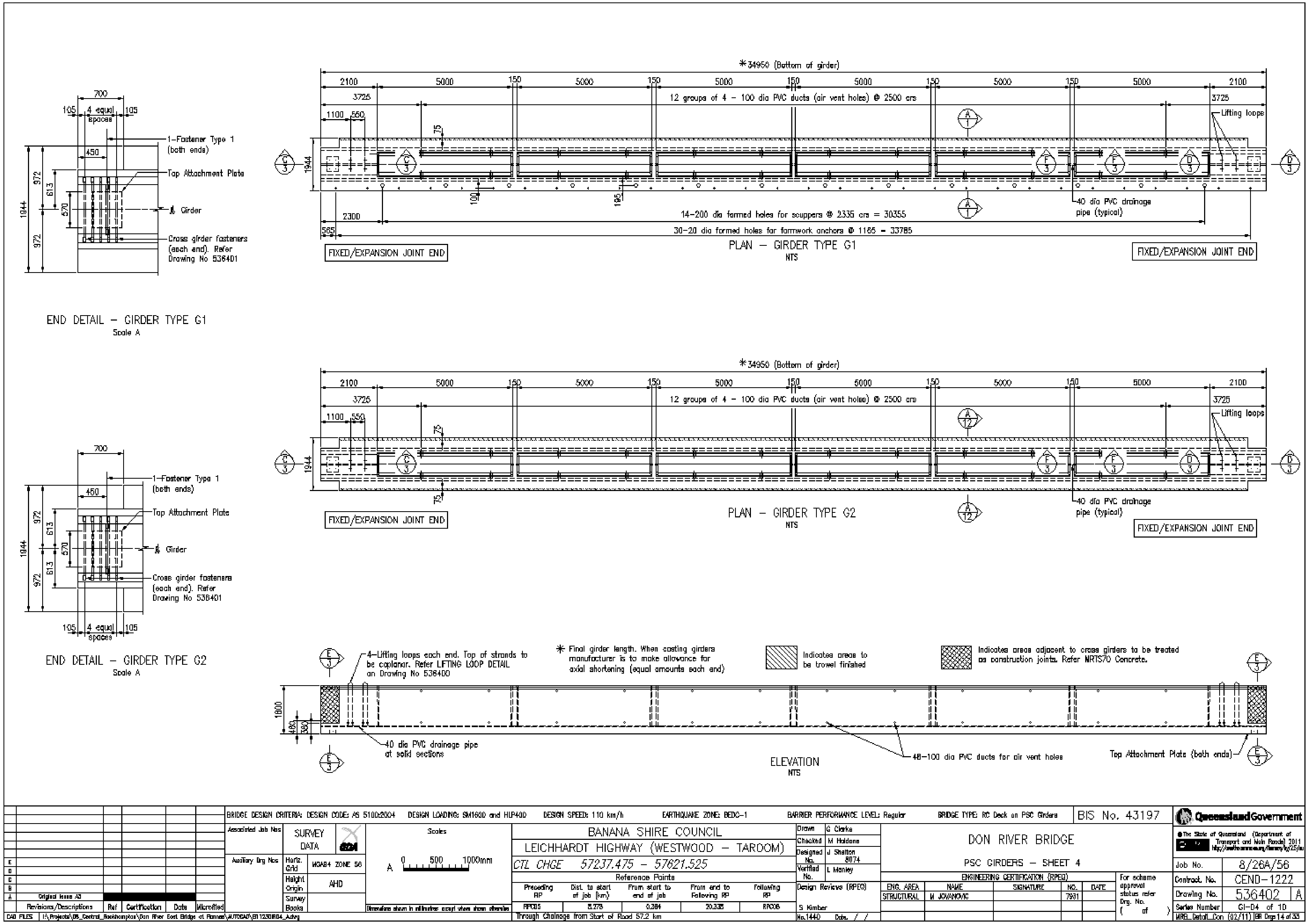
GIRDER TYPES G1 TO G6

STRAND No	STRAND LOCATION & LENGTH OF DEBONDING ('L') 1	2	3	4	5	6	7	STRANDS PER ROW
ROW F							0	2
ROW E					9000	0		4
ROW D	7000	0	0	5000	0	3000		12
ROW C	9000	0	7000	0	3000	0		12
ROW B	5000	0	0	9000	0	7000		12
ROW A	7000	0	5000	0	3000	0		12
							TOTAL PER GIRDER	54

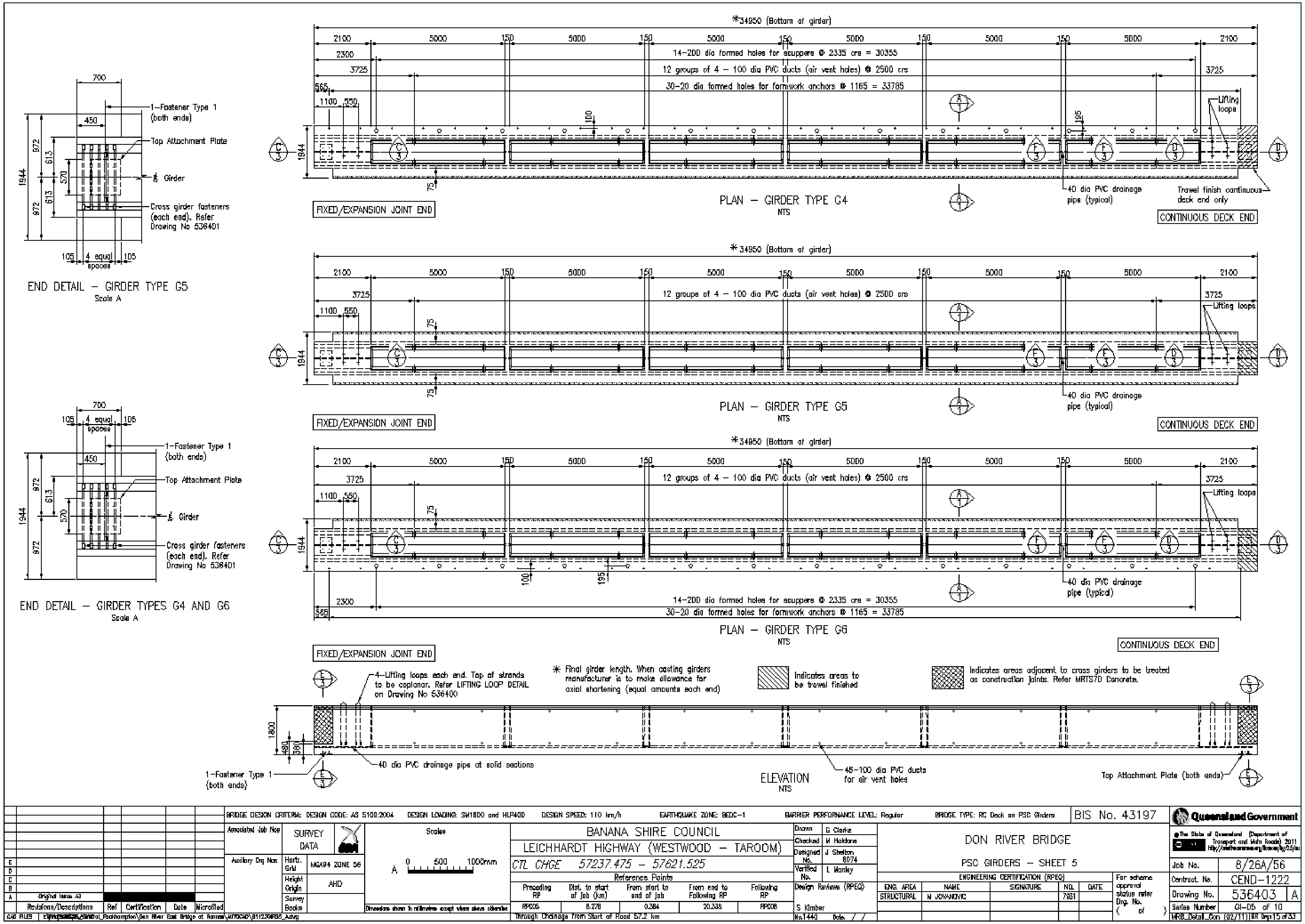
Appendix B – Example Super T-girder Drawings – Sheet 3



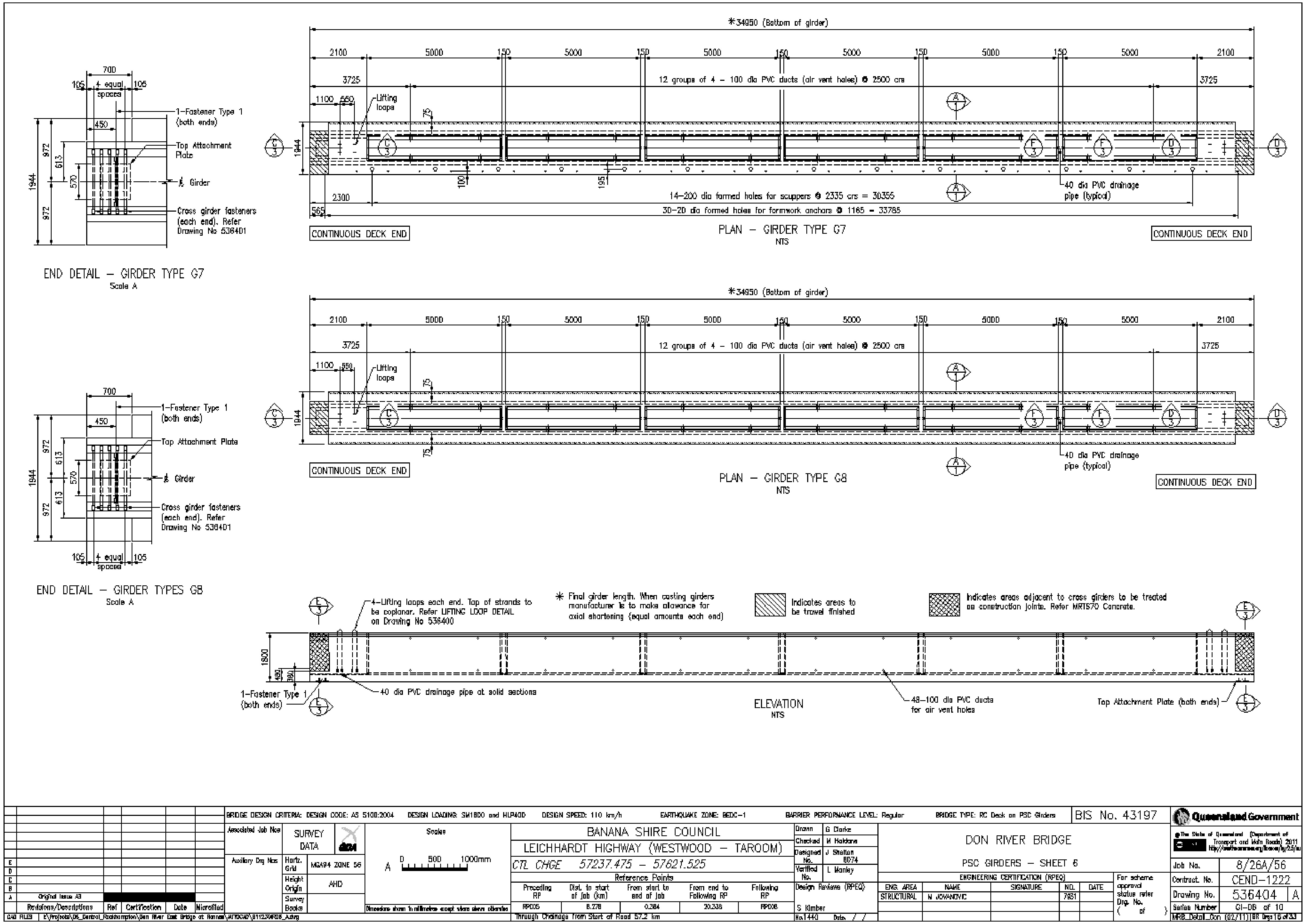
Appendix B - Example Super T-girder Drawings – Sheet 4



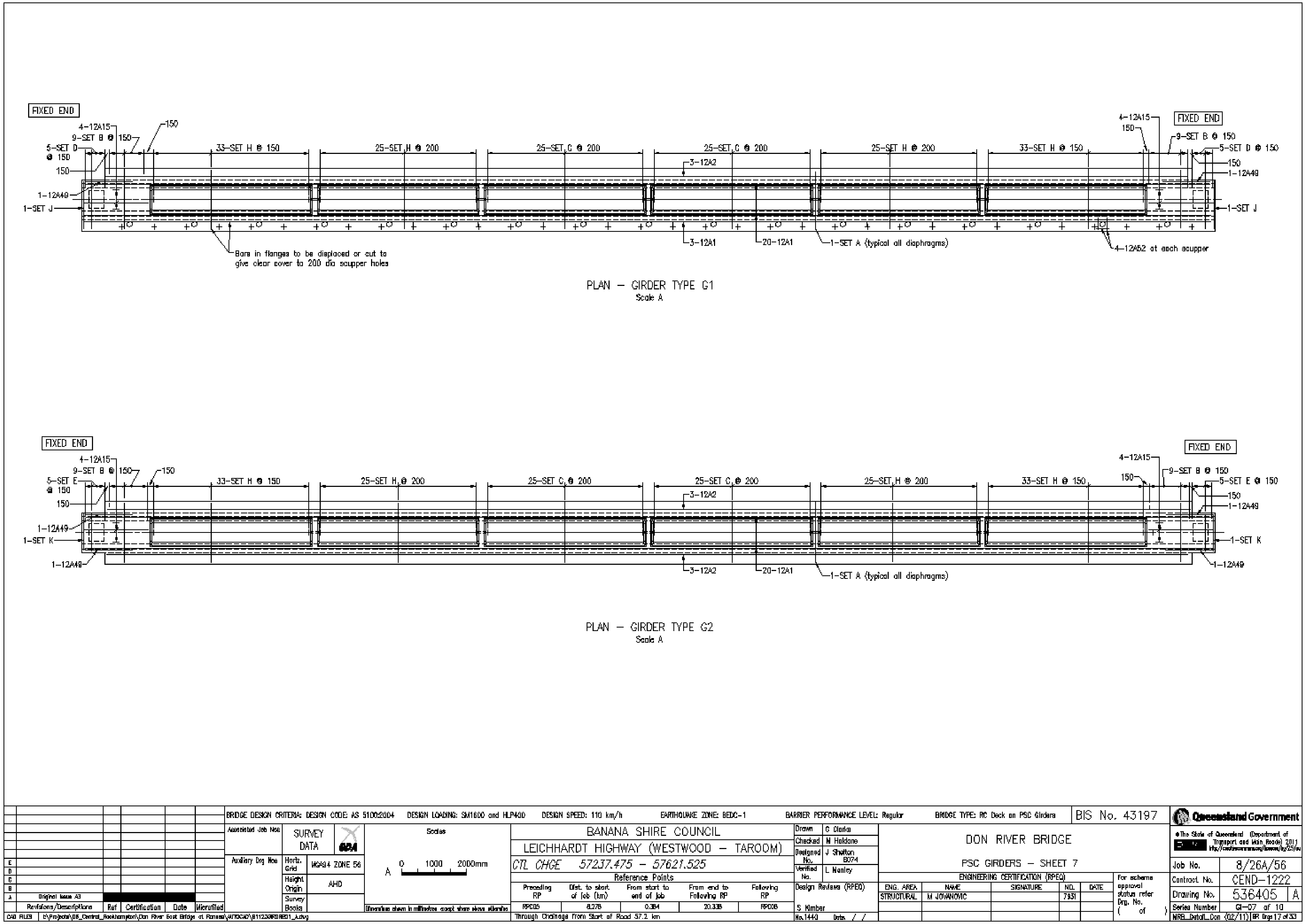
Appendix B – Example Super T-girder Drawings – Sheet 5



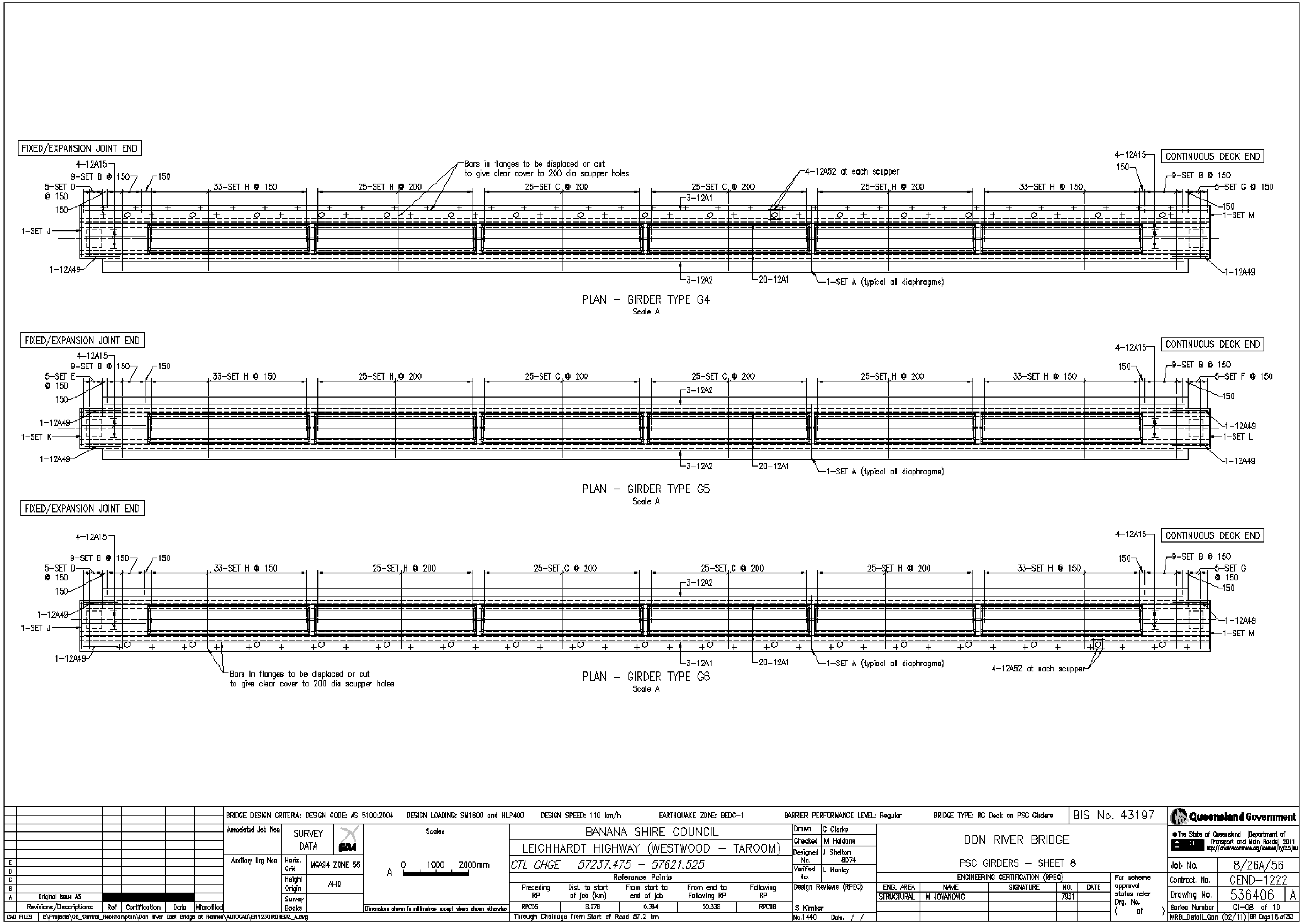
Appendix B – Example Super T-girder Drawings – Sheet 6



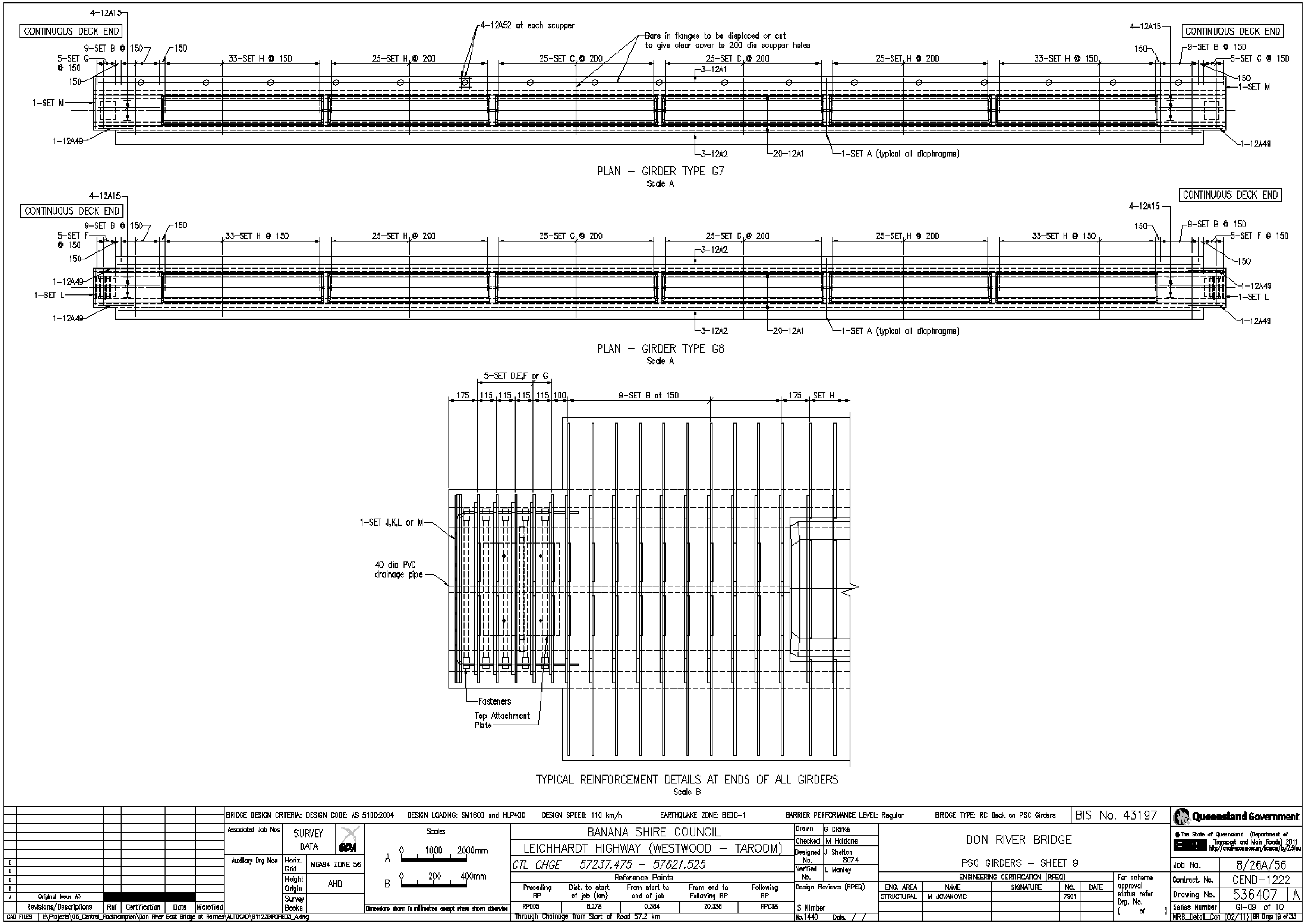
Appendix B – Example Super T-girder Drawings – Sheet 7



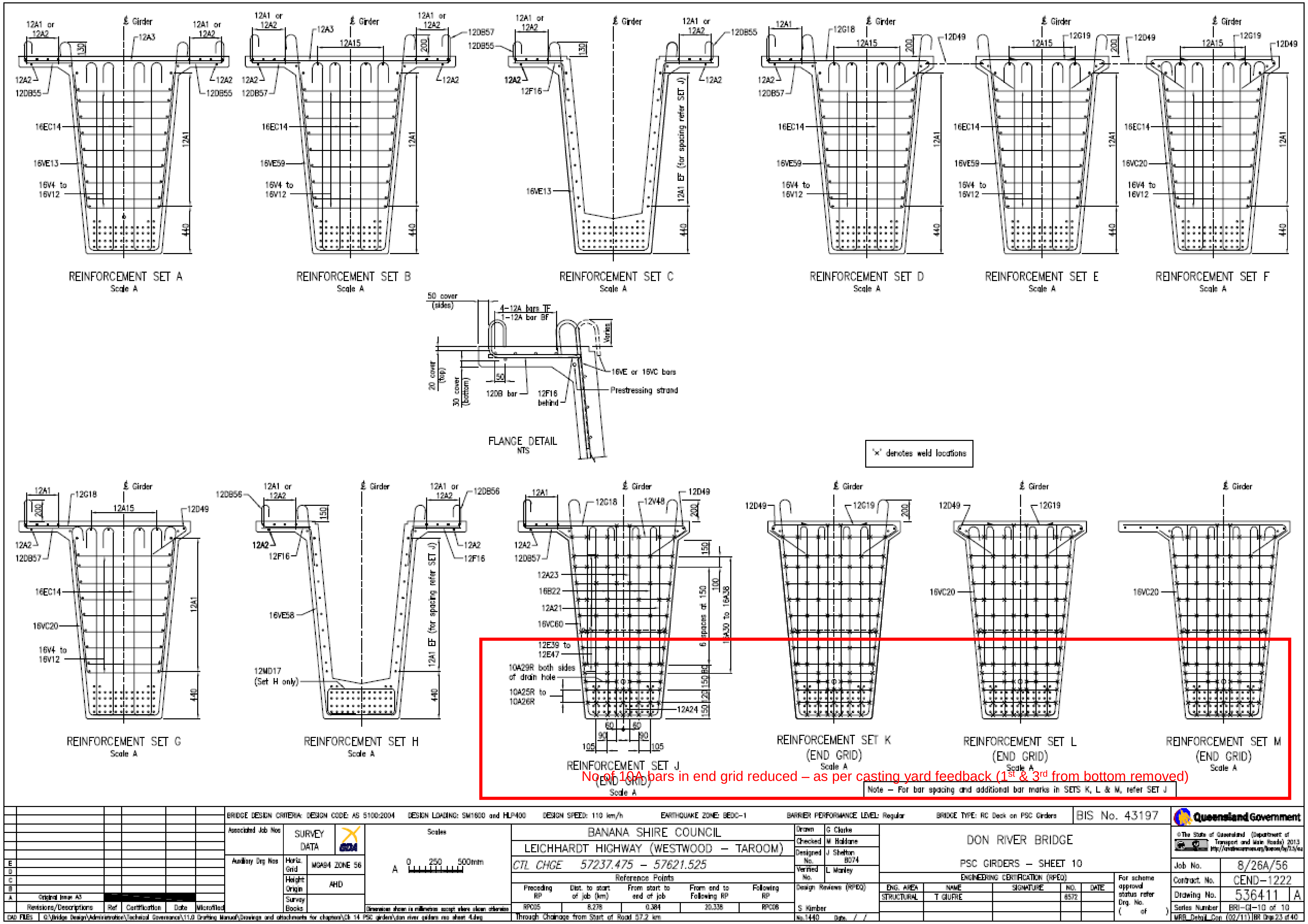
Appendix B – Example Super T-girder Drawings – Sheet 8



Appendix B – Example Super T-girder Drawings – Sheet 9



Appendix B – Example Super T-girder Drawings – Sheet 10



Drafting and Design Presentation Standards
Volume 3: Structural Drafting Standards

Chapter 15: Prestressed Concrete Deck Units

December 2015

Queensland Government

Feedback: Please send your feedback regarding this document to: tmr.techdocs@tmr.qld.gov.au

Chapter 15 Amendments

Revision register

<table>
<tr><th>Issue/Rev No.</th><th>Reference Section</th><th>Description of Revision</th><th>Authorised by</th><th>Date</th></tr>
<tr><td>1</td><td>–</td><td>First Issue.</td><td>Manager (Structural Drafting)</td><td>April 2011</td></tr>
<tr><td rowspan="5">2</td><td>–</td><td>Document name change.</td><td rowspan="5">Manager (Structural Drafting)</td><td rowspan="5">Feb 2012</td></tr>
<tr><td>15.5</td><td>Table deleted – refer STD drawings for dimensions and strand details</td></tr>
<tr><td>15.8</td><td>Add formwork kick details to Table 15.8-1. Update Figure 15.8-4.
Remove figures for bridge traffic barrier post.</td></tr>
<tr><td>15.9</td><td>Recess depth increased to 55 mm. Remove figures for deck unit layout.</td></tr>
<tr><td>15.10</td><td>Update Figure 15.10-1.</td></tr>
<tr><td rowspan="5">3</td><td>15.3</td><td>Delete references excluding PSC Kerb Units</td><td rowspan="5">Team Leader (Structural Drafting)</td><td rowspan="5">December 2015</td></tr>
<tr><td>15.4</td><td>Delete 20152 reference to ‘std drawings in development’</td></tr>
<tr><td>15.5</td><td>Section deleted – following sections renumbered</td></tr>
<tr><td>15.6 (was 15.7)</td><td>Reference added to nominal unit lengths for standard spans to ensure designs use standardised lengths where practical</td></tr>
<tr><td>15.7</td><td>TMR Standard Drwing 2042 (was 1519)
Figure 15.7-1 revised
Figure 15.7-2 and 15.7-3 – clearer images inserted
Dimensions of bearing plates.
Foamwork and services anchors not to be placed over transverse stressing holes.
20YC bars deleted – in process of removing from Standard Drawings.
Figure 15.7-5 changed to match std unit drawings</td></tr>
</table>

Issue/Rev No.	Reference Section	Description of Revision	Authorised by	Date
3 cont.	15.8	Reference to deletion of HD bolts / dowels deleted as braking force distribution requires all bolts in place Holding Down Bolt Hole Setting Out for Fixed and Continuous Decks: size of hold down bolt recess deleted – shown on std drawings.	Team Leader (Structural Drafting)	December 2015
	15.9	Reference to Chapter 17 – Deck Design Sketches deleted.		
	15.11	Figure 15.11-2 added		
	15.12	Change to Less than 30deg skew = skewed ligatures to match Figure 15.12-1 and 15.12-2		
	15.14	Scuppers on overpass bridges, Incorrect wording deleted		
	Appendices	Example Deck Units Standard Drawings Deleted – refer published drawings		

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15 Prestressed Concrete Deck Units

15.1 Glossary of terms

For a complete glossary of terms refer Chapter 1 – *Introduction.*

15.2 Figures and examples shown in this volume

The figures and examples shown in this volume are for presentation purposes only, and may contain some details that are now superseded. These details have been included for ease of reference, to illustrate typical solutions, and to show the required standard of drafting presentation. The details are not to be used without an engineering check and certification by a Structural RPEQ to confirm that the details are appropriate for the specific project.

15.3 General

This chapter will be expanded as further departmental standard deck unit drawings are developed. This chapter is read in conjunction with MRTS74 *Supply and Erection of Prestressed Concrete Deck and Kerb Units*.

PSC deck units are 596 mm wide. This unusual dimension has evolved from the imperial deck unit predecessor being 1′ 11 ½ ″. Deck units greater than 13 m in length contain polystyrene voids to reduce their weight. The voids have 75 x 75 mm fillets to ensure adequate cover to the hooks on the reinforcing steel, and to provide better flow of concrete during placement. Strands shall have a minimum of 60 mm cover to the voids.

15.4 Standard Drawings

A number of Standard Drawings are published for PSC Deck Units

The standard deck unit drawings shall be used as the basis for project drawings to ensure consistency in presentation and detail, to ensure production costs are minimised, and productivity of the precast industry is sustained. The design assumptions for the standard deck unit drawings are stated in TMR Standard Drawing 2042 – *Precast Unit - Design Assumptions for Transversely Stressed Standard Deck Units*. Further engineering checks will be needed if a project does not comply with these design assumptions.

Deck unit bridges with a RC deck will need project specific deck unit design. Refer 15.13 *RC Deck on Deck Units*.

15.5 Drilling Holes into Deck Units

Drilling holes into deck units is not permitted, for example, ferrules for installation of signs and other accessories, and presents a major structural risk from both cutting of strands and/or ligatures, and structural integrity of the connection. It is also a risk to the durability of the deck unit. The following text shall be shown on the General Arrangement drawing besides the section deck detail '*DRILLING INTO THE DECK UNITS IS NOT PERMITTED. ALL FERRULES/ATTACHMENTS MUST BE CAST-IN*'.

15.6 Constructability

Efficiency of precast production relies on the ability to implement a daily casting schedule. The design of individual units, with minor variations in length and/or skew, is not efficient to precast and significantly increases manufacture costs and increases delays in project delivery. Therefore, the following conditions shall apply when setting out complicated horizontal geometry for deck unit bridges:

- wherever possible, use the departmental standard deck unit drawings. Variations from details shown on the drawings will not be permitted without the approval of the Deputy Chief Engineer (Structures)
- formwork anchor details shall always comply with the details on the standard drawings; additional anchors may be added when services are attached
- minimise the number of variations in skew
- minimise the number of variations in deck unit length.
- Lengths of units shall generally be 9950 for a 10 m span, 11950 for a 12 m span and so on.

15.7 Presentation

All deck unit drawings for departmental bridges are to be presented in a similar manner to the standard drawings.

Referenced documents and the note '*THIS DRAWING TO BE READ IN CONJUNCTION WITH STANDARDS DRAWING 2042 – PRECAST UNIT - DESIGN ASSUMPTIONS FOR TRANSVERSELY STRESSED STANDARD DECK UNITS*' are not required on project drawings.

The notes shown on the standard drawings shall be replaced with those shown in Chapter 5 – *Notes, 5.8 PSC Deck Unit Notes*.

In addition to the details shown on the standard drawings, the following details shall be added to project drawings:

- Deck Unit Schedule
- Transverse Stressing Unit Schedule.

Design Hog and Formwork Kick of Deck Units

Hogs and formwork kick are to be shown in a table on the drawings. The formwork kick shall be calculated to ensure that the ends of the deck units are vertical at 100 days. The hog shall be shown at three stages after the deck unit is cast so that it can be measured progressively to check that it is hogging as designed. The design hog shall be shown:

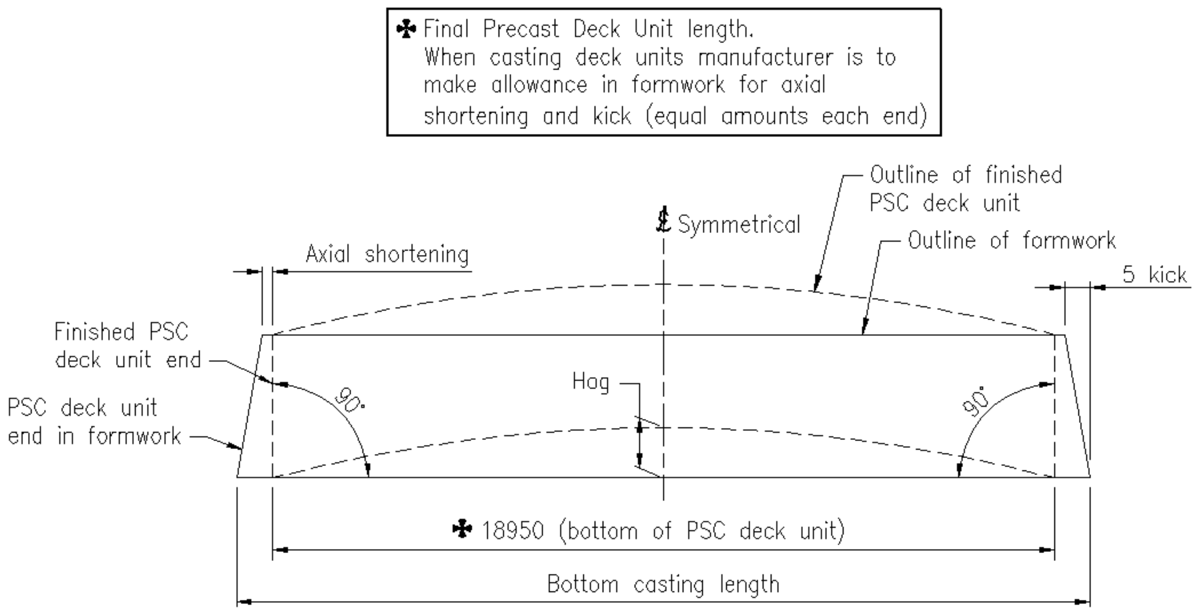
- at transfer
- at 30 days
- at 100 days.

The 100 day hog is used to calculated bridge geometry. Refer Figure 15.8-1 *Design Hog of Deck Units*.

Figure 15.7-1 Design Hog of Deck Units

HOG SCHEDULE

DESIGN HOG (mm)		
Transfer	30 days	100 days
35	50	60



ELEVATION

FORMWORK KICK DIAGRAM

Deck Unit Schedule

A schedule for the deck units is to be shown in a table on the drawings.

The schedule shows the number of each deck unit type, the mass of each deck unit type, and the combined mass of each deck unit type. For deck unit mass calculations, the specific density of 2.6 tonnes/m^3 shall be used for inner deck units (without starter bars) and 2.7 tonnes/m^3 for outer deck units, and those supporting an RC deck (with starter bars).

Refer Figure 15.7-2 *Deck Unit Schedule*.

Figure 15.7-2 Deck Unit Schedule

DECK UNIT SCHEDULE

TYPE OF DECK UNIT	MASS (tonnes approx.)	No OFF	TOTAL MASS (tonnes)
19A	18.3	10	183
19B	20.1	1	20.1
19C	23.2	1	23.2

Transverse Stressing Unit Schedule

A schedule for the transverse stressing units is to be shown in a table on the drawings.

The schedule shows the length of stressing bar, the combined mass of the stressing bar and its anchorages, the number of stressing units, and the total mass of stressing units. Refer Figure 15.7-3 *Transverse Stressing Unit Schedule*.

When calculating the length of transverse stressing bars, perform the base calculation, round up to the nearest 50 mm then add an additional 50 mm to the length. The mass of 29 mm diameter transverse stressing bar is calculated at 5.44 kg/m. The mass of one 150 x 130 x 40 mm thick anchor plate is 6 kg.

Figure 15.7-3 Transverse Stressing Unit Schedule

TRANSVERSE STRESSING UNIT SCHEDULE

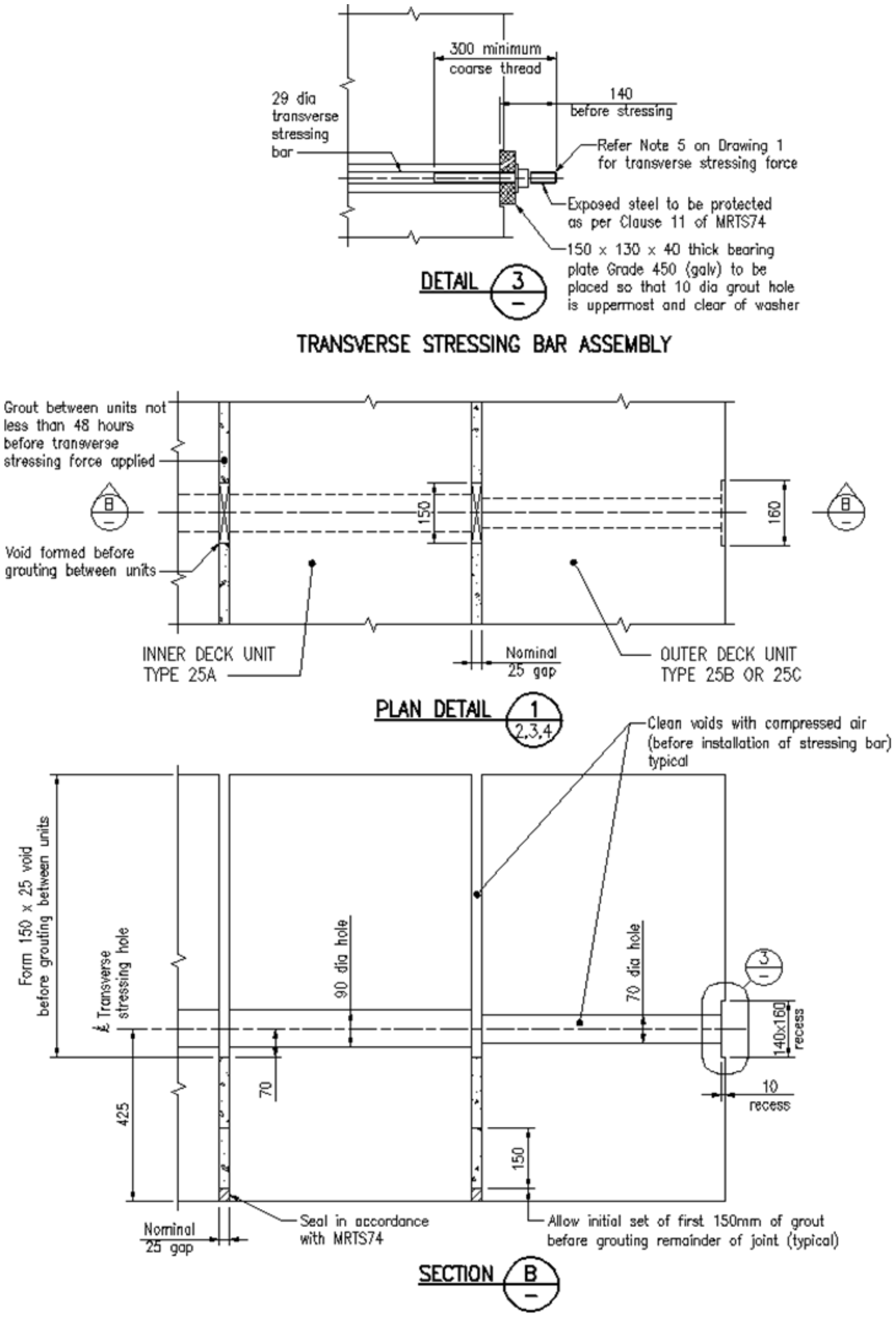
LENGTH (m)	MASS # (tonnes)	No OFF	TOTAL MASS # (tonnes)
13.250m	0.084	44	3.696

including transverse stressing anchorages

Transverse Stressing Assembly

Transverse stressing bars are to AS/NZS 4672.2 and AS/NZS 4672.1-bar-29-1030-P (with 300 mm minimum coarse tread at each end). Anchorages consist of a bearing plate 150 x 140 x 40 mm thick supplied with a nut and flat washer. These components are to be hot dip galvanised. Refer Figure 15.7-4 *Square Transverse Stressing Assembly*. On occasions it may be necessary, for tolerance, to have a larger hole than the normal 70 mm diameter in the outer deck units, for example on a bridge widening. The designer is to check the bending of the anchor plate into the hole to ensure the plate is of sufficient thickness.

Figure 15.7-4 Square Transverse Stressing Assembly



Bridge Traffic Barrier Post Locations

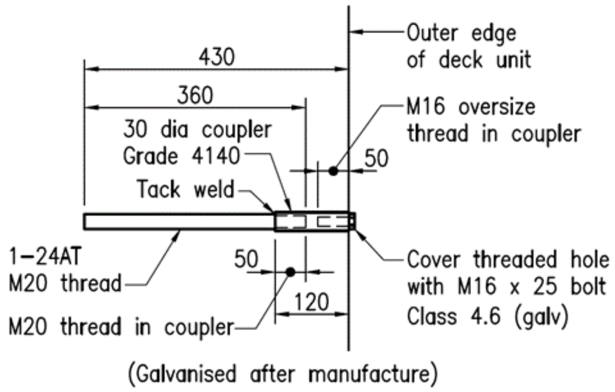
Refer to Standard Drawing 2510 – *Bridge barriers (Regular performance)* for post spacing details. The drafter is to check for any clashes between kerb starter bars and post anchorages. The location of kerb starter bars may need to be altered to avoid clashes.

Formwork and Services Anchor

All outer deck units have cast in formwork anchors. Refer Figure 15.7-5 *Formwork and Service Anchor*. These anchors may also be used for future services attachment as follows:

- Formwork anchors: One row of anchors, 110 mm down from top of unit
- Service attachment anchors: Generally one row, 110 mm down from top of unit, but two rows may be needed (one at the top and one near the bottom of the deck unit between strands) dependent on size of services.
- Avoid placing anchors directly over or near transverse stressing units so as to prevent potential clashes of formwork and services supports with transverse stressing units.

Figure 15.7-5 Formwork and Service Anchor – Typical details



15.8 Holding Down Bolt Holes

A holding down hole/slotted hole is cast into both ends of a deck unit. A holding down bolt/threaded rod/dowel bar is grouted into this hole to attach the deck unit to the headstock it is supported by. If the hole is for a holding down bolt/threaded rod, a recess is cast above the hole.

Dowel bars may only be used for bridges seated on cement mortar, where the soffit of the bridge super-structure is above a 2000 ARI flood.

Holding Down Bolt Hole Setting Out for Fixed and Continuous Joints

As detailed on the standard drawings when the deck unit is square, a 70 mm diameter holding down bolt hole is located 200 mm from each end of the deck unit. In order to maintain required cover from the holding down bolt recess to the second end grid, this distance increases as the skew increases.

Holding Down Bolt Hole Setting Out Expansion Joints

If the end of a deck unit sits on an expansion elastomeric bearing, the hole is slotted and the recess above it is rectangular. When the deck unit is square, a slotted holding down bolt hole is located 240 mm from each end of the deck unit. In order to maintain requred cover from the holding down bolt recess to the second end grid, this distance increases as the skew increases.

15.9 Skewed Deck Units

Void Lengths

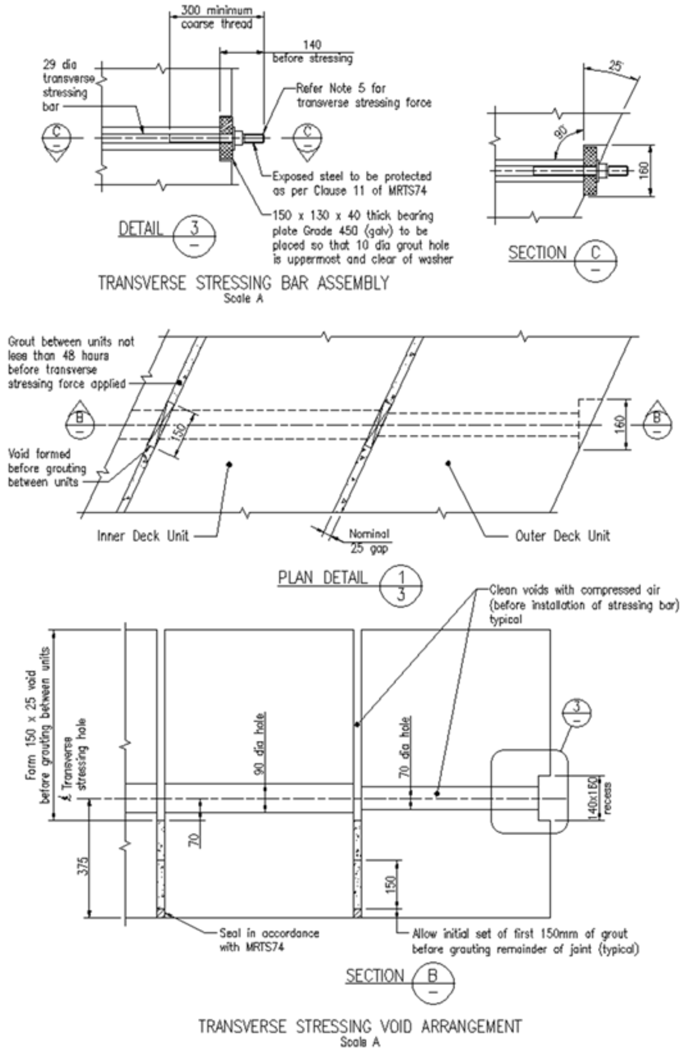
Void lengths in skewed deck units shall be reduced to maintain 50 mm minimum clearance to scuppers, reinforcement and transverse stressing holes. This will necessitate a change in the mass of units. The density of concrete used to calculate the mass is:

- 2.6 t/m^3 – inner deck units
- 2.7 t/m^3 – outer deck units
- 2.7 t/m^3 – deck units on RC deck bridges.

Transverse Stressing Assembly

On transversely stressed deck unit bridges, the recesses in which the bearing plates sit are formed to match the skew. Refer Figure 15.9-1 *Skewed Transverse Stressing Assembly*.

Figure 15.9-1 Skewed Transverse Stressing Assembly



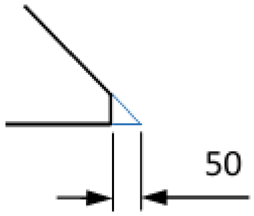
Shear Keys

On transversely stressed deck unit bridges skewed >30°, shear keys shall be provided. Generally, shear keys shall be 225 mm wide, 12 mm deep, and extend from the top of the deck units down to a level 75 mm above the bottom of the deck unit. Shear keys are to be spaced at approximately 1 m centres along the length of deck units. Shear key details are to be verified as part of the design and certification process.

Chamfers

On bridges skewed >30°, the acute angle corners of deck units are to be chamfered. Refer Figure 15.9-2 *Chamfered Corners*.

Figure 15.9-2 Chamfered Corners



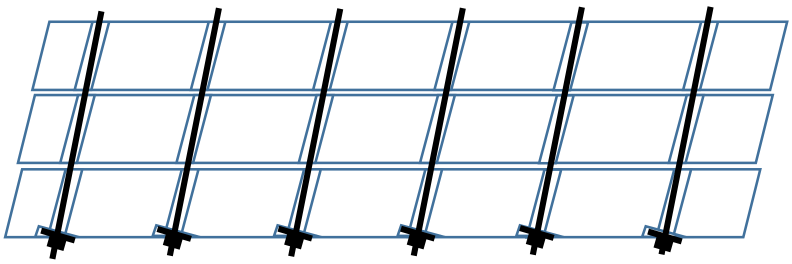
15.10 Expansion Joints

At piers or abutments where the deck units have expansion bearings, (or expansion/fixed at piers), an expansion joint is required to accommodate movements and seal the deck units on adjacent spans. Refer Chapter 18 – *Expansion Joints and Miscellaneous Details* and Chapter 17 – *Cast Insitu Kerbs and Decks, Appendix A Deck Design Sketches.*

15.11 Bridges around Curves

When deck unit bridges are built around a horizontal curve, the combination of skew, radius of curve, and span length, contributes to the ends of the deck units assuming a 'saw tooth' profile – shown diagrammatically in Figure 15.11-1.

Figure 15.11-1 Sawtooth Effect



Under this saw tooth effect, the resultant angle of skew on common points of the deck units, for example the stressing bar holes, varies from the nominated skew of the deck.

The size of stressing bar holes in inner deck units only may be altered where necessary to accommodate this variation as follows:

- ≥0.5° variation, use standard 70 mm diameter hole
- 0.5 to 2° variation, use 140 x 70 mm diameter slotted hole

- >2° variation, a RC deck design shall be used, eliminating the need for transverse stressing bars entirely

15.12 RC Deck on Deck Units

The department's standard deck units cannot be used in conjunction with a RC deck. Deck unit bridges with a RC deck will need project specific deck unit design, however, the layout of the drawings shall be similar to the standard deck unit drawings. Generally these deck units are not as deep as the corresponding standard deck units.

While the ligatures in standard deck units are placed normal to the edge of the units, they may be skewed for RC deck on deck unit bridges for skews ≤ 30°. The deck reinforcement is also skewed so that the starter bars from the deck units and the deck reinforcement are in the same plane. Refer Figure 15.12-1 *Reinforcement for Skews ≤ 30°*.

For skews > 30° the starter bars and deck reinforcement are to be placed normal to the control line. Refer Figure 15.12-2 *Reinforcement for Skews > 30°*.

Figure 15.12-1 Reinforcement for Skews ≤30°

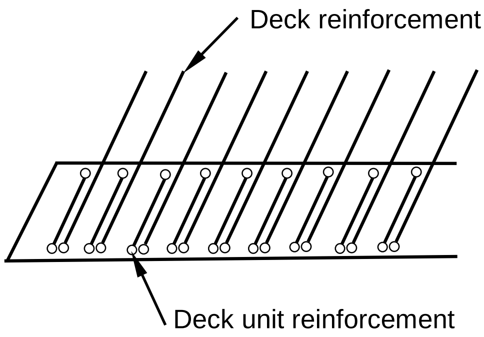
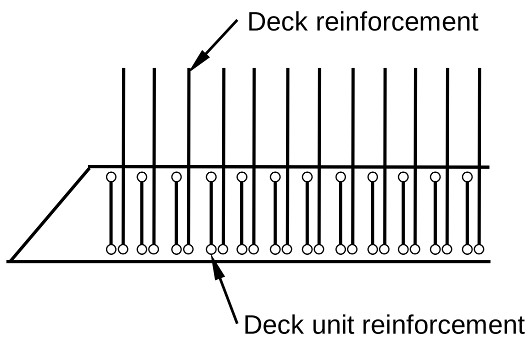


Figure 15.12-2 Reinforcement for Skews >30°



The starter bars that protrude into the deck can be one of two shapes. When there are only small gaps between deck units (up to 50 mm), the bars can be vertical as shown in Figure 15.12-3 *Close Gaps between Deck Units*.

Where the deck units are spaced more widely apart (over 50 mm), formwork (FC sheet) is placed on top of the deck unit. In this case LL shape bars are used. These bars are angled in, and tied to the top strands in the unit (which are also moved inwards). This provides a larger area on top of the unit for the FC sheet to be placed. Refer Figure 15.12-4 *Large Gaps between Deck Units* and Chapter 17 – *Cast Insitu Kerbs and Decks, Appendix A Deck Design Sketches – Sheet 3*.

Figure 15.12-3 Close Gaps between Deck Units

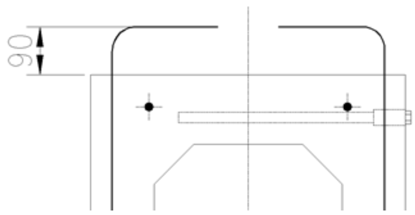
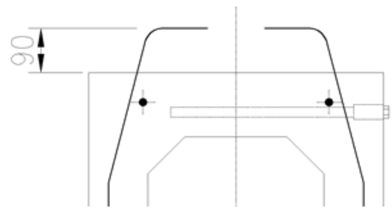


Figure 15.12-4 Large Gaps between Deck Units



15.13 Stage Construction and Bridge Widening

When the deck is constructed in stages, or the bridge is being widened, discontinuous couplers are used to couple the transverse stressing bar extension to the original bar. For additional details refer Chapter 8 – *Bridge Widening, 8.6 PSC Deck Unit Issues*.

The full requirements for recesses, stressing bar, anchorages and couplers are to be detailed on the deck unit drawings. The length of stressing bar shall be based on positioning the coupler adjacent to the gap in the deck units. Refer Figure 15.13-1 *Example Joint* and Figure 15.13-2 *Recess for Stage Construction* for typical details.

Figure 15.13-1 Example Joint

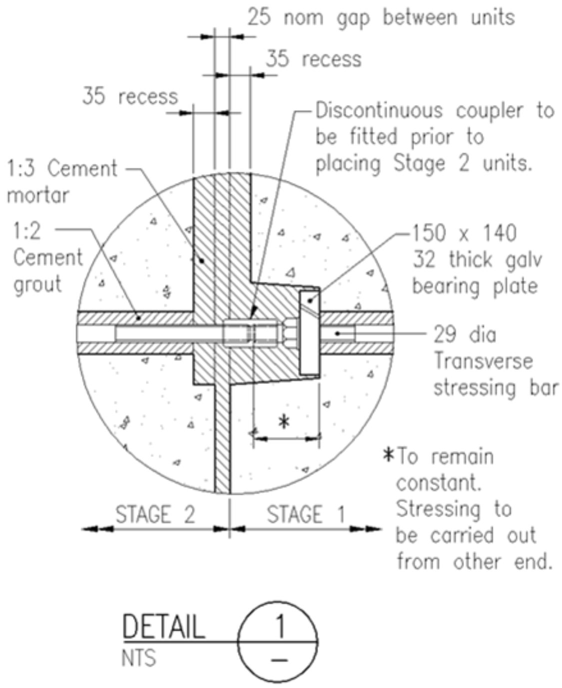
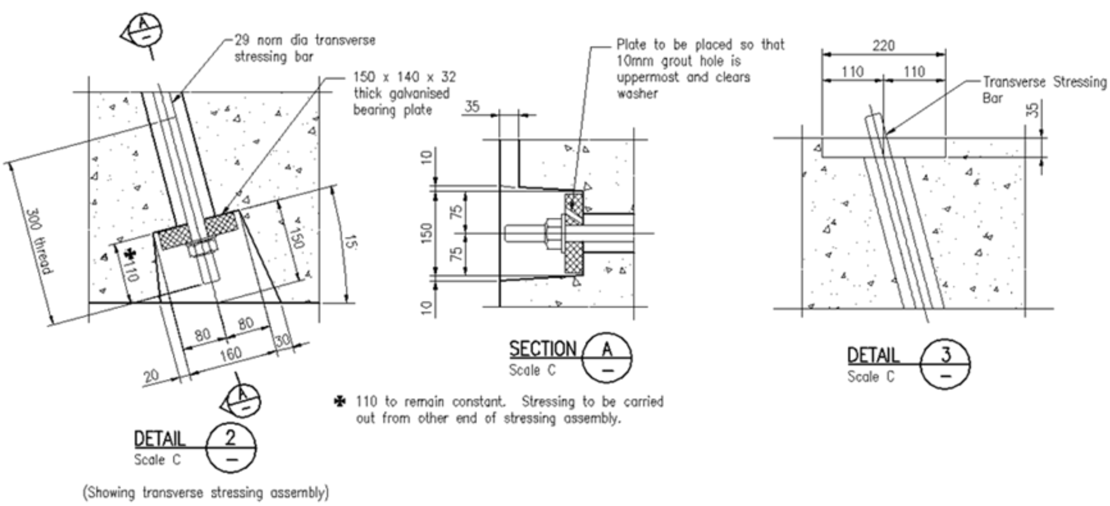


Figure 15.13-2 Recess for Stage Construction



15.14 Deck Drainage

The need for scuppers shall be determined by a hydraulic analysis.

Cast Insitu Kerbs

On superelevated deck unit bridges with cast insitu kerbs or concrete barriers, the unit on the high side is to be detailed without scuppers.

Scuppers on Overpass Bridges

Water shall not discharge directly onto the roadway below. Instead, the water shall be collected with an approved drainage system and channelled off the bridge. For additional information refer Chapter 17 – *Cast Insitu Kerbs and Decks, 17.12 Deck Drainage and Scuppers*.

Drafting and Design Presentation Standards
Volume 3: Structural Drafting Standards

Chapter 16: Piles and Footings

May 2013

Queensland Government

Feedback: Please send your feedback regarding this document to: tmr.techdocs@tmr.qld.gov.au

Chapter 16 Amendments

Revision register

Issue/Rev No.	Reference Section	Description of Revision	Authorised by	Date
1	–	First Issue.	Manager (Structural Drafting)	March 2011
2	–	Document name change.	Manager (Structural Drafting)	Nov 2011
	16.4	450 and 500 mm piles shall not be used.		
3	16.10	Cast in Place pile wording details revised. Figure 16.10-1 amended.	Team Leader (Structural Drafting)	May 2013
	–	Appendix G – new drawing added.		

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16 Piles and Footings

16.1 Glossary of terms

For a complete glossary of terms refer Chapter 1 – *Introduction.*

16.2 Figures and examples shown in this volume

The figures and examples shown in this volume are for presentation purposes only, and may contain some details that are now superseded. These details have been included for ease of reference, to illustrate typical solutions, and to show the required standard of drafting presentation. The details are not to be used without an engineering check and certification by a Structural RPEQ to confirm that the details are appropriate for the specific project.

16.3 General

The most common types of foundations used in bridge construction are as follows:

- Driven Piles
- Cast in place piles
- Spread footings.

Driven piles most commonly used in bridge design are as follows:

- Precast Prestressed Concrete (PSC) Piles
- Precast Prestressed Concrete (PSC) Spliced Piles.

Other types of driven piles may be used, if approved on a project specific basis, by the Department of Transport and Main Roads:

- Reinforced Concrete (RC) Piles
- Composite Piles (a combination of PSC and RC piles)
- Steel Piles.

Piles and footings shall be set out on the Abutment and Pier drawings and also on the Pile Identification and Setting Out Diagram which is shown on the General Arrangement drawings. Refer Chapter 11 – *General Arrangements, Figure 11.7.3 – Pile Identification and Setting Out Diagram*.

16.4 Precast Prestressed Concrete Piles

PSC piles are the most commonly used pile type. They are octagonal in cross section, measure 550 mm across opposite faces, and can be manufactured up to 28 m in length.

450 mm and 500 mm PSC piles were once commonplace, however, they shall no longer be used because most casting yards are not set up to produce them.

Pile drawings require a Schedule. Details to be supplied in the Schedule may include, but are not limited to:

- Pile location
- Pile length
- Numbers of each pile type

- Headbar diameter, length and number per pile
- Total mass of piles

Refer *Appendix A Example PSC Pile Drawing*.

16.5 Precast Prestressed Concrete Spliced Piles

Typically, casting yards are only set up to make piles up to 28 m in length. When piles longer than 28 m are required, two segments of the same profile are joined together with a mechanical splice. The splice shall be placed in the lower half of the pile where the bending moment is reduced. The department intends to produce a new standard drawing for spliced piles.

Refer *Appendix B Example PSC Spliced Pile Drawings*.

16.6 Reinforced Concrete Piles

RC piles are square in cross section and are not prestressed. Their use is not permitted for bridge foundations. Any Designer who believes the use of such piles is cost effective and will achieve the strength and durability required, may prepare a written submission for consideration by the Deputy Chief Engineer (Structures). Delays in assessing such submissions, and any consequent costs are entirely the responsibility of the Designer.

16.7 Composite Piles

The most common form of composite pile used in bridge design is a PSC pile and a RC pile joined by a mechanical splice. However, their use is not permitted for bridge foundations. Any Designer who believes the use of such piles is cost effective and will achieve the strength and durability required, may prepare a written submission for consideration by the Deputy Chief Engineer (Structures). Delays in assessing such submissions, and any consequent costs are entirely the responsibility of the Designer. Refer *Appendix C Example Composite Pile Drawing*.

16.8 PSC Pile Rock Shoe

When the ground is too hard to drive PSC piles fitted with a standard cast iron pile shoe, the shoe may be substituted with a steel rock shoe. The hardened steel pin on the shoe is designed to break through rock. Refer *Appendix D Example PSC Pile Rock Shoe Drawing*.

16.9 Steel Piles

Steel Universal Columns (UC) may sometimes be used for the following reasons:

- to save on transport costs when the bridge is in a dry, remote area
- they may be permitted in overflow bridges (not the main channel) where there is no permanent water in the stream
- the ground is too hard for PSC piles.

The use of steel piles must be approved by the Director (Bridge and Marine Engineering).

Fabrication details shall be shown on the drawings as necessary. Details may include, but are not limited to:

- Layout of piles about the Bridge Control

- Type and size of pile
- Orientation of pile
- Height of pile tip
- Height of soffit of pilecap or headstock
- Rake of pile if not vertical
- Ultimate Pile Capacity
- Pile tip details.

Steel piles may be used in conjunction with precast abutment and pier headstocks that are precast off site. These are typically used in remote areas where the procurement of large quantities of fresh concrete is impractical, or when a quick construction period is required. Refer *Appendix F Example Steel Pile and Precast Headstock Drawing*.

16.10 Cast in Place Piles

Cast in place piles in bridge structures consist of a reinforced concrete column contained in either a concrete pipe liner or a steel liner. The liner is founded on suitable hard strata using a socketed base. Belled bases are not permitted. Bored piles (constructed on site without a liner) are not permitted for bridge foundations.

Details of cast in place piles to be shown on the abutment and pier drawings may include, but are not limited to:

- Layout of piles about the Bridge Control
- Size, grade and type of liner
- Height of soffit of pilecap/headstock
- Height of toe of liner
- Provisional Height of bottom of socket/bell
- A note clarifying the fixity requirements of the socket/bell into rock
- Details of the size and shape of the socket/bell
- Design Foundation Bearing Pressure
- Rock anchors
- Cover to steel reinforcing details. The size of the stainless steel nib depends on the reinforcement cover requirements. Refer Figure 16.10-1 *Example Stainless Steel Nib*
- Cathodic protection details. Note that stainless steel nibs cannot be used with cathodic protection. An alternate such as ceramic spacers will be required.
- Stiffening band details at the toe of the steel liner, including transition liner details if required. Refer Figure 16.10-2 *Example Stiffening Band*. The thickness of the stiffening band, transition liner and the main pile liner may vary depending on the ground conditions and the diameter and length of the liner.

Refer *Appendix G Example CIP Pile Drawing.*

Figure 16.10-1 Example Stainless Steel Nib

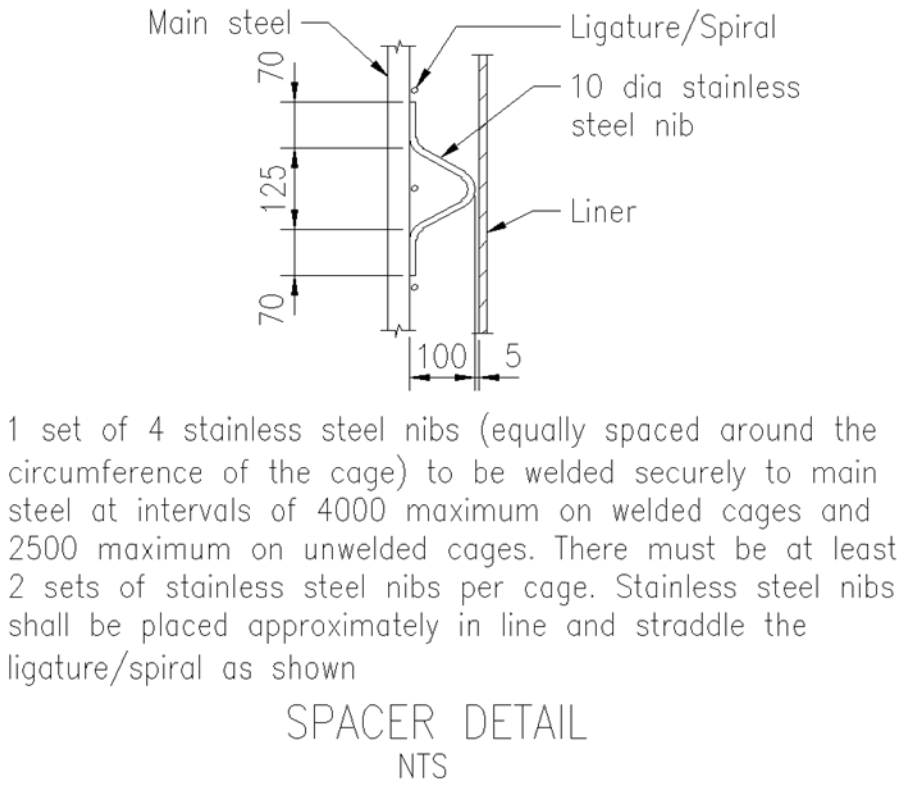
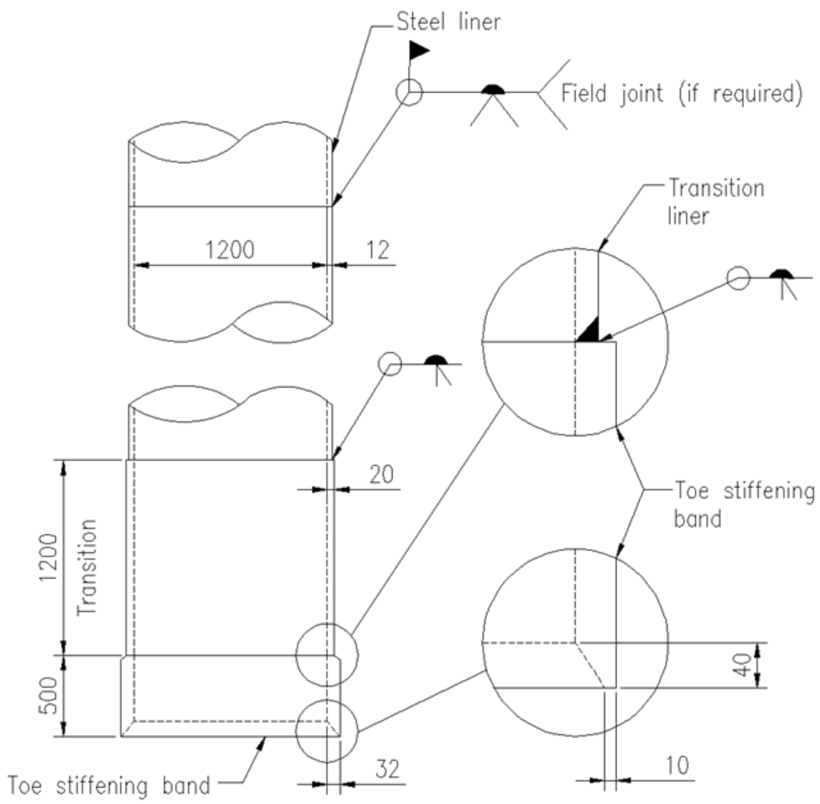


Figure 16.10-2 Example Stiffening Band



16.11 Spread Footings

Spread footings are used when strata capable of carrying the design loads is found close to the ground surface.

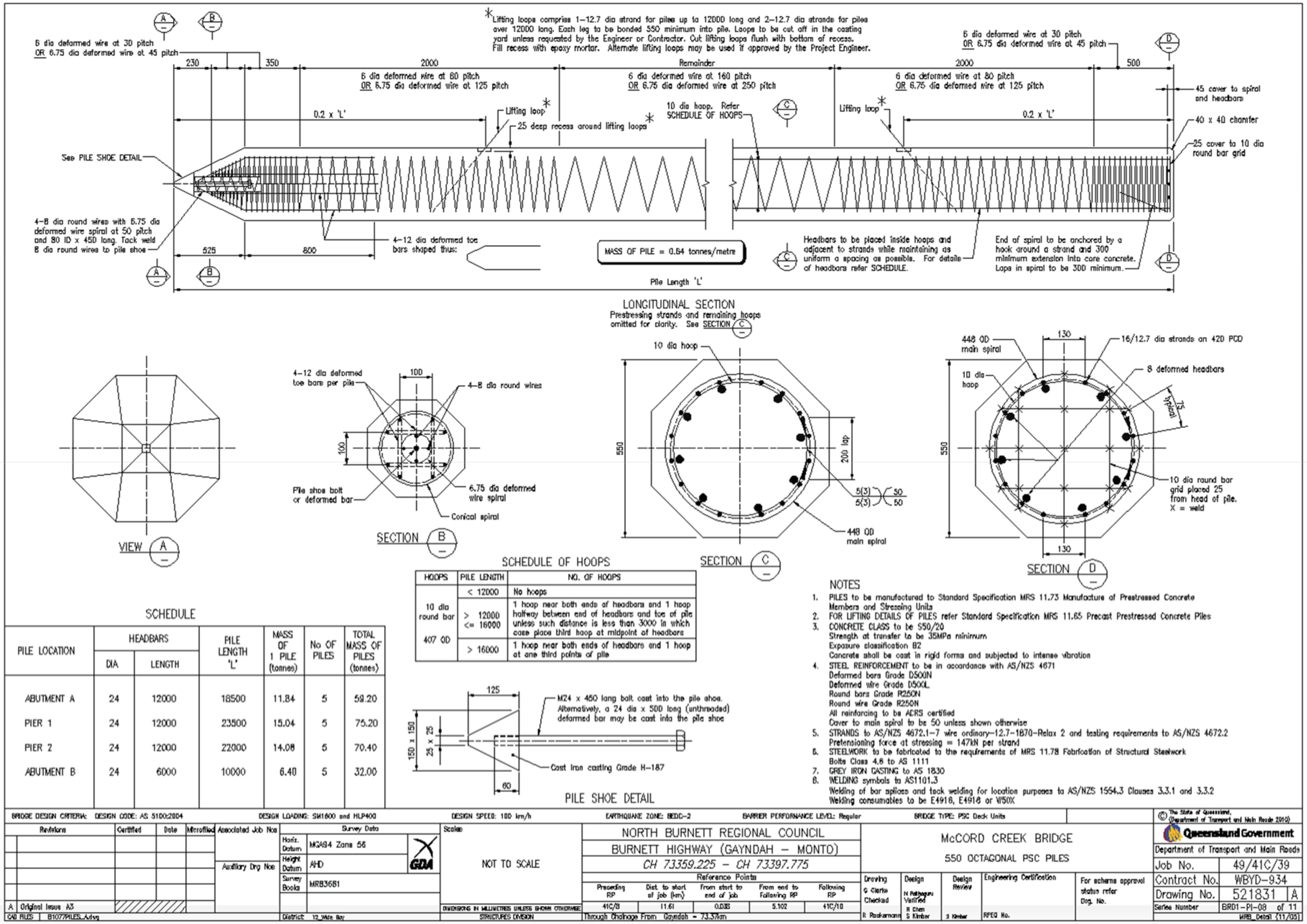
Details of spread footings to be shown on the abutment and pier drawings may include, but are not limited to:

- Layout of footings about the Bridge Control
- Dimensions of footing
- Reinforcement details
- Height of soffit of footing
- Rock anchors
- Blinding concrete
- Design Foundation Bearing Pressures.

Refer *Appendix H Example Spread Footing Drawings*.

Appendix A – Example PSC Pile Drawing

Appendix A – Example PSC Pile Drawing

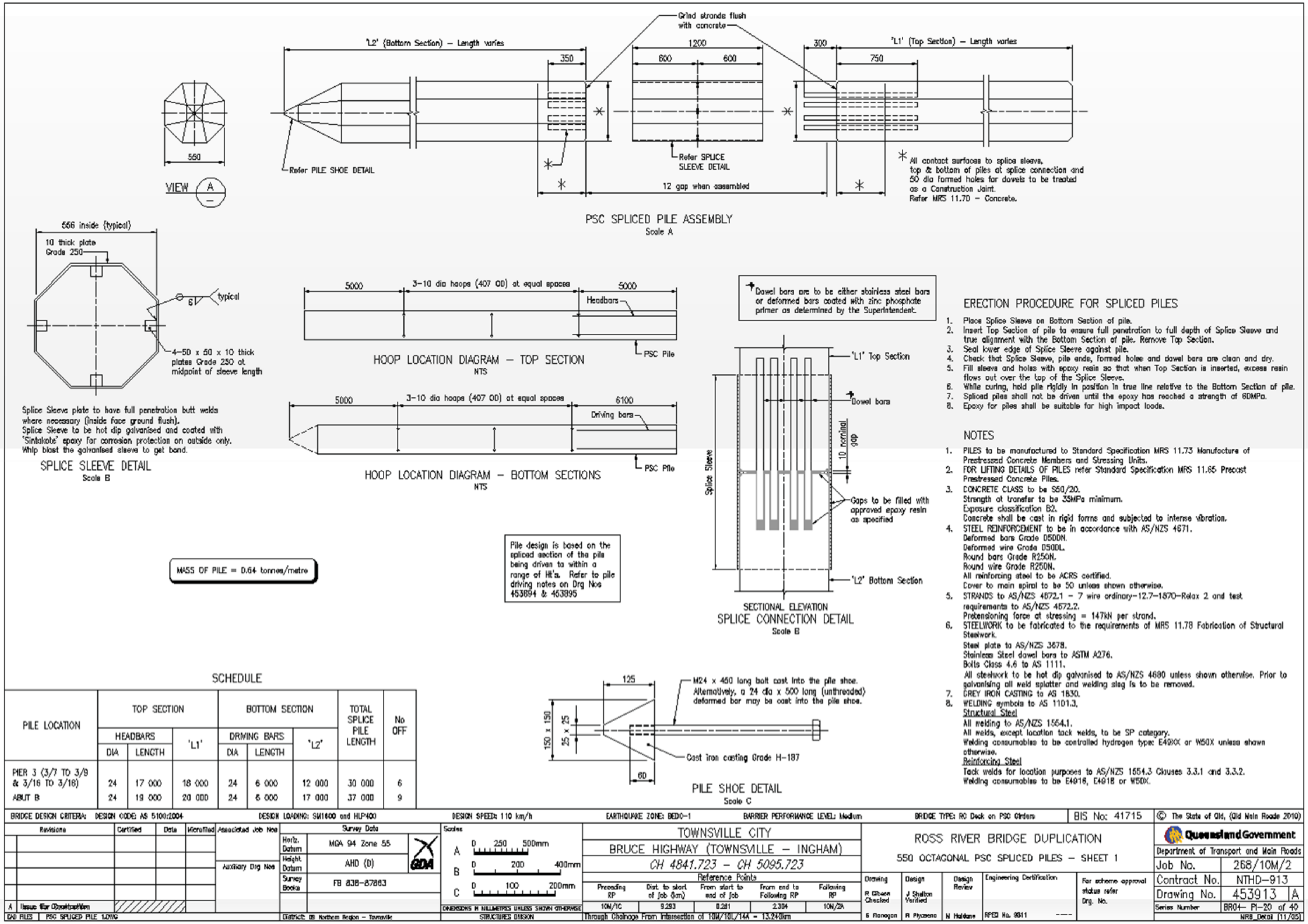


HOOPS	PILE LENGTH	NO. OF HOOPS
10 dia round bar 407 OD	< 12000	No hoops
	> 12000 <= 16000	1 hoop near both ends of headbars and 1 hoop halfway between end of headbars and toe of pile unless such distance is less than 3000 in which case place third hoop at midpoint of headbars
	> 16000	1 hoop near both ends of headbars and 1 hoop at one third points of pile

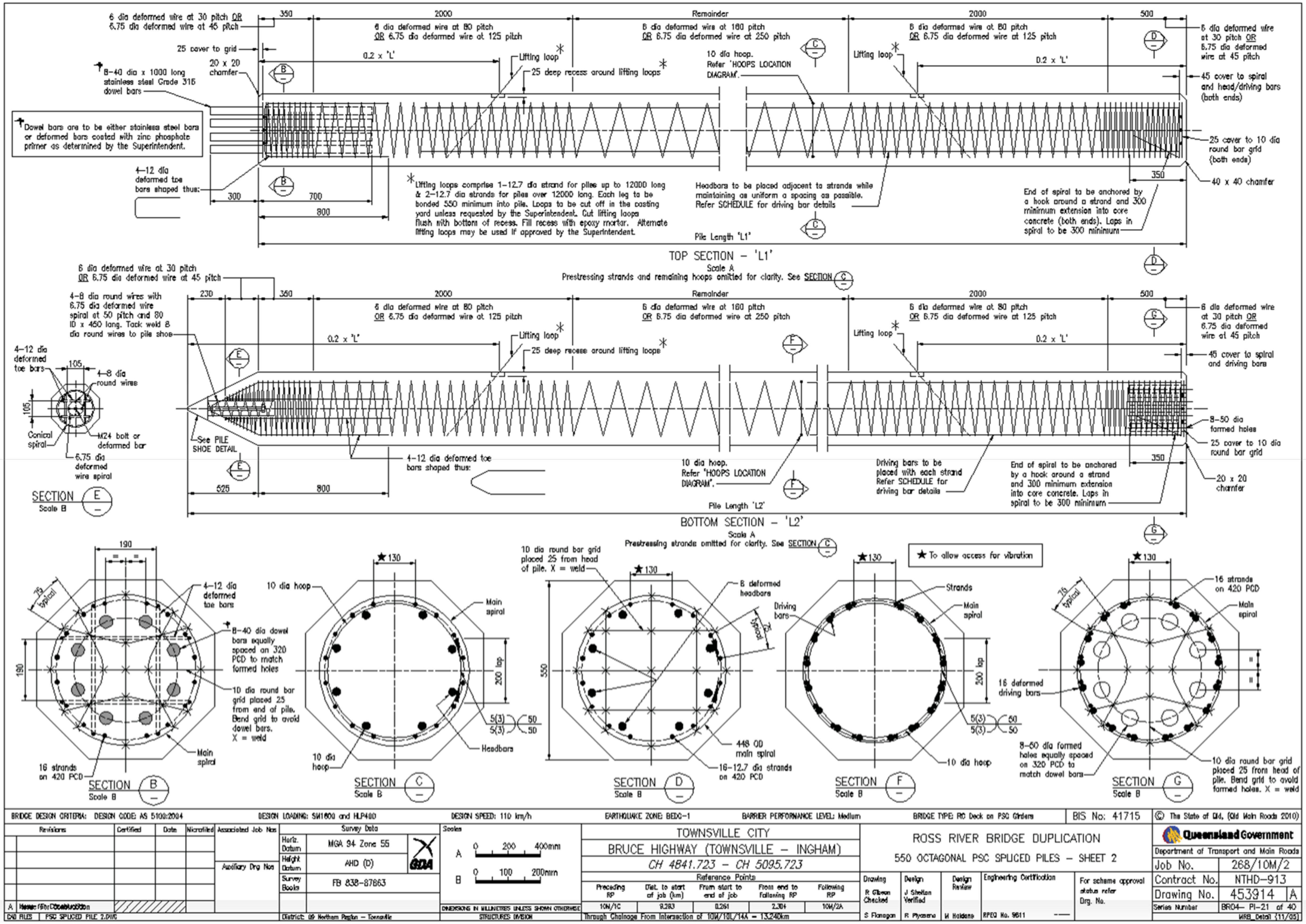
PILE LOCATION	HEADBARS DIA	HEADBARS LENGTH	PILE LENGTH 'L'	MASS OF 1 PILE (tonnes)	No OF PILES	TOTAL MASS OF PILES (tonnes)
ABUTMENT A	24	12000	18500	11.84	5	59.20
PIER 1	24	12000	23500	15.04	5	75.20
PIER 2	24	12000	22000	14.08	5	70.40
ABUTMENT B	24	6000	10000	6.40	5	32.00

Appendix B – Example PSC Spliced Pile Drawings

Appendix B – Example PSC Spliced Pile Drawings – Sheet 1

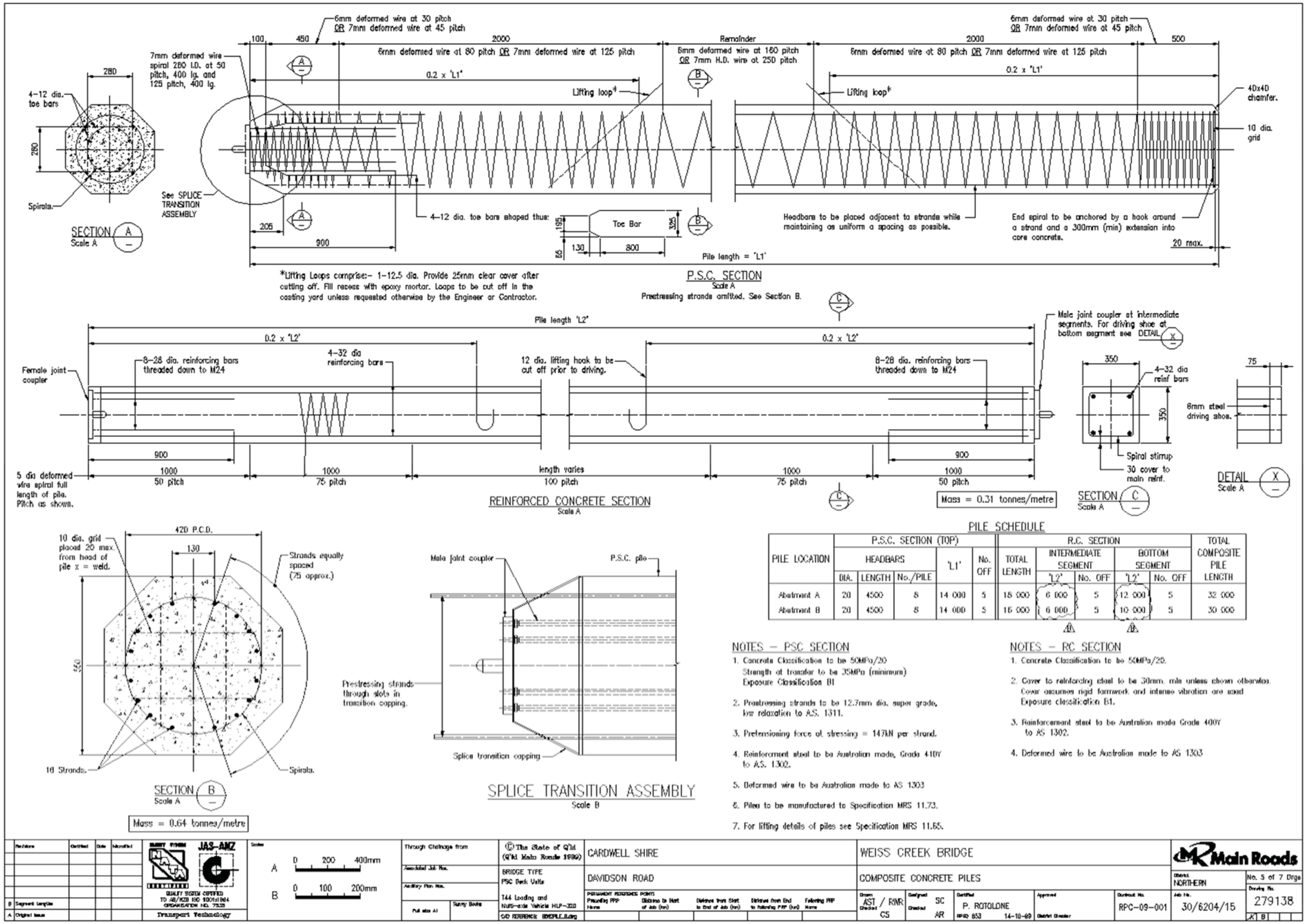


Appendix B – Example PSC Spliced Pile Drawings – Sheet 2



Appendix C – Example Composite Pile Drawing

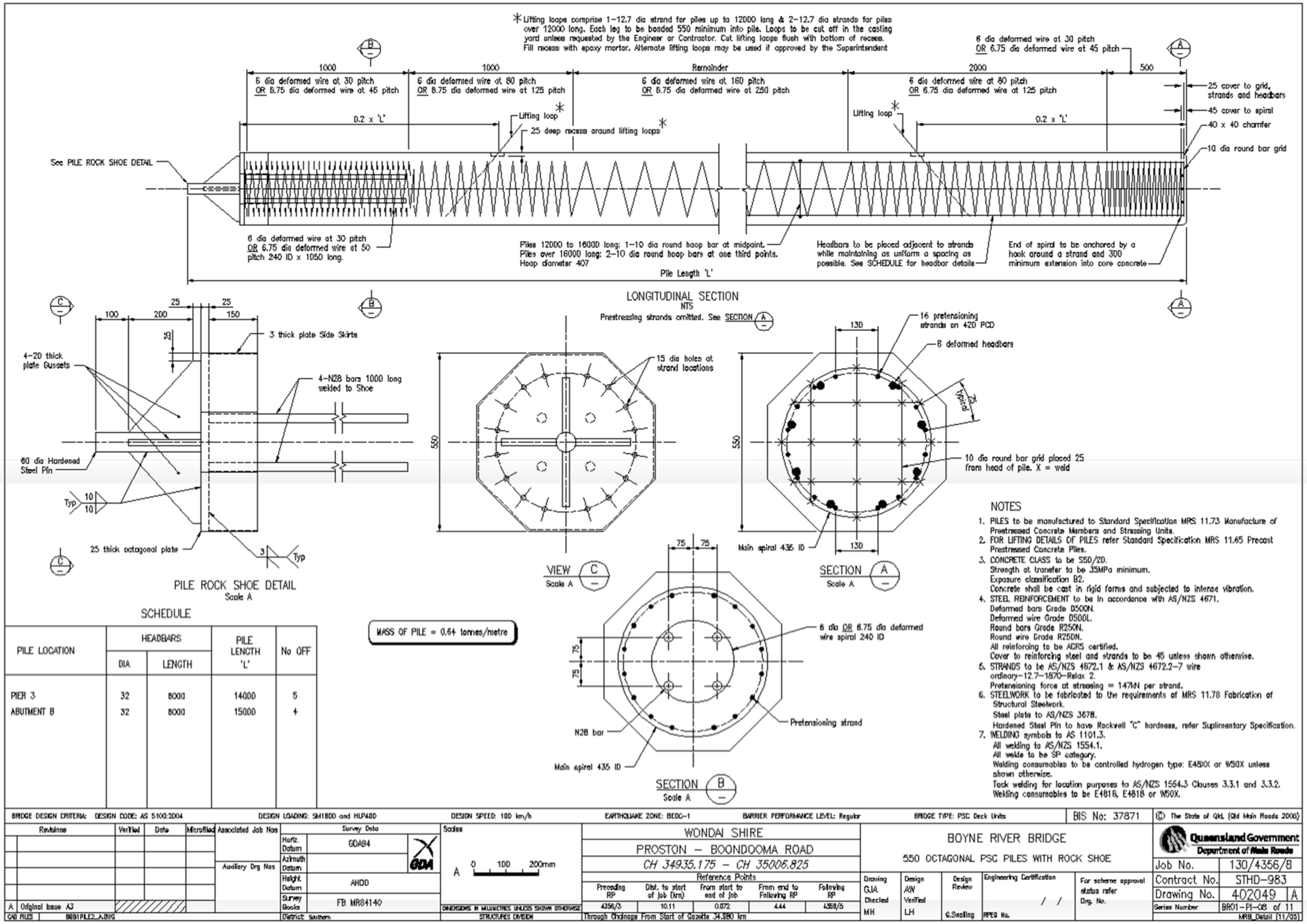
Appendix C – Example Composite Pile Drawing



PILE LOCATION	P.S.C. SECTION (TOP) HEADBARS DIA.	LENGTH	No./PILE	'L1'	No. OFF	R.C. SECTION TOTAL LENGTH	INTERMEDIATE SEGMENT 'L2'	No. OFF	BOTTOM SEGMENT 'L2'	No. OFF	TOTAL COMPOSITE PILE LENGTH
Abutment A	20	4500	8	14 000	5	18 000	6 000	5	12 000	5	32 000
Abutment B	20	4500	8	14 000	5	16 000	6 000	5	10 000	5	30 000

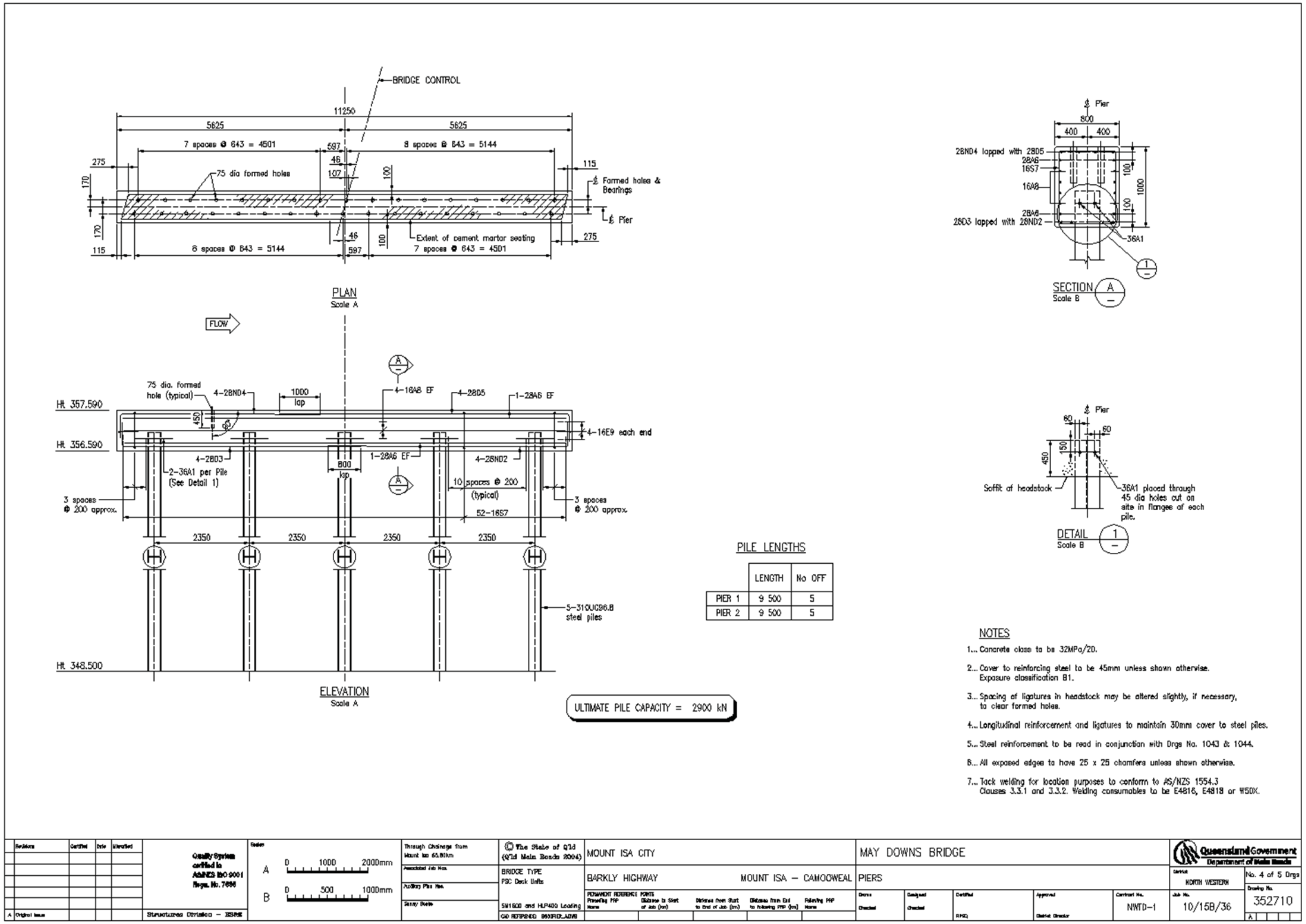
Appendix D – Example PSC Pile Rock Shoe Drawing

Appendix D – Example PSC Pile Rock Shoe Drawing



Appendix E – Example Steel Pile and Cast Insitu Headstock Drawing

Appendix E – Example Steel Pile and Cast Insitu Headstock Drawing



PILE LENGTHS

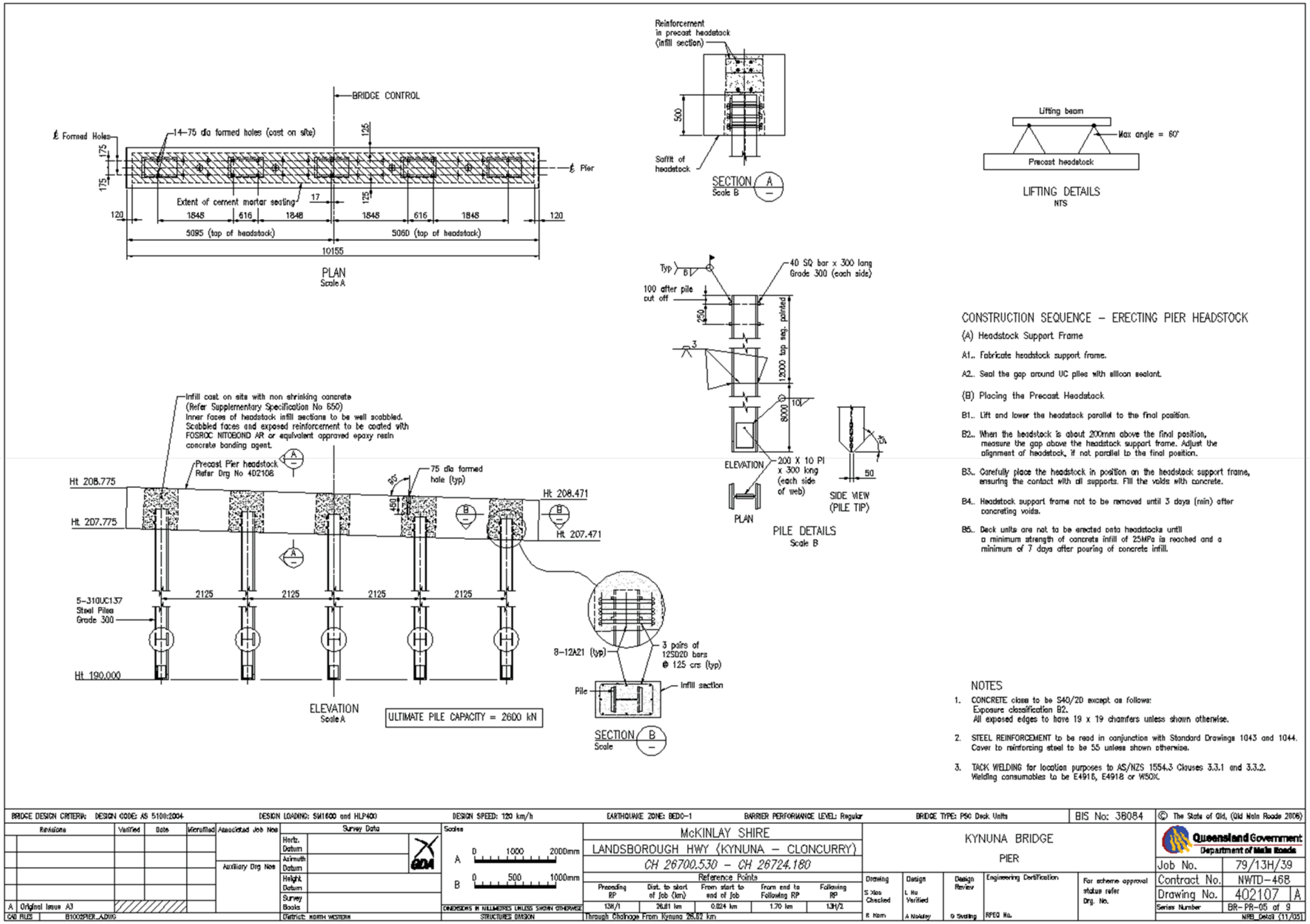
	LENGTH	No OFF
PIER 1	9 500	5
PIER 2	9 500	5

NOTES

1. Concrete class to be 32MPa/20.
2. Cover to reinforcing steel to be 45mm unless shown otherwise. Exposure classification B1.
3. Spacing of ligatures in headstock may be altered slightly, if necessary, to clear formed holes.
4. Longitudinal reinforcement and ligatures to maintain 30mm cover to steel piles.
5. Steel reinforcement to be read in conjunction with Drgs No. 1043 & 1044.
6. All exposed edges to have 25 x 25 chamfers unless shown otherwise.
7. Tack welding for location purposes to conform to AS/NZS 1554.3 Clauses 3.3.1 and 3.3.2. Welding consumables to be E4816, E4818 or W50X.

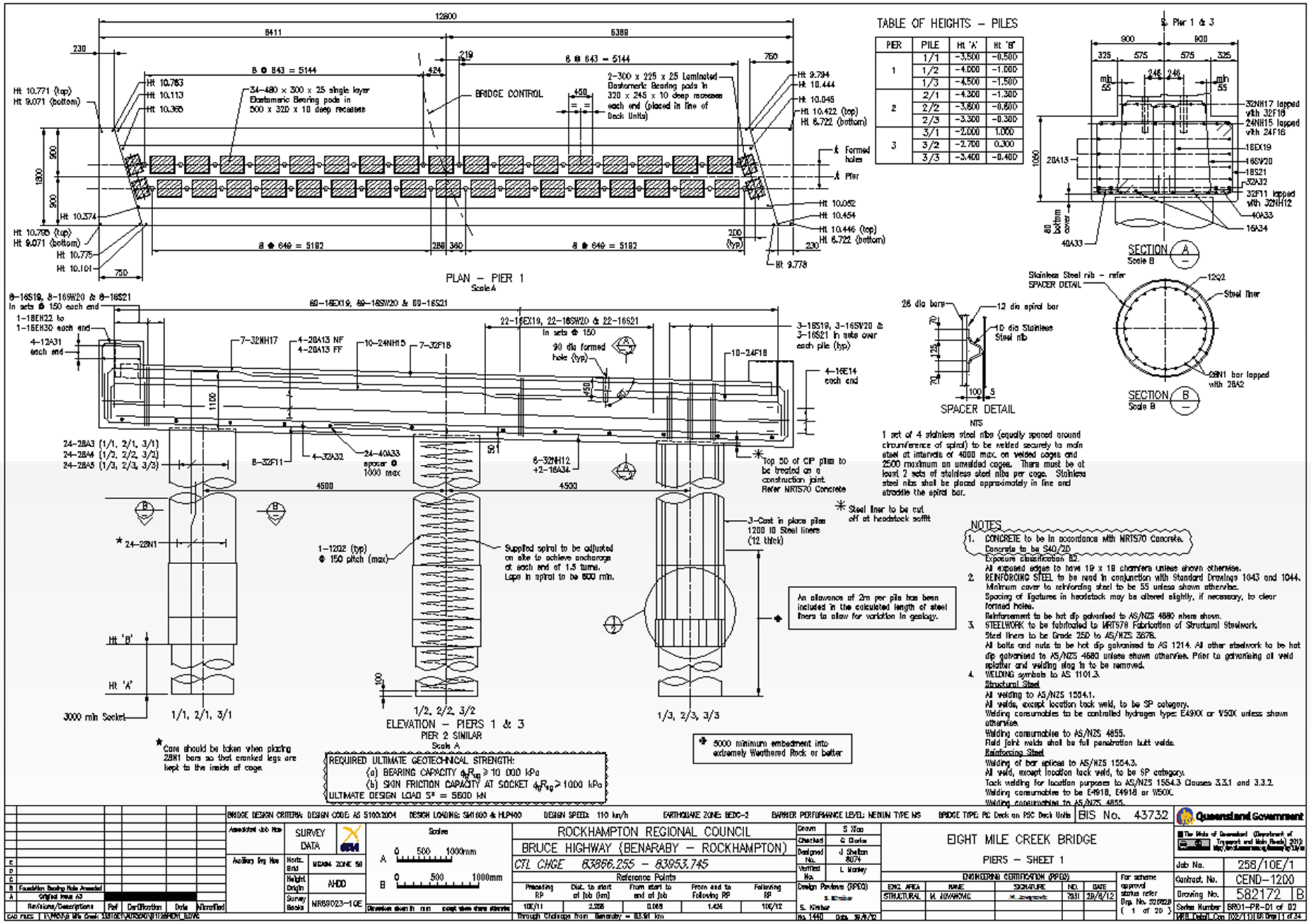
Appendix F – Example Steel Pile and Precast Headstock Drawing

Appendix F – Example Steel Pile and Precast Headstock Drawing



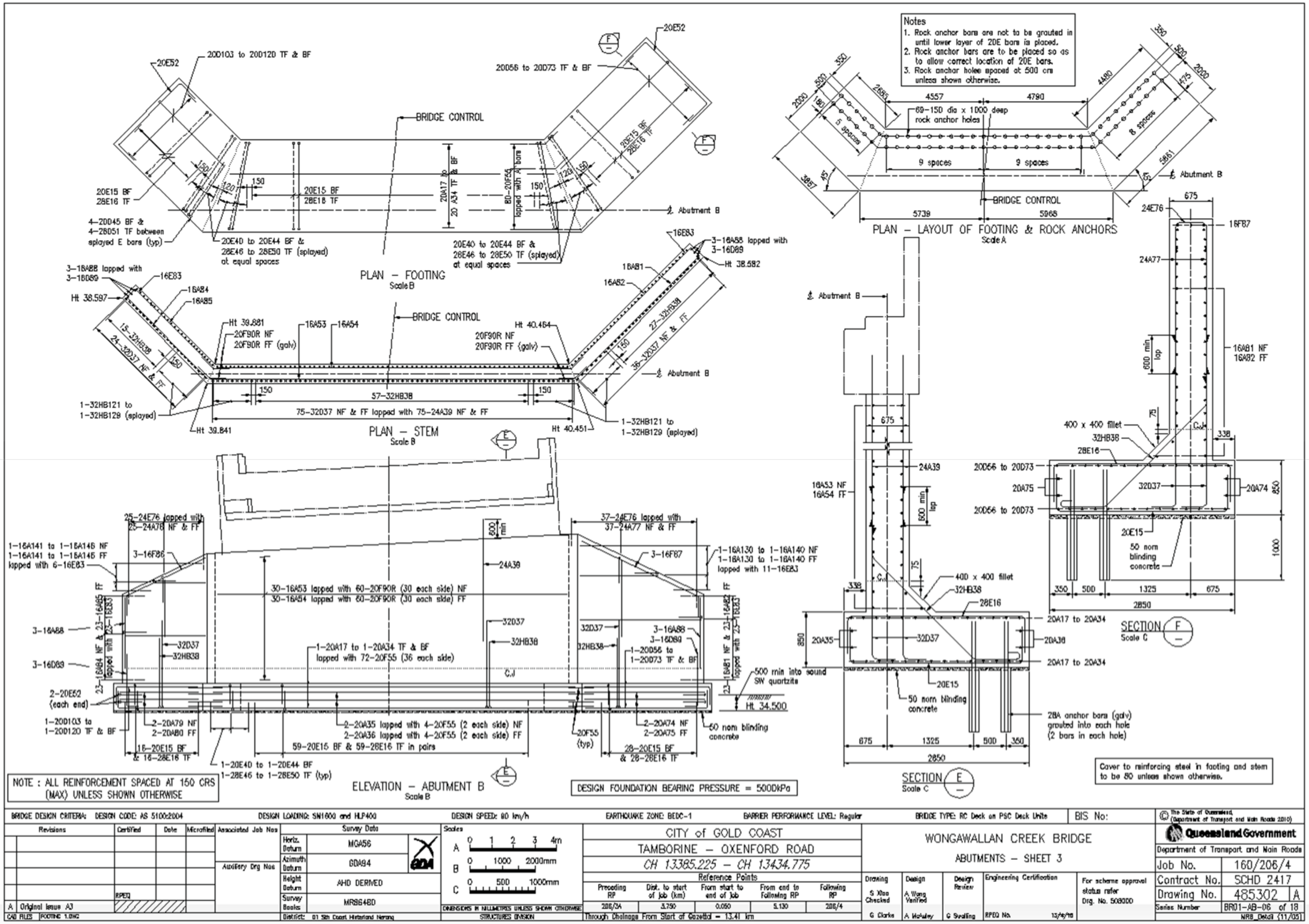
Appendix G – Example CIP Pile Drawing

Appendix G – Example CIP Pile Drawing

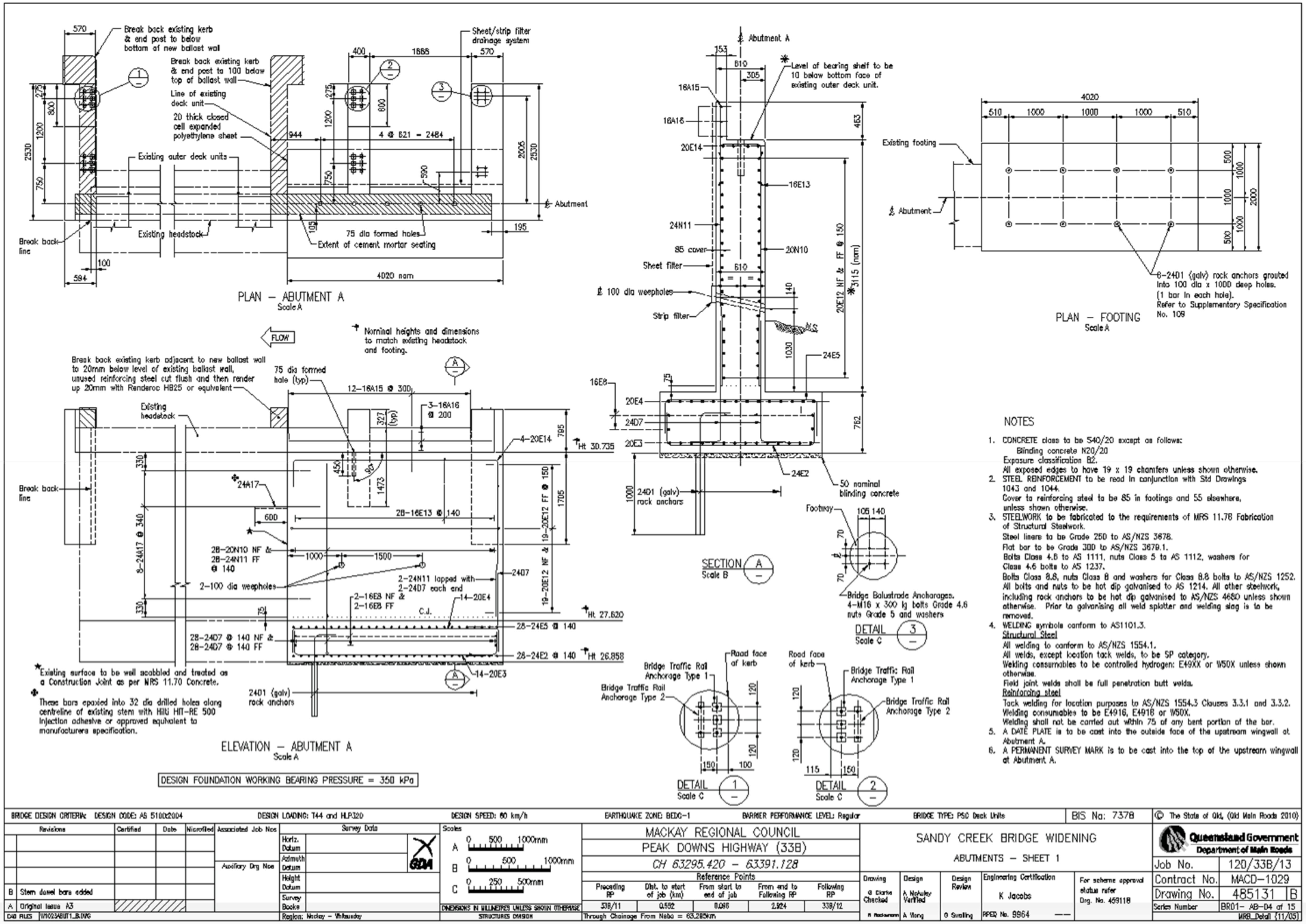


Appendix H – Example Spread Footing Drawings

Appendix H – Example Spread Footing Drawings – Sheet 1



Appendix H – Example Spread Footing Drawings – Sheet 2



Drafting and Design Presentation Standards
Volume 3: Structural Drafting Standards

Chapter 17: Cast Insitu Kerbs and Decks

May 2013

Queensland Government

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Chapter 17 Amendments

Revision register

<table>
<tr><th>Issue/Rev No.</th><th>Reference Section</th><th>Description of Revision</th><th>Authorised by</th><th>Date</th></tr>
<tr><td>1</td><td>–</td><td>First Issue.</td><td>Manager (Structural Drafting)</td><td>April 2011</td></tr>
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<tr><td>17.12</td><td>Add reference to section 10.10.</td></tr>
<tr><td>Appendix A</td><td>Update deck design sketches with latest typical details.</td></tr>
<tr><td rowspan="7">3</td><td>–</td><td>Page numbers for Appendix A updated throughout the whole chapter/</td><td rowspan="7">Team Leader (Structural Drafting)</td><td rowspan="7">May 2013</td></tr>
<tr><td>17.3</td><td>Wording changed to steel bridge traffic barrier.</td></tr>
<tr><td>17.4</td><td>Wording changed to steel bridge traffic barrier.</td></tr>
<tr><td>17.5</td><td>Continuous Deck without DWS – Paragraph re-worded.</td></tr>
<tr><td>17.13</td><td>Note on concrete inserts added.</td></tr>
<tr><td>17.14</td><td>Paragraph 4 – 50 mm nominal gap was 100 mm. Re-worded XJS expansion joint details.

Figure 17.14-1 – deleted.</td></tr>
<tr><td>Appendix A</td><td>Deck design sketches re-numbered and revised.</td></tr>
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17 Cast Insitu Kerbs and Decks

17.1 Glossary of terms

For a complete glossary of terms refer Chapter 1 – *Introduction.*

17.2 Figures and examples shown in this volume

The figures and examples shown in this volume are for presentation purposes only, and may contain some details that are now superseded. These details have been included for ease of reference, to illustrate typical solutions, and to show the required standard of drafting presentation. The details are not to be used without an engineering check and certification by a Structural RPEQ to confirm that the details are appropriate for the specific project.

17.3 General

Bridges have either cast insitu kerbs or a reinforced concrete deck. The deck may have a kerb with a steel bridge traffic barrier or it will have a concrete traffic barrier. Refer Chapter 9 – *Bridge Deck Types*. Many of the details that are required to produce kerb and deck drawings have been standardised and are shown on standard deck design sheets which have been developed in Bridge and Marine Engineering and are used as the standard for design and presentation in the production of departmental bridge drawings. The design sheets also show additional details such as girder restraint angles and cast in socket details for deck units.

Engineers may use these standard details, modifying them to be project specific, and issue them as design sheets. Drafters use the standard sheets in their AutoCAD form to produce detailed deck drawings. Refer *Appendix A Deck Design Sketches*.

17.4 Cast Insitu Kerbs

Standard cast insitu kerbs are 500 mm wide. This is wide enough to fit an 80 mm electrical/telecommunications conduit when required. The top of the kerb is 275 mm above the road running surface.

Deck unit bridges with cast insitu kerbs have starter bars protruding from the outer deck unit which are used to bond the kerb to the deck unit. The kerbs have additional ligatures where the steel bridge traffic barrier post anchorages are cast into it.

Top Face of Kerbs

The top face of the kerb is level on bridges with a crossfall or superelevation up to and including three per cent. For bridges with a superelevation greater than three per cent, the top face of the kerb follows the superelevation. *Appendix A Deck Design Sketches – Sketch 5* shows standard details for kerb reinforcement.

Expansion Joints

On bridges with an extruded aluminium expansion joint, recesses are cast into the kerbs. Refer *Appendix A Deck Design Sketches – Sketch 6*.

Due to the effects of crossfall and/or hog, the thickness of DWS at piers and abutments may be particularly thick if the bridge does not have a concrete deck. Because the top of an extruded aluminium expansion joints finishes flush with the top of the DWS, an expansion joint bolted directly onto deck units may need to be seated on a deep layer of epoxy mortar.

When the thickness of epoxy mortar beneath the expansion joint exceeds 70 mm, the epoxy mortar shall be reinforced. In *Appendix A Deck Design Sketches* this is referred to as deep DWS. Epoxy mortar that does not need to be reinforced is referred to as shallow DWS.

Reinforcing the epoxy mortar is done with stainless steel 12AT bars which are screwed into M10 sockets cast in the deck units and bent on site. Refer *Appendix A Deck Design Sketches – Sketches 6, 7 and 8*. On bridges with a crowned running surface, the thickness of the epoxy mortar may be such that the 12AT bars are not required on some of the outer deck units.

Deck Wearing Surface Height Diagram

Bridges on vertical curves are required to show finished DWS Heights at specific intervals along the bridge. The spacing of the Heights depends on the VC radius. The smaller the radius, the closer the Height spacing. Heights can either be given at set chainages, for example every 5 m, or a span can be divided into equal length segments and Heights given at these spacings. Deck crossfall/superelevation details and deck cross section dimensions are also required.

Heights are to be given at right angles to the Bridge Control (or radially if the bridge is on a horizontal curve), and should start and finish at a chainage which wholly includes the relieving slabs. It must be clearly noted that the Heights are given at right angles to the bridge control and not along the skew line of the bridge. For an example of the required details refer Figure 17.4.1 *Example Deck Wearing Surface Heights*.

Bridges with a varying crossfall/superelevation also need a table of Heights following the same methodology as a bridge on a VC.

Where the bridge documentation is delivered as part of a set that includes civil and alignment drawings, the DWS Heights are usually defined within that set. The DWS Heights need not be shown on the bridge drawings. On Design and Construct projects, it is common practice that the Contractor's Surveyors use the alignment model (from 12D) to determine the DWS Heights at any point they require.

Figure 17.4.1 Example Deck Wearing Surface Heights

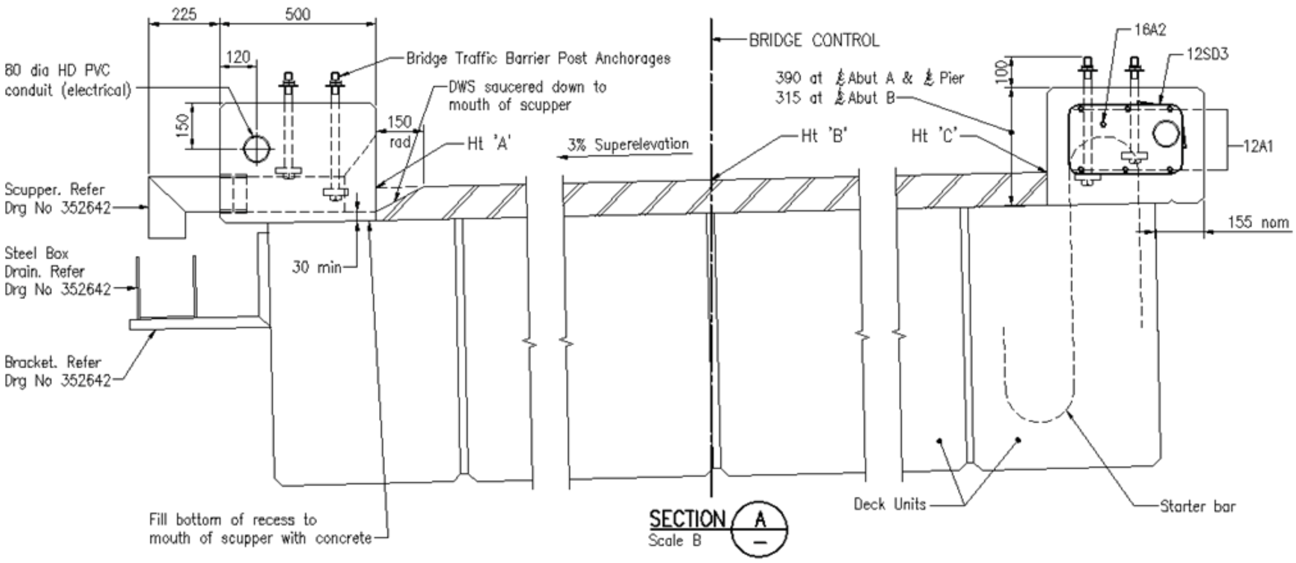
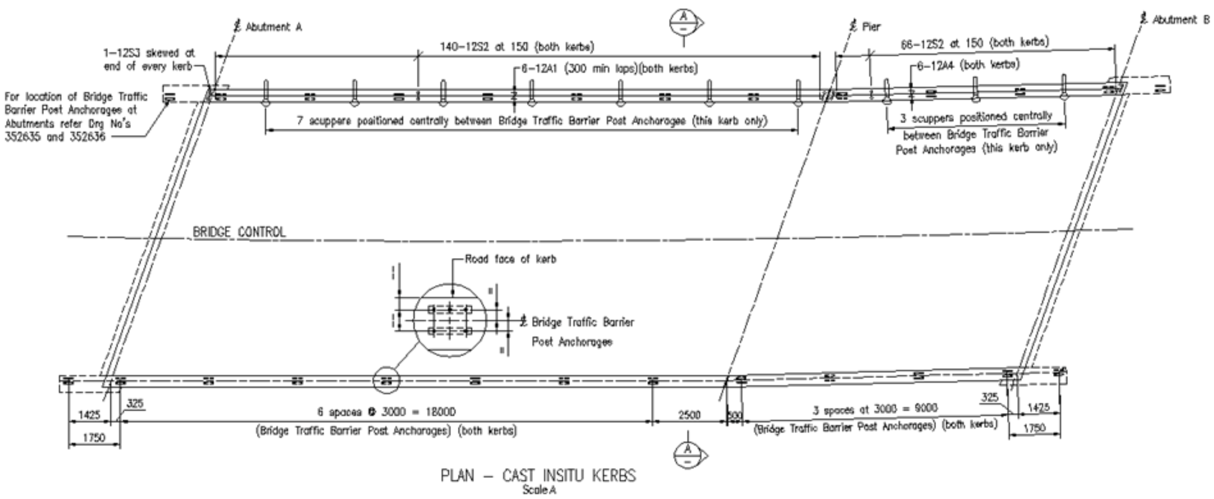


TABLE OF Ht's (All Ht's are radial to BRIDGE CONTROL)

CHAINAGE	3516	3518	3520	3522	3524	3526	3528	3530	3532	3534	3536	3538	3540	3542	3544	3546	3548	3550	3552
Ht 'A'	–	–	41.317	41.328	41.341	41.354	41.370	41.386	41.404	41.423	41.444	41.466	41.488	41.513	41.537	41.563	41.590	41.619	41.649
Ht 'B'	41.436	41.446	41.457	41.469	41.482	41.496	41.512	41.528	41.546	41.565	41.585	41.606	41.628	41.652	41.676	41.702	41.729	41.757	41.786
Ht 'C'	41.577	41.586	41.596	41.607	41.620	41.633	41.649	41.665	41.683	41.702	41.723	41.744	41.766	41.790	41.814	41.840	41.867	–	–



17.5 Decks

Decks are used on all girder bridges.

Decks are also used on deck unit bridges in special cases, typically:

- Multi span bridges on small radius horizontal curves and/or vertical curves
- Footwalks and bikeway bridges where deck units are widely spaced to act as girders
- Skews greater than 40°.

Decks are coated with bituminous waterproofing membrane to stop water permeating through the concrete deck and damaging the bridge components below.

The barrier on a deck is typically either a steel bridge traffic barrier bolted to concrete kerb, or a full height concrete traffic barrier. Refer Chapter 19 – *Bridge Barriers, 19.9 Single Sloped Concrete Traffic Barriers*.

Decks are designed to link simply supported deck spans at piers and abutments in one of three ways: fixed joint, expansion joint or continuous deck.

Fixed Joint

At abutments where the deck units/girders have fixed bearings (not cement mortar seating), an XJS expansion joint system (or approved equivalent) shall be installed. Refer *Appendix A Deck Design Sketches – Sketch 6*.

Expansion Joint

At piers or abutments where the decks units/girders have expansion bearings, (or expansion/fixed at piers), an expansion joint is required to join the deck sections of the adjacent spans. Refer Chapter 18 – *Expansion Joints and Miscellaneous Details* and *Appendix A Deck Design Sketches – Sketches 6 and 7*.

Continuous Deck with DWS

At piers where the deck units/girders have fixed bearings the concrete deck is cast over the gap between the adjacent spans. Concrete is used rather than a filler material because it is the better option for making the joint waterproof. The deck is not poured over two adjacent spans at once, rather it is done in a series of initial and infill pours. The infill pour is done over the pier and the deck is debonded from the decks units/girders with a sheet of closed cell expanded polyethylene. Refer *Appendix A Deck Design Sketches – Sketches 1, 3 and 4*.

Continuous Deck without DWS

When DWS is not used, the construction joint to one side of the pier centreline must be spread widely apart to ensure a smooth transition between pours. Refer *Appendix A Deck Design Sketches – Sketches 2, 3 and 4*.

17.6 Deck Overhang

Limits of Overhang

The deck units/steel girders supporting the deck should be set out so that the maximum overhang on both sides of the bridge is equal. The maximum overhang for a deck unit bridge should be approximately 350 mm, refer *Appendix A Deck Design Sketches – Sketch 3 (Section C)*. If a greater overhang is required, the Drafter shall liaise with the Design Engineer to establish an acceptable outcome.

Bridge decks are often designed to follow horizontally curved alignments. This results in the RHS and LHS kerbs being cast on concentric circular curves which create a varying overhang of the deck outside the line of prestressed beams. The bridge overhang at the centre of span on one side of the bridge and the overhang at the ends of the span on the opposite side of the bridge should be approximately equal.

When super T-girders are used, the outer flange of the outer girders is cast to match the curved alignment. Refer Chapter 14 – *Prestressed Concrete Girders, 14.5 Girder Profiles*.

17.7 Steel Reinforcement Layout around Curves

Longitudinal reinforcement is placed in a straight line in each span to follow the line of the starter bars protruding from the decks units/girders. At the extremities of the deck adjacent to the kerbs, the longitudinal steel shall be cut to avoid clashing with the curved longitudinal bars in the kerbs. Refer *Appendix A Deck Design Sketches – Sketch 1 (Deck Reinforcement in Bridges with Small Radius Horizontal Curves)*.

17.8 Pre-camber

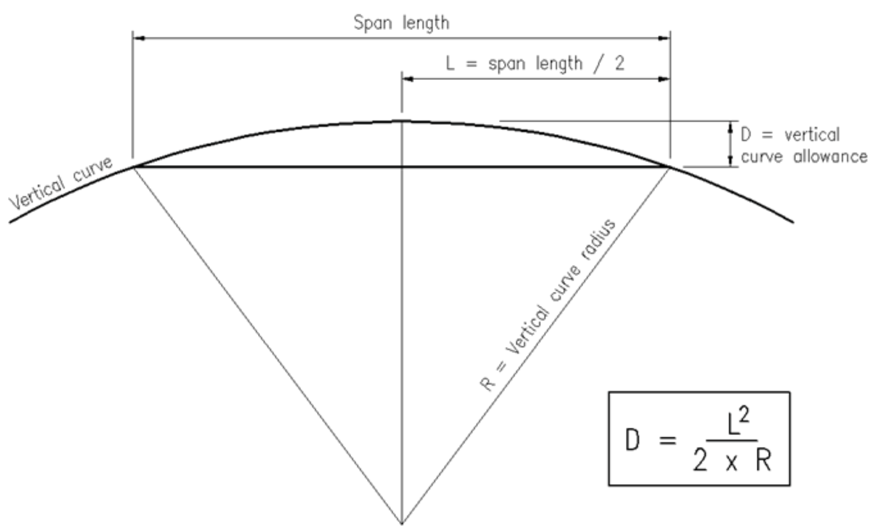
When a deck is poured onto deck units/girders the mass of the concrete deck will cause the hog in the beams to reduce. This is known as pre-camber and the distance that the hog will reduce is calculated by the design engineer and must be shown on the deck drawings in a pre-camber diagram. When the bridge is being constructed, the formwork will be set higher than the finished height by the pre-camber amount. Therefore, once the deck has been poured, the deck shall settle at the correct height. Formwork for the deck shall be supported by the girders/deck units. On no account is the formwork to be tommed from the ground. Refer *Appendix A Deck Design Sketches – Sketch 3 (Pre-camber Diagram)*.

17.9 Deck Thickness

When calculating the deck thickness at the abutments and piers, the pre-camber and hog are taken into account. The deck thickness at the abutments and piers is the minimum deck thickness at midspan, plus the hog, minus the pre-camber.

A further complication is added on bridges with a VC. On a crest VC, an additional allowance is subtracted from the deck thickness. Therefore the deck thickness at the abutments and piers is the minimum deck thickness at midspan, plus the hog, minus the pre-camber, minus the VC allowance.

Figure 17.9-1 Vertical Curve Allowance



On a sag VC, an additional allowance is added to the deck thickness. Therefore the deck thickness at the abutments and piers is the minimum deck thickness at midspan, plus the hog, minus the pre-camber, plus the VC allowance. A check of the additional deck thickness shall be undertaken to ensure overloading of the abutments and piers does not occur. Refer Figure 17.9-1 *Vertical Curve Allowance*.

17.10 Deck Heights

The drawings must provide enough deck Heights in order for the deck to be constructed. Level bridges require a control line Height, crossfall/superelevation details, and deck cross section dimensions.

Bridges on a grade require the control line Height at all abutments and piers, crossfall/superelevation details, and deck cross section dimensions. Because the grade is constant, the Heights along the bridge can be easily calculated by the construction crew.

Bridges on a VC require Heights to be given every few meters because they cannot be easily calculated in the field. The spacing of the Heights depends on the VC radius. The smaller the radius, the closer the Height spacing. Heights can either be given at set chainages, for example every 5 m, or a span can be divided into equal length segments and Heights given at these spacings. Additional Heights shall be shown at the abutment and pier centrelines. Deck crossfall/superelevation details and deck cross section dimensions are also required. Refer *Appendix B Example Deck Drawings – Sheet 2*.

Heights are to be given at right angles to the Bridge Control (or radially if the bridge is on a horizontal curve), and should start and finish at a chainage which wholly includes the relieving slabs. If the bridge is skewed, it must be clearly noted that the Heights are given at right angles to the bridge control and not along the skew line of the bridge.

Bridges with a varying crossfall/superelevation also need a table of Heights following the same methodology as a bridge on a VC.

The top face of the kerb is level on bridges with a crossfall or superelevation up to and including three per cent. For bridges with a superelevation greater than three per cent, the top face of the kerb follows the superelevation.

Where the bridge documentation is delivered as part of a set that includes civil and alignment drawings, the DWS heights are usually defined within that set. The deck Heights need not be shown on the bridge drawings. The DWS thickness shall be shown on the drawings and the Contractor's Surveyors use the alignment model (from 12D) to determine the deck Heights at any point they require.

17.11 Cross Girders

Bridges with super T-girders shall have cross girders. The cross girder reinforcement protrudes into the deck. The cross girders must be cast separately to the deck slab. Refer Chapter 14 – *14.10 Cross Girders*.

17.12 Deck Drainage and Scuppers

Bridge decks are required to be drained so that no ponding of water (or spillage from vehicles), occurs on the roadway surface. Drainage is generally achieved by the use of scuppers, either through the kerbs or through the deck units, discharging directly to the stream bed below, or into a drainage system when required (refer Environmental Drainage on the following page).

Bridges over train lines, pedestrian walkways or roads, are not to discharge deck drainage in the manner described above. When these situations arise, drainage is to be achieved using an acceptable method suitable to the design of the structure involved. The solutions need to be considered on an individual basis which may include any of the following examples:

- build the bridge on a grade (in extenuating circumstances the bridge must be level). Refer Chapter 10 – *Bridge Geometry, 10.10 Road Design Considerations with Respect to Low-Level Frequently Flooded Bridges*
- Scuppers may not be necessary for a short bridge if the bridge is on a grade
- provide a collection drain or pipe on the outside of the deck to collect the water and run it to the end of the bridge.

Queensland Railways must always be consulted before a bridge is designed over their train lines to ensure it meets their current requirements, particularly in regards to deck drainage, future works, barrier requirements and minimum clearances.

Scuppers through Cast Insitu Kerbs on Deck Units

There are two methods commonly used in this situation:

- **Method 1**

PVC scuppers are provided in deck units, where applicable. The departmental standard deck units have scuppers 80 mm in diameter, and at 2.05 m centres. Non-standard scupper details may be required if determined by a hydraulic analysis. Kerbs are cast with a suitable blockout at each scupper location which is removed after casting, to form the completed scupper system. Refer *Appendix A – Deck Design Sketches – Sketch 5*.

- **Method 2**

Scuppers formed with 100 mm diameter PVC tube spaced at a maximum of 2.05 m centres passing through the kerb. The scuppers shall be placed centrally between the bridge traffic barrier post anchorages. The 2.05 m maximum spacing may be increased if a hydraulic analysis determines that it can be.

Scuppers in Decks

There are two methods commonly used in this situation:

- **Method 1**

Scuppers formed with 150 mm diameter PVC tube spaced at a maximum of 2.4 m centres passing through the kerb. The scuppers shall be placed centrally between the bridge traffic barrier post anchorages. The 2.4 m maximum spacing may be increased if a hydraulic analysis determines that it can be. Depending on the application, the scupper shown on TMR Standard Drawing 1145 *Details for Cast Insitu Deck* may be suitable

- **Method 2**

Scuppers formed with 100 mm diameter PVC tube spaced at a maximum of 2.4 m centres passing through the kerb. The scuppers shall be placed centrally between the bridge traffic barrier post anchorages. The 2.4 m maximum spacing may be reduced if a hydraulic analysis determines that it can be. Refer *Appendix A Deck Design Sketches – Sketch 4* for examples

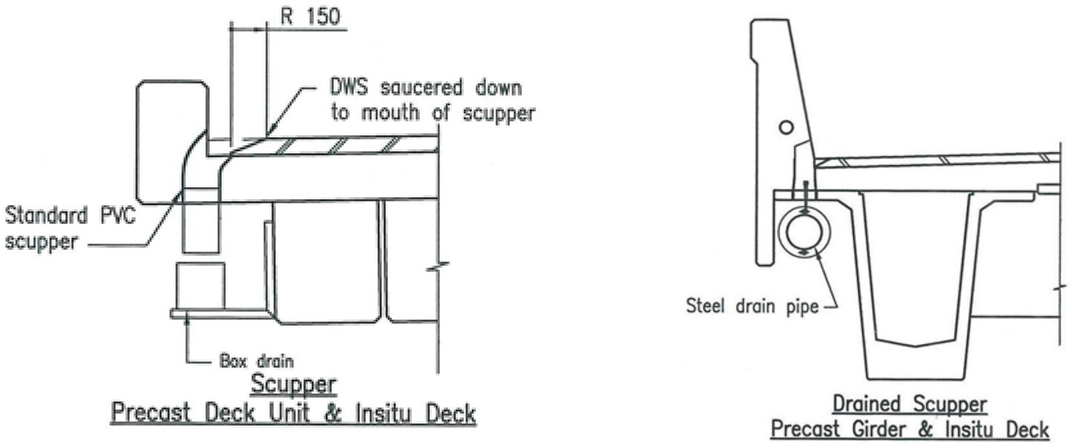
Environmental Drainage

In certain circumstances there are requirements to provide deck drainage systems to ensure that any spillages that may occur on bridges will be channelled off the bridge and dispersed, rather than run directly to the waterway.

Generally the systems provided to achieve these requirements are by way of scuppers and a drain fixed externally to the bridge structure.

Refer Figure 17.12-1 *Deck Drainage Systems*, for examples of typical scupper arrangements and *Appendix A Deck Design Sketches – Sketches 4 and 5* for standard scupper details.

Figure 17.12-1 Deck Drainage Systems



17.13 Junction Boxes

Because of the difficulty in pulling wires through a long length of conduit, junction boxes shall be placed at a maximum of every:

- 80 m when the conduit has bends at the abutments where it dives below ground
- 150 m when the conduit has no bends.

The junction box shall be covered with a recessed 10 mm thick stainless steel plate when the plate presents a snagging point for traffic; that is, when attached to the traffic side of a concrete traffic barrier. Otherwise the plate shall be fabricated from 3 mm thick stainless steel.

Concrete inserts cast into bridge concrete traffic barriers/kerbs for attachment of junction box covers are to be placed on the traffic approach side of joint. Refer *Appendix A Deck Design Sketches – Sketch 6*.

17. 14 Conduits

Most bridges in urban areas require conduits for electrical and/or telecommunication services. Even if the service is not required in the short term, an empty conduit may be installed for future services. The Client will advise what service requirements are required on the Bridge Design Information Request Form. Refer Chapter 1 – *Introduction, Appendix A Example Bridge Design Information Request Letter*.

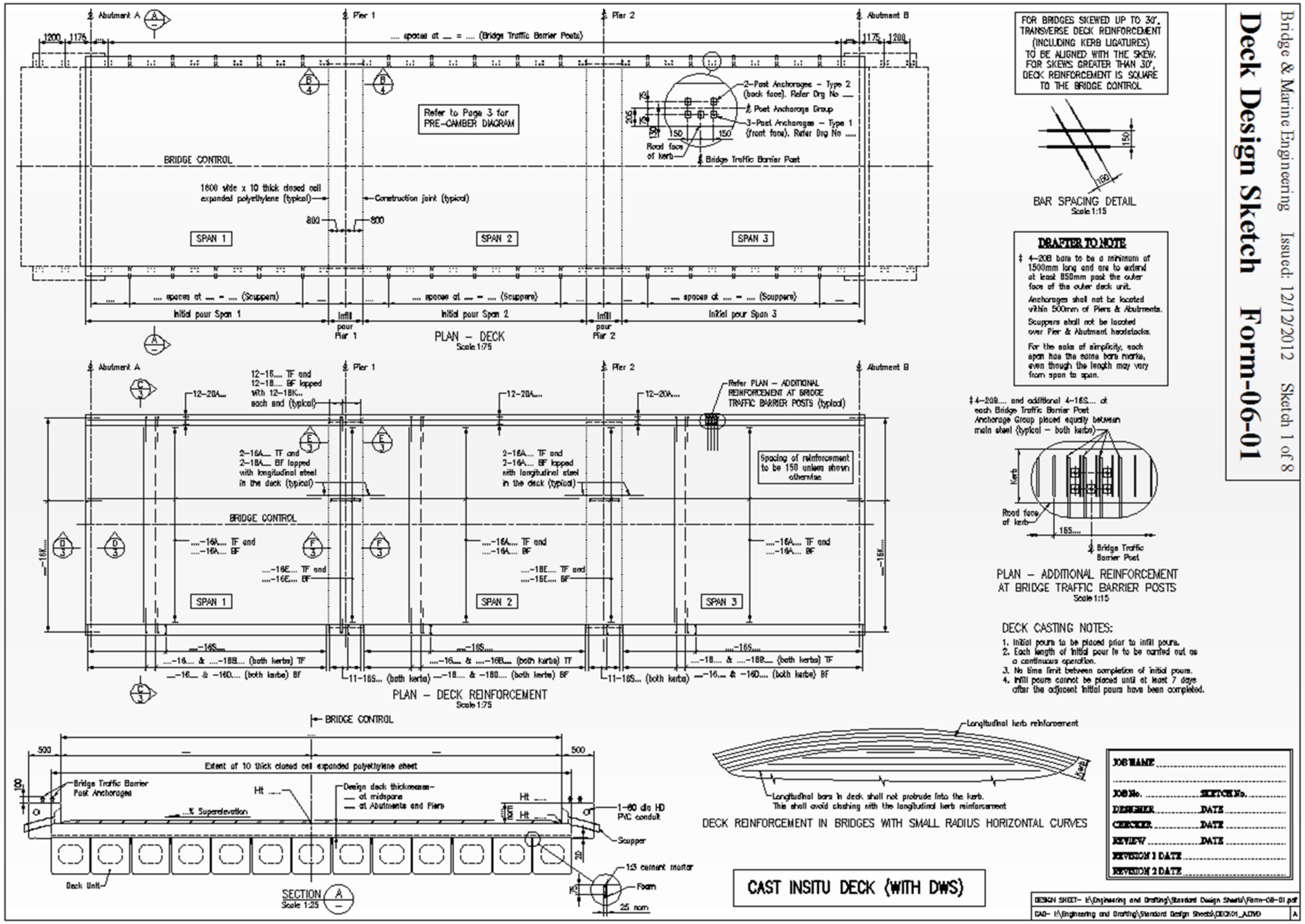
If services are required, the width of the bridge concrete traffic barriers/kerbs may need to increase to accommodate the conduits, therefore this issue must be resolved before detailed design begins. A standard kerb is 500 mm wide and can accommodate only one 80 mm diameter conduit.

Larger diameter conduits may make installation of the wiring easier. Therefore, in concrete traffic barriers, 100 mm diameter conduits shall be used whenever there is enough room, provided the deck units/girders are not supported by bearings. If this is the case, the conduits shall be 80 mm diameter to allow 100 mm diameter ‘Stormflex’ pipe to be wrapped around it. The ‘Stormflex’ pipe is used to allow for expansion due to concrete shrinkage, temperature differential, and jacking.

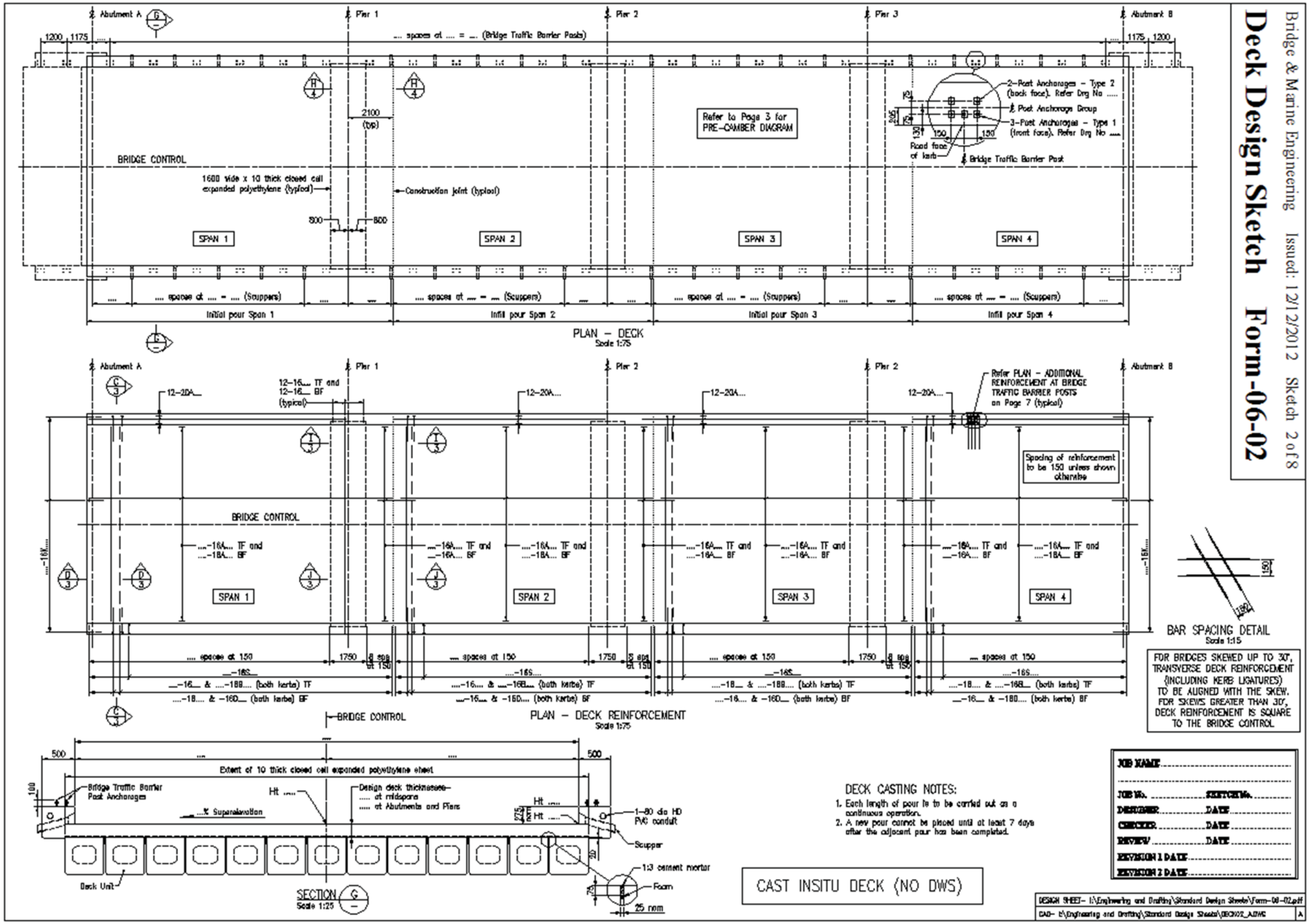
A 50 mm nominal gap between adjacent kerbs shall be provided to allow the ‘Stormflex’ pipe to accommodate the change of conduit alignment caused by bridge jacking. When an XJS expansion joint (or approved equivalent) is provided at the abutments, the gap between the deck and the relieving slab is 25 mm. The additional 25 mm required shall be taken up in the kerb. However a recess will need to be formed around the ‘Stormflex’ pipe. Refer *Appendix A Deck Design Sketches – Sketch 8*.

Appendix A – Deck Design Sketches

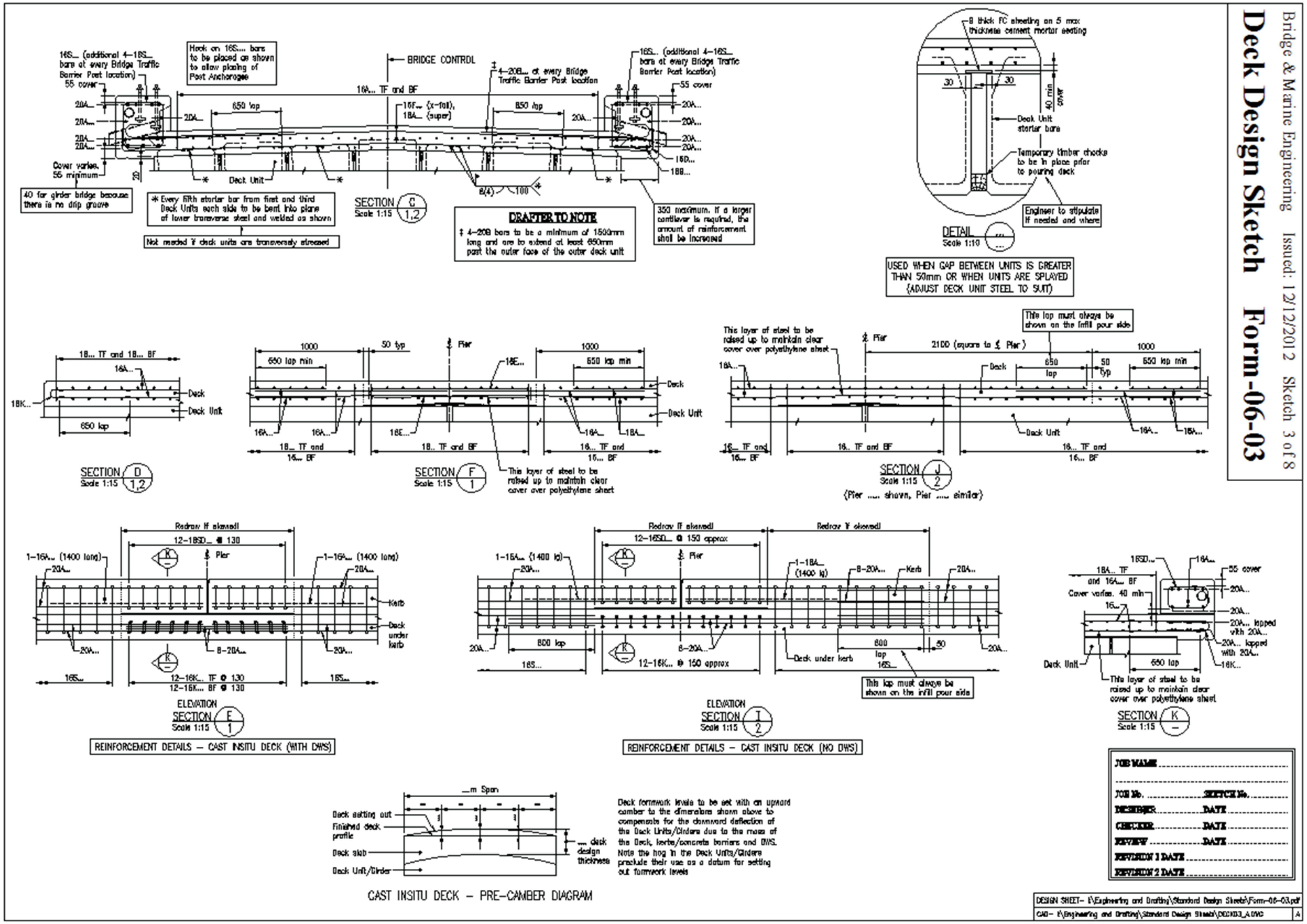
Appendix A – Deck Design Sketches – Sketch 1



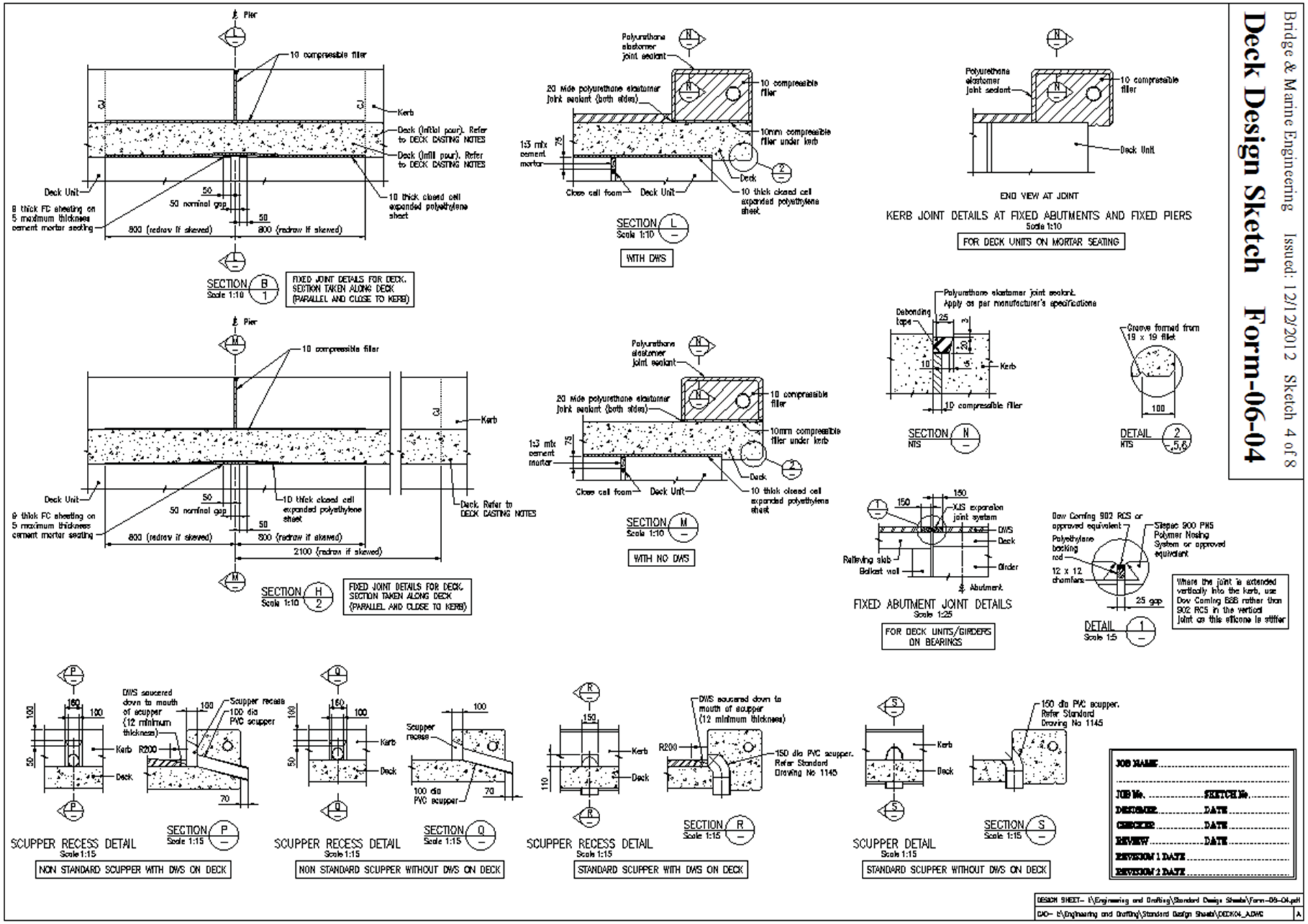
Appendix A – Deck Design Sketches – Sketch 2



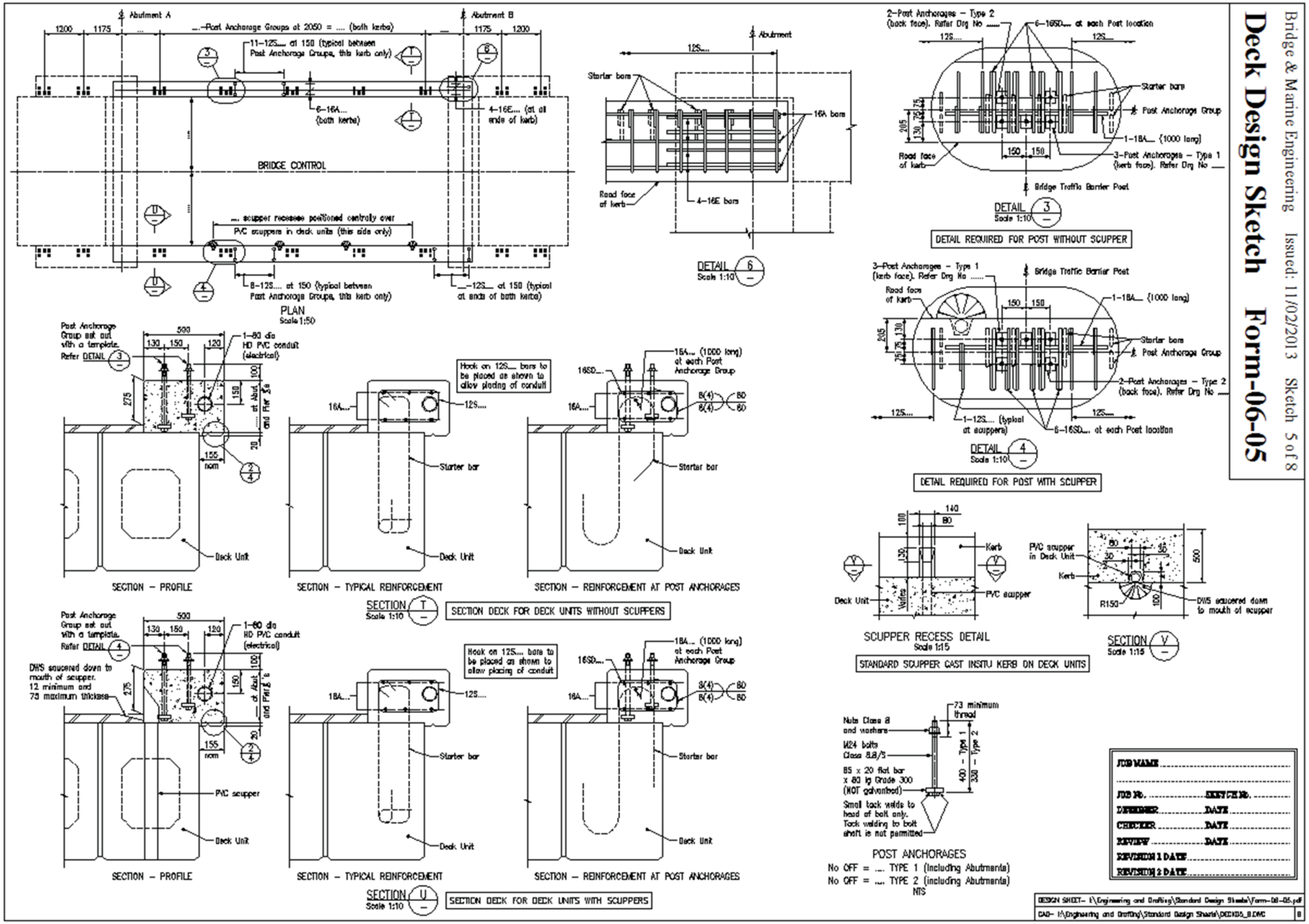
Appendix A – Deck Design Sketches – Sketch 3



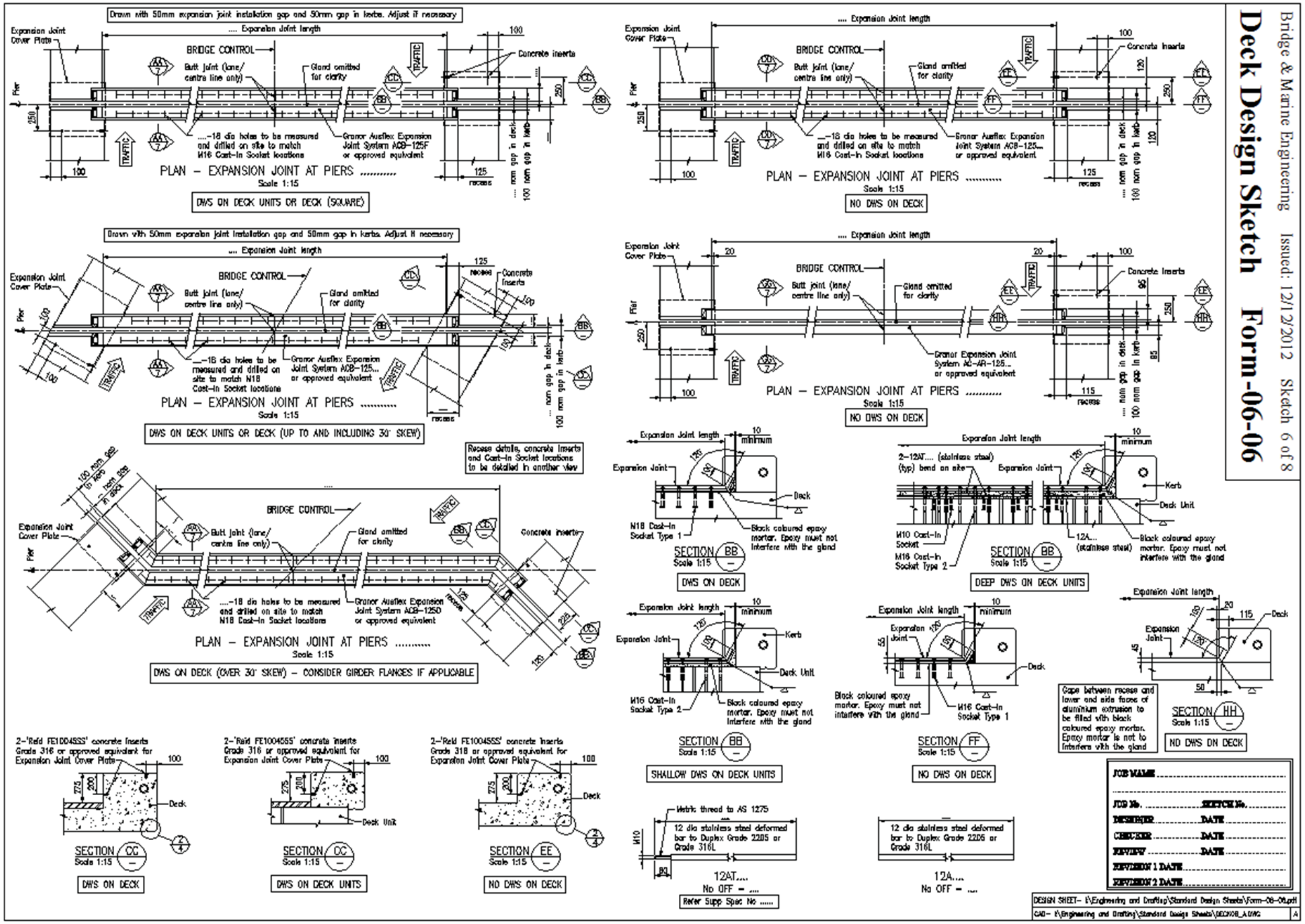
Appendix A – Deck Design Sketches – Sketch 4



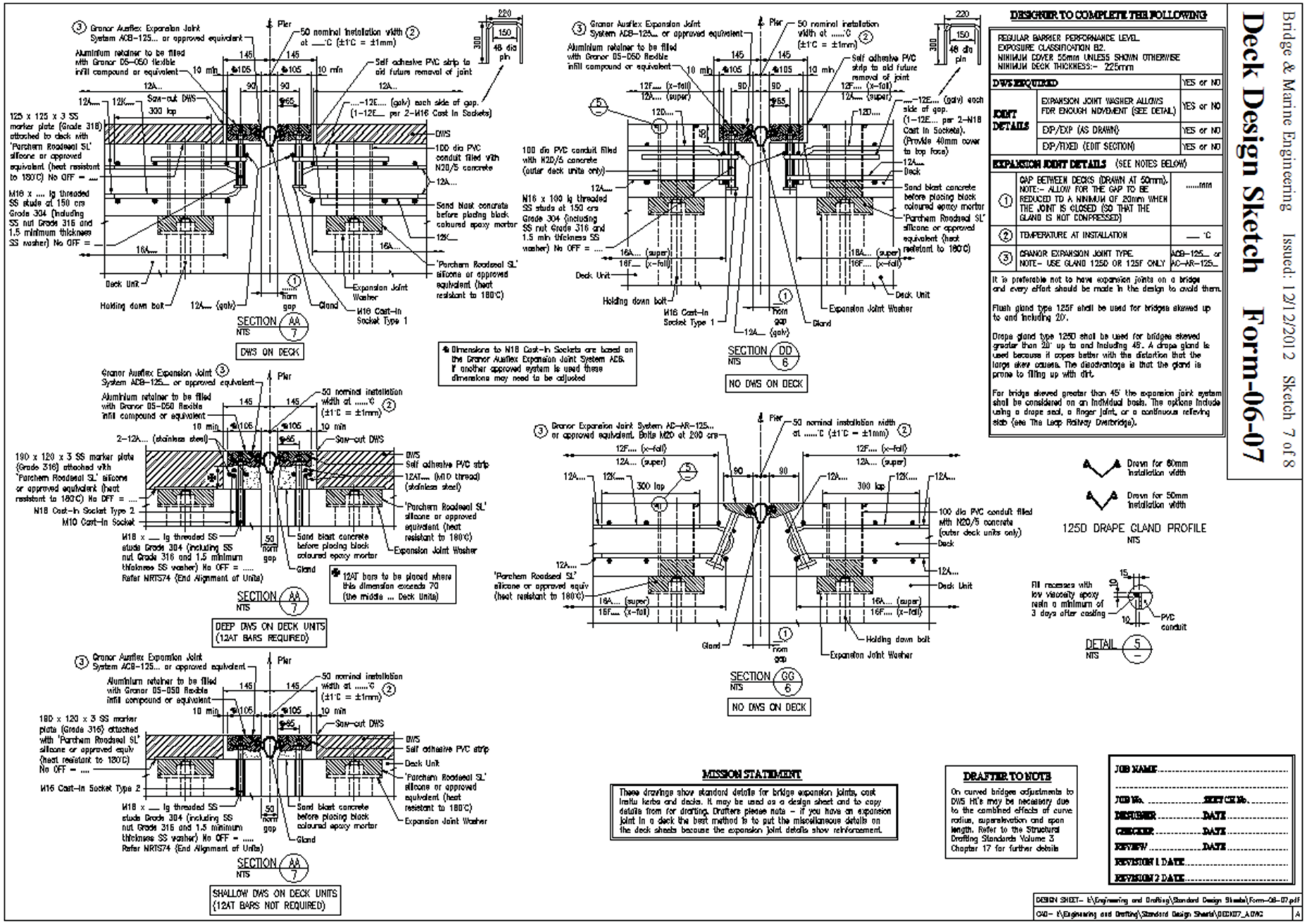
Appendix A – Deck Design Sketches – Sketch 5



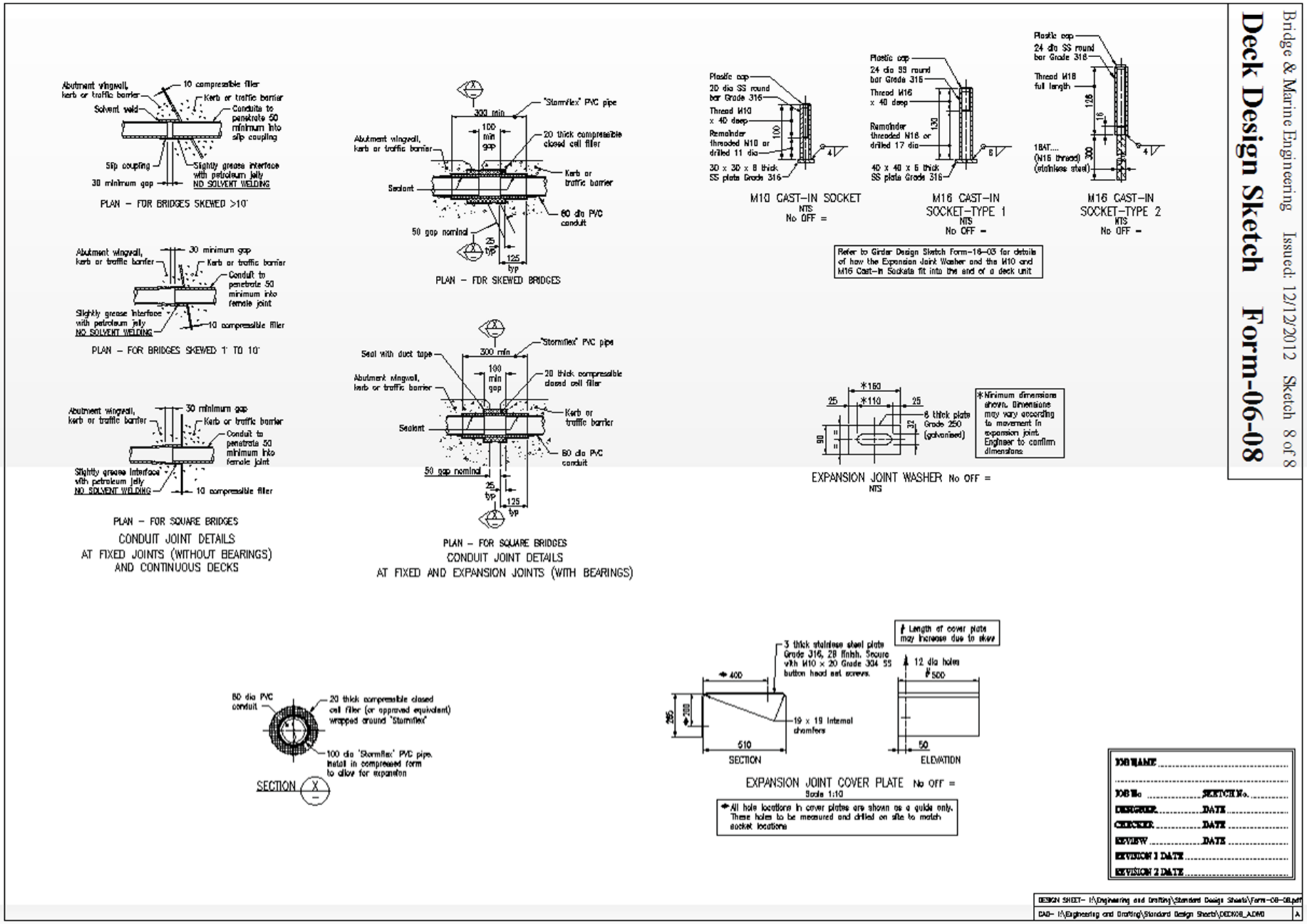
Appendix A – Deck Design Sketches – Sketch 6



Appendix A – Deck Design Sketches – Sketch 7

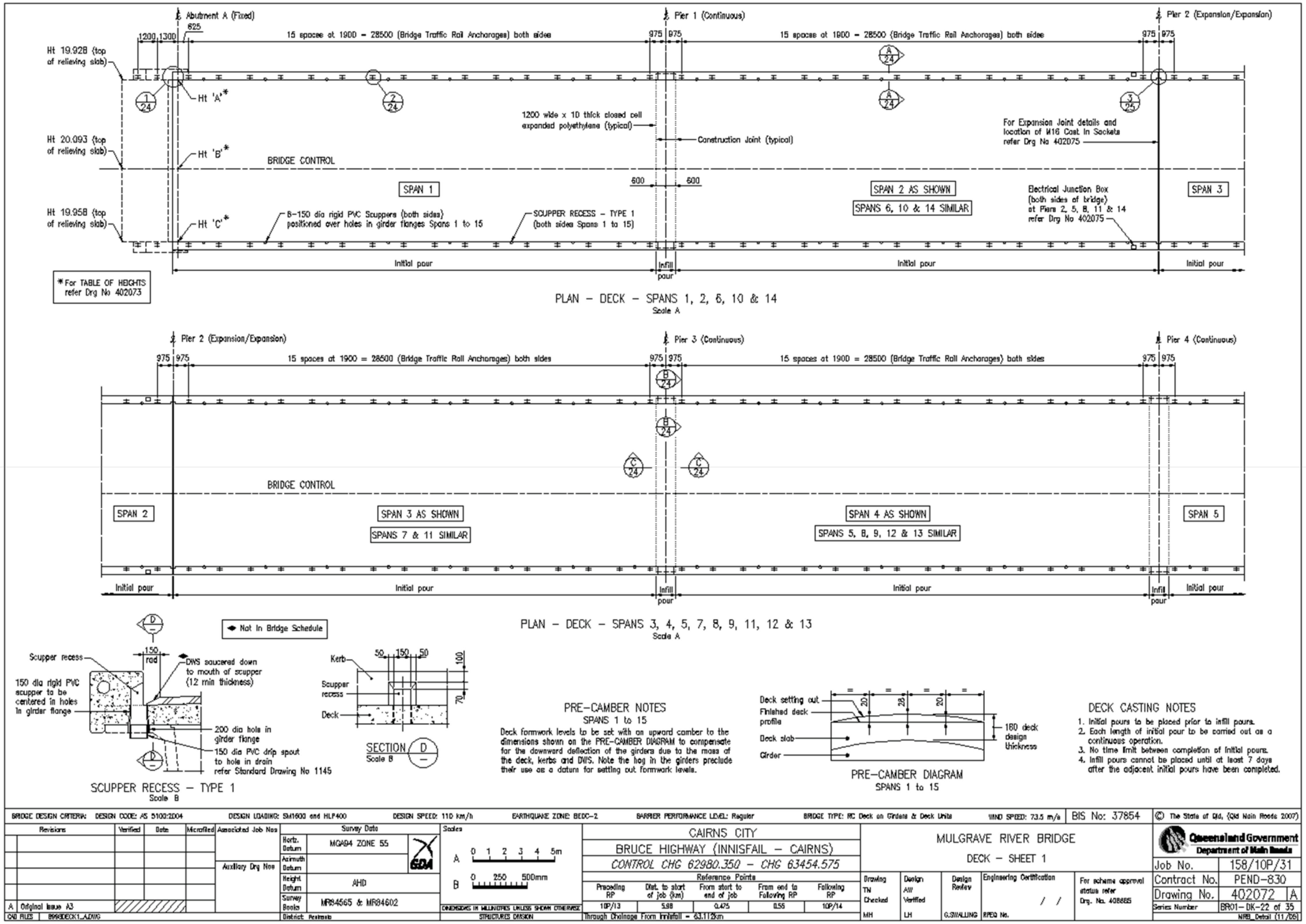


Appendix A – Deck Design Sketches – Sketch 8



Appendix B – Example Deck Drawings

Appendix B – Example Deck Drawings – Sheet 1



Appendix B – Example Deck Drawings – Sheet 2

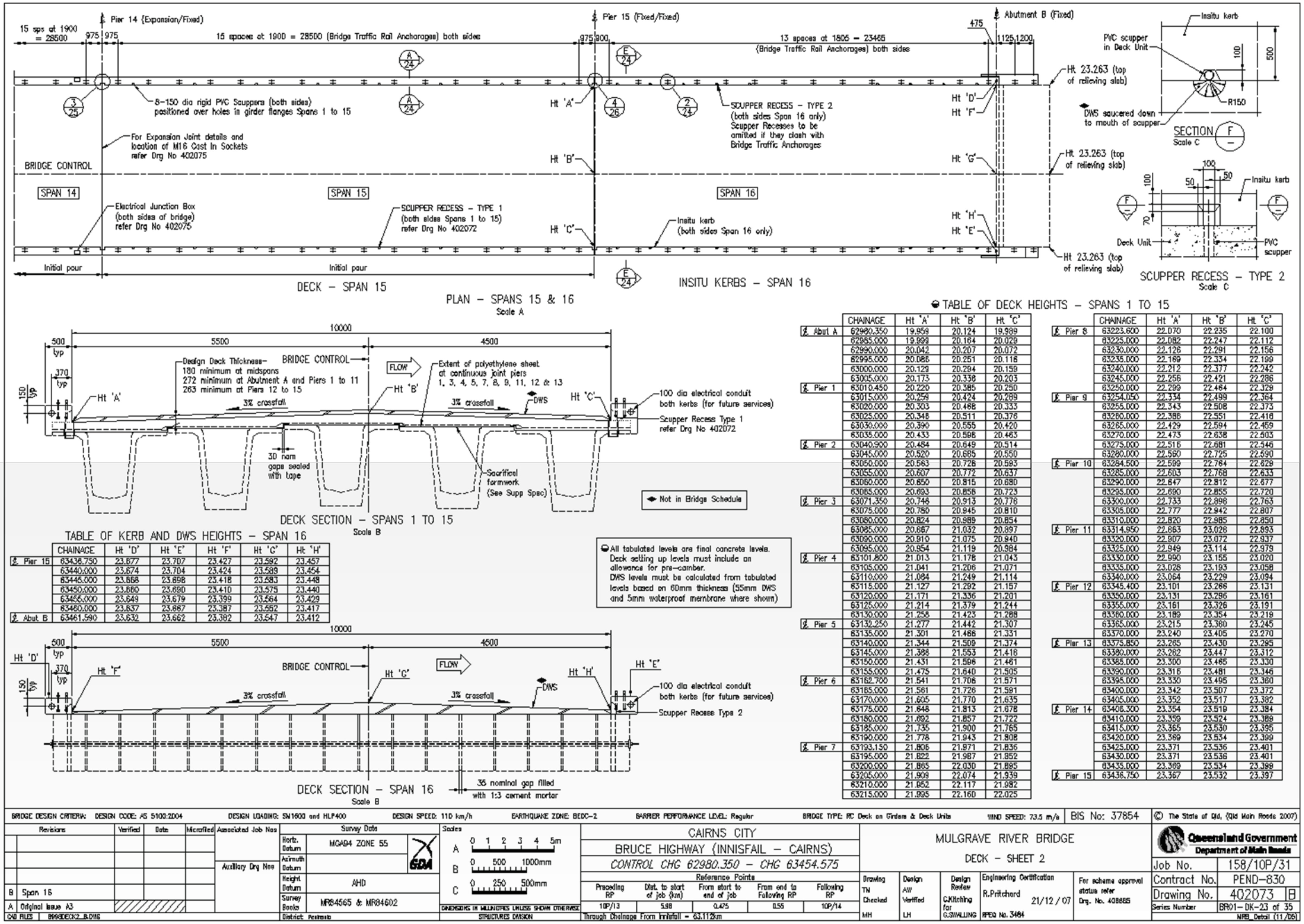


TABLE OF DECK HEIGHTS - SPANS 1 TO 15

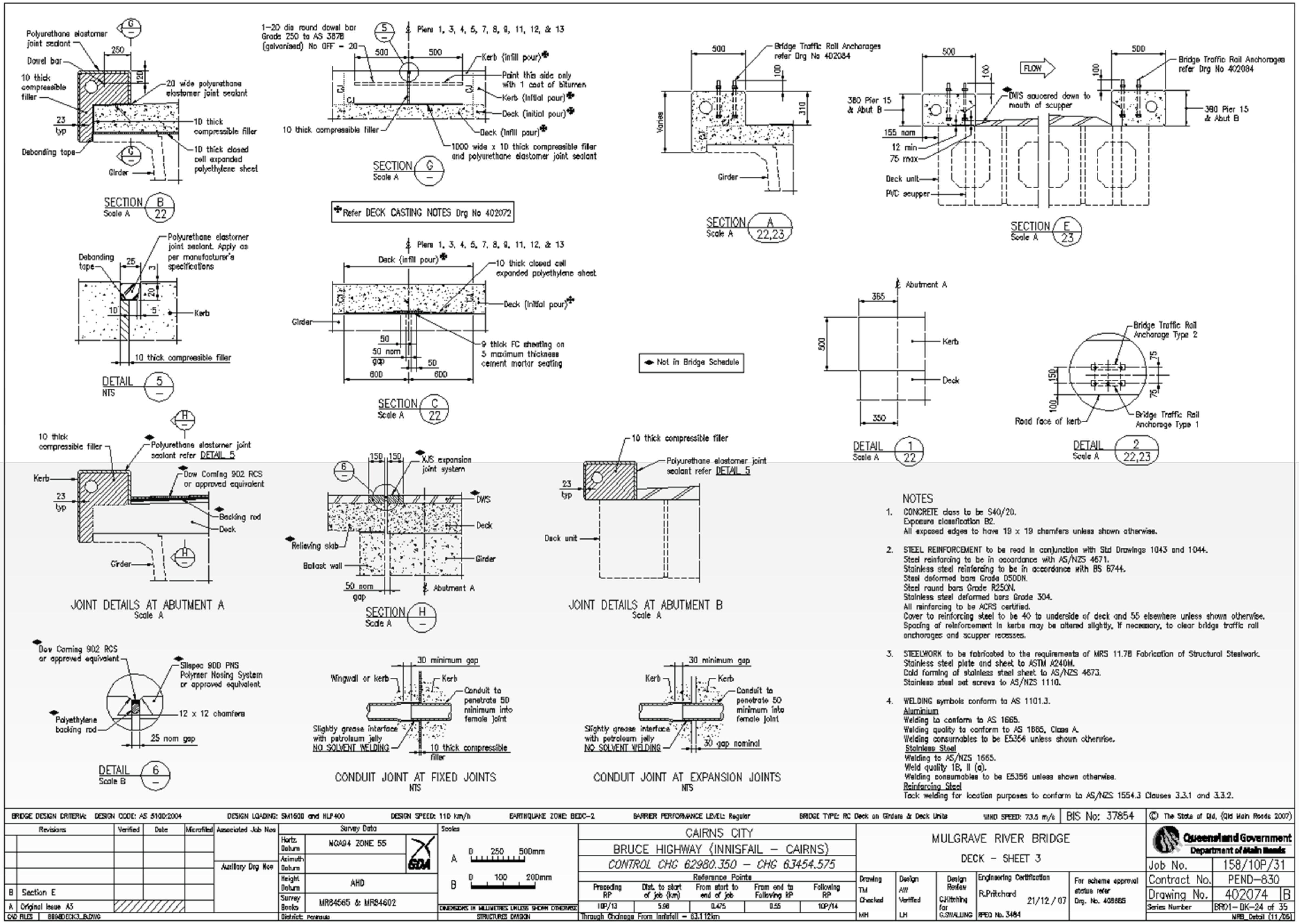
	CHAINAGE	Ht 'A'	Ht 'B'	Ht 'C'
℄ Abut A	62980.350	19.959	20.124	19.989
	62985.000	19.999	20.164	20.029
	62990.000	20.042	20.207	20.072
	62995.000	20.086	20.251	20.116
	63000.000	20.129	20.294	20.159
	63005.000	20.173	20.338	20.203
℄ Pier 1	63010.450	20.220	20.385	20.250
	63015.000	20.259	20.424	20.289
	63020.000	20.303	20.468	20.333
	63025.000	20.348	20.511	20.376
	63030.000	20.390	20.555	20.420
	63035.000	20.433	20.598	20.463
℄ Pier 2	63040.900	20.484	20.649	20.514
	63045.000	20.520	20.685	20.550
	63050.000	20.563	20.728	20.593
	63055.000	20.607	20.772	20.637
	63060.000	20.650	20.815	20.680
	63065.000	20.693	20.858	20.723
℄ Pier 3	63071.350	20.748	20.913	20.778
	63075.000	20.780	20.945	20.810
	63080.000	20.824	20.989	20.854
	63085.000	20.867	21.032	20.897
	63090.000	20.910	21.075	20.940
	63095.000	20.954	21.119	20.984
℄ Pier 4	63101.800	21.013	21.178	21.043
	63105.000	21.041	21.206	21.071
	63110.000	21.084	21.249	21.114
	63115.000	21.127	21.292	21.157
	63120.000	21.171	21.336	21.201
	63125.000	21.214	21.379	21.244
	63130.000	21.258	21.423	21.288
℄ Pier 5	63132.250	21.277	21.442	21.307
	63135.000	21.301	21.466	21.331
	63140.000	21.344	21.509	21.374
	63145.000	21.388	21.553	21.418
	63150.000	21.431	21.596	21.461
	63155.000	21.475	21.640	21.505
℄ Pier 6	63162.700	21.541	21.706	21.571
	63165.000	21.561	21.726	21.591
	63170.000	21.605	21.770	21.635
	63175.000	21.648	21.813	21.678
	63180.000	21.692	21.857	21.722
	63185.000	21.735	21.900	21.765
	63190.000	21.778	21.943	21.808
℄ Pier 7	63193.150	21.806	21.971	21.836
	63195.000	21.822	21.987	21.852
	63200.000	21.865	22.030	21.895
	63205.000	21.909	22.074	21.939
	63210.000	21.952	22.117	21.982
	63215.000	21.995	22.160	22.025

	CHAINAGE	Ht 'A'	Ht 'B'	Ht 'C'
℄ Pier 8	63223.600	22.070	22.235	22.100
	63225.000	22.082	22.247	22.112
	63230.000	22.126	22.291	22.156
	63235.000	22.169	22.334	22.199
	63240.000	22.212	22.377	22.242
	63245.000	22.256	22.421	22.286
	63250.000	22.299	22.464	22.329
℄ Pier 9	63254.050	22.334	22.499	22.364
	63255.000	22.343	22.508	22.373
	63260.000	22.386	22.551	22.416
	63265.000	22.429	22.594	22.459
	63270.000	22.473	22.638	22.503
	63275.000	22.516	22.681	22.546
	63280.000	22.560	22.725	22.590
℄ Pier 10	63284.500	22.599	22.764	22.629
	63285.000	22.603	22.768	22.633
	63290.000	22.647	22.812	22.677
	63295.000	22.690	22.855	22.720
	63300.000	22.733	22.898	22.763
	63305.000	22.777	22.942	22.807
	63310.000	22.820	22.985	22.850
℄ Pier 11	63314.950	22.863	23.028	22.893
	63320.000	22.907	23.072	22.937
	63325.000	22.949	23.114	22.979
	63330.000	22.990	23.155	23.020
	63335.000	23.028	23.193	23.058
	63340.000	23.064	23.229	23.094
℄ Pier 12	63345.400	23.101	23.266	23.131
	63350.000	23.131	23.296	23.161
	63355.000	23.161	23.326	23.191
	63360.000	23.189	23.354	23.219
	63365.000	23.215	23.380	23.245
	63370.000	23.240	23.405	23.270
℄ Pier 13	63375.850	23.265	23.430	23.295
	63380.000	23.282	23.447	23.312
	63385.000	23.300	23.465	23.330
	63390.000	23.316	23.481	23.346
	63395.000	23.330	23.495	23.360
	63400.000	23.342	23.507	23.372
	63405.000	23.352	23.517	23.382
℄ Pier 14	63408.300	23.354	23.519	23.384
	63410.000	23.359	23.524	23.389
	63415.000	23.365	23.530	23.395
	63420.000	23.369	23.534	23.399
	63425.000	23.371	23.536	23.401
	63430.000	23.371	23.536	23.401
	63435.000	23.369	23.534	23.399
℄ Pier 15	63436.750	23.367	23.532	23.397

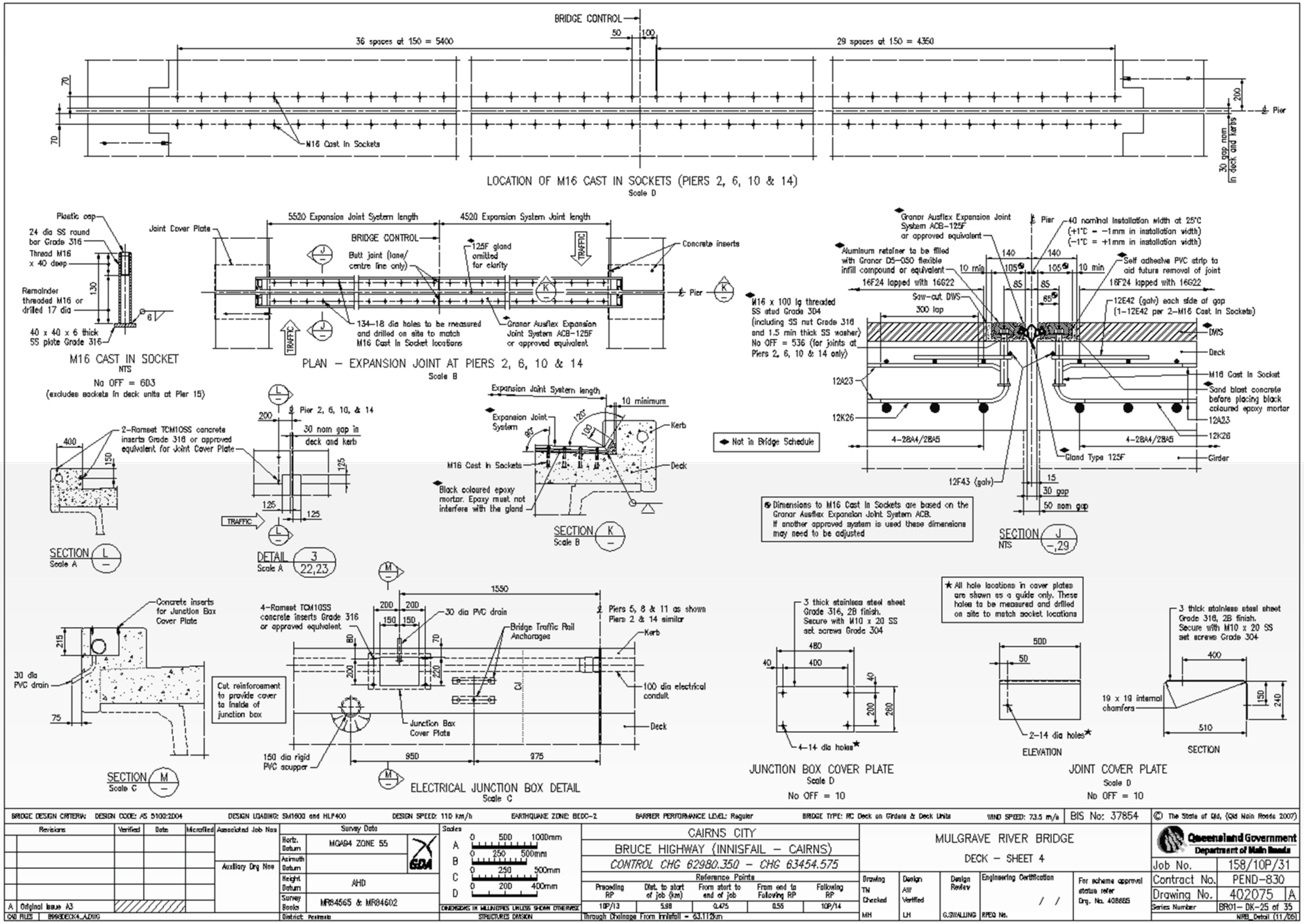
TABLE OF KERB AND DWS HEIGHTS - SPAN 16

	CHAINAGE	Ht 'D'	Ht 'E'	Ht 'F'	Ht 'G'	Ht 'H'
℄ Pier 15	63436.750	23.677	23.707	23.427	23.592	23.457
	63440.000	23.674	23.704	23.424	23.589	23.454
	63445.000	23.668	23.698	23.418	23.583	23.448
	63450.000	23.660	23.690	23.410	23.575	23.440
	63455.000	23.649	23.679	23.399	23.564	23.429
	63460.000	23.637	23.667	23.387	23.552	23.417
℄ Abut B	63461.590	23.632	23.662	23.382	23.547	23.412

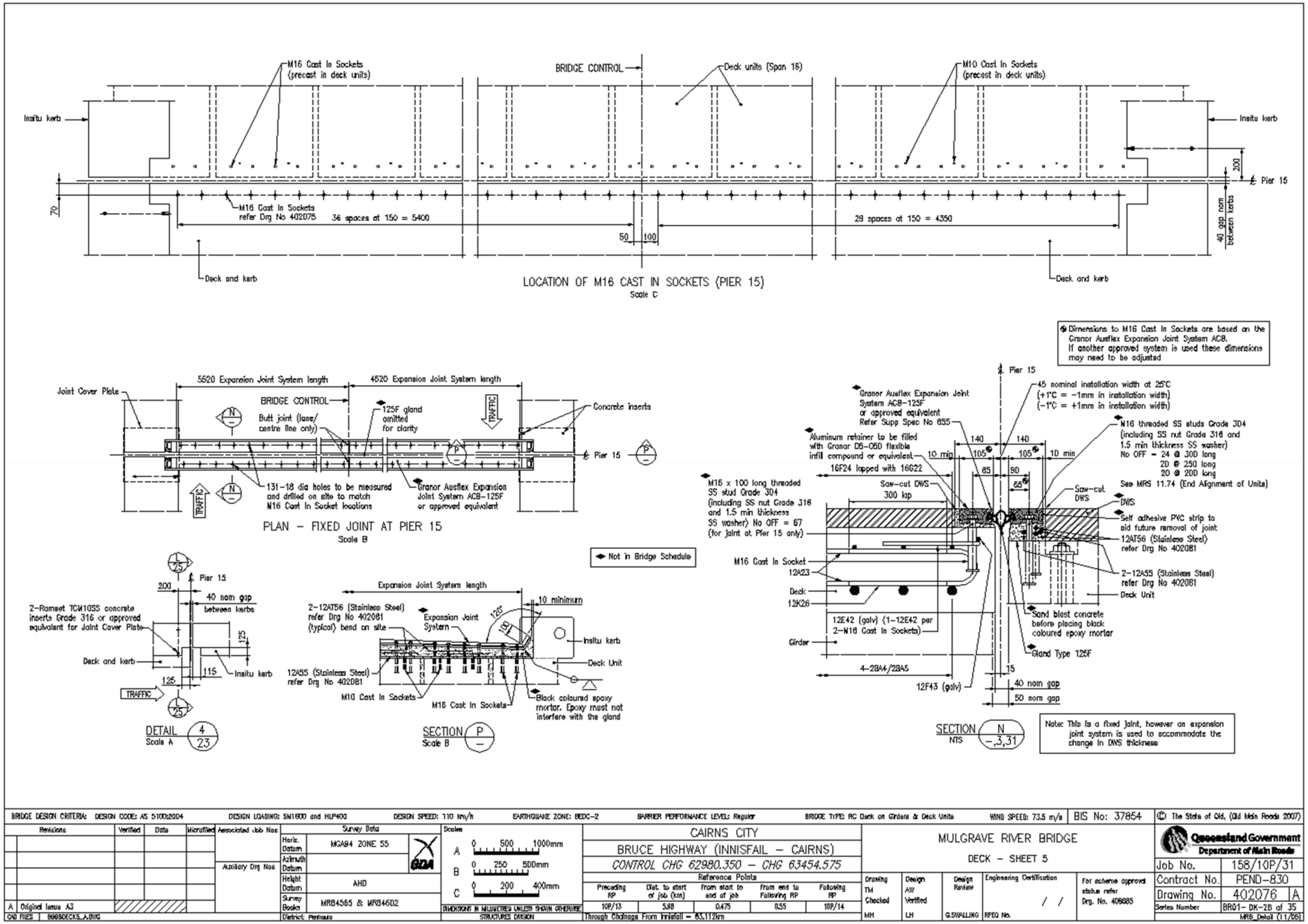
Appendix B – Example Deck Drawings – Sheet 3



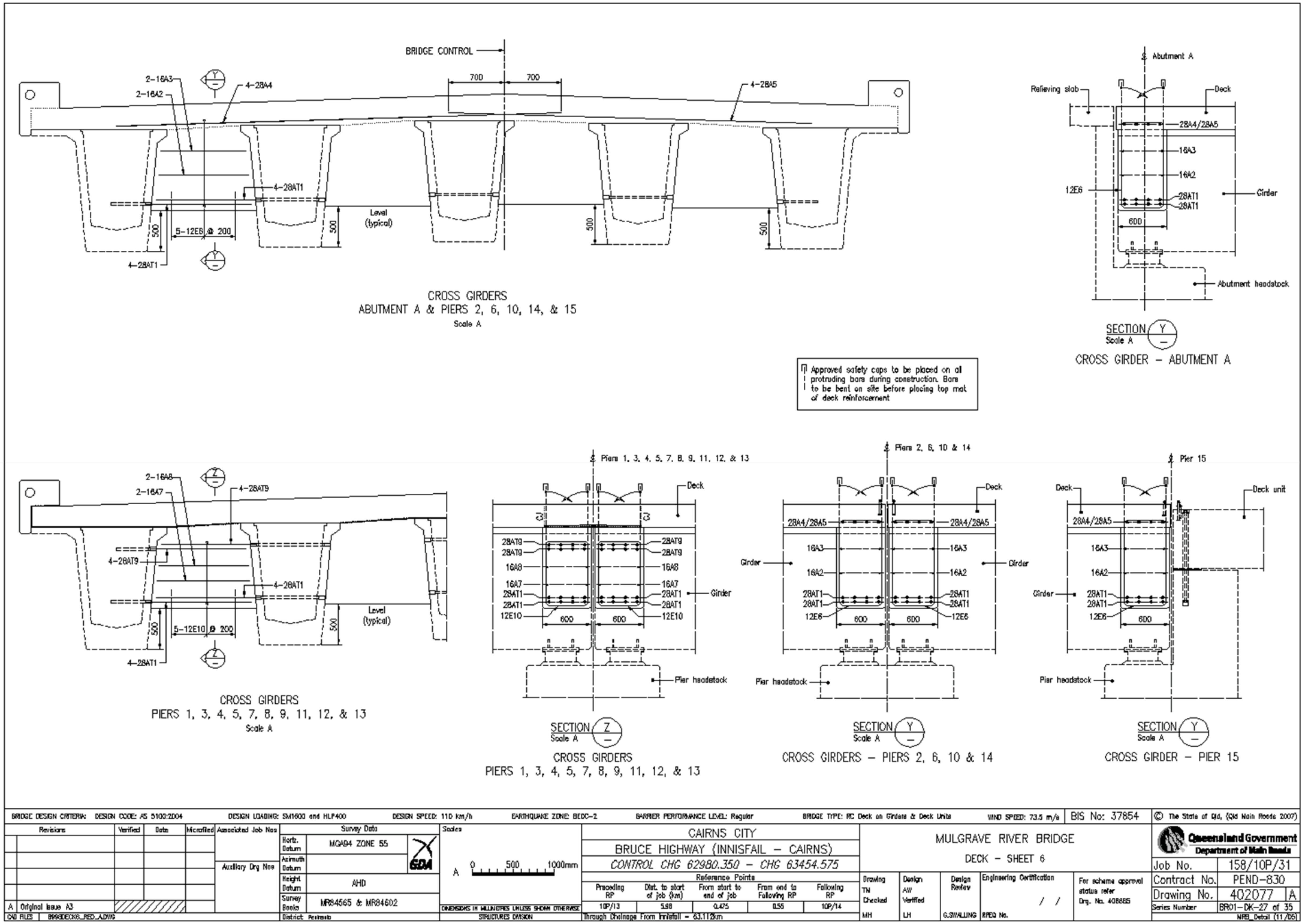
Appendix B – Example Deck Drawings – Sheet 4



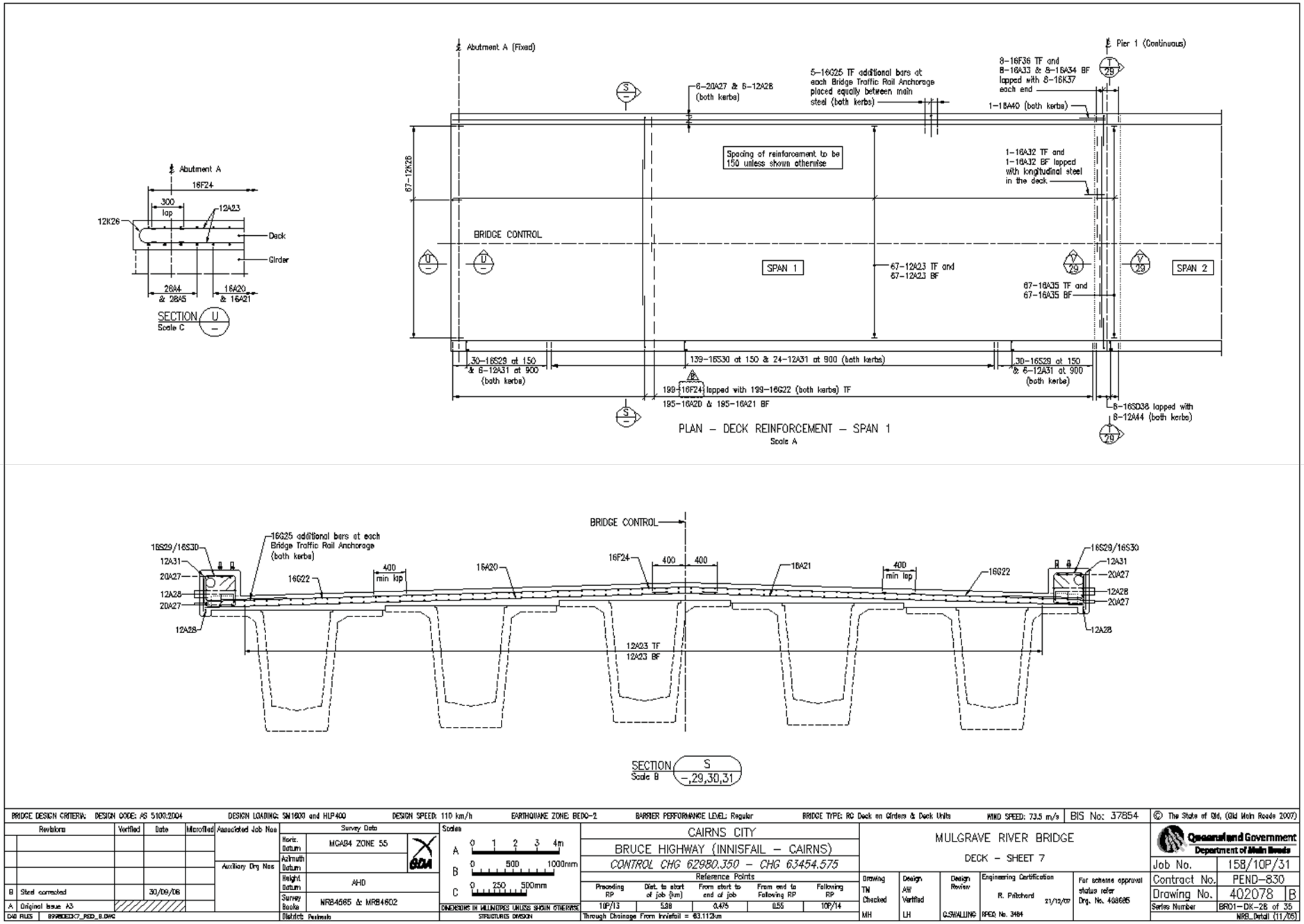
Appendix B – Example Deck Drawings – Sheet 5



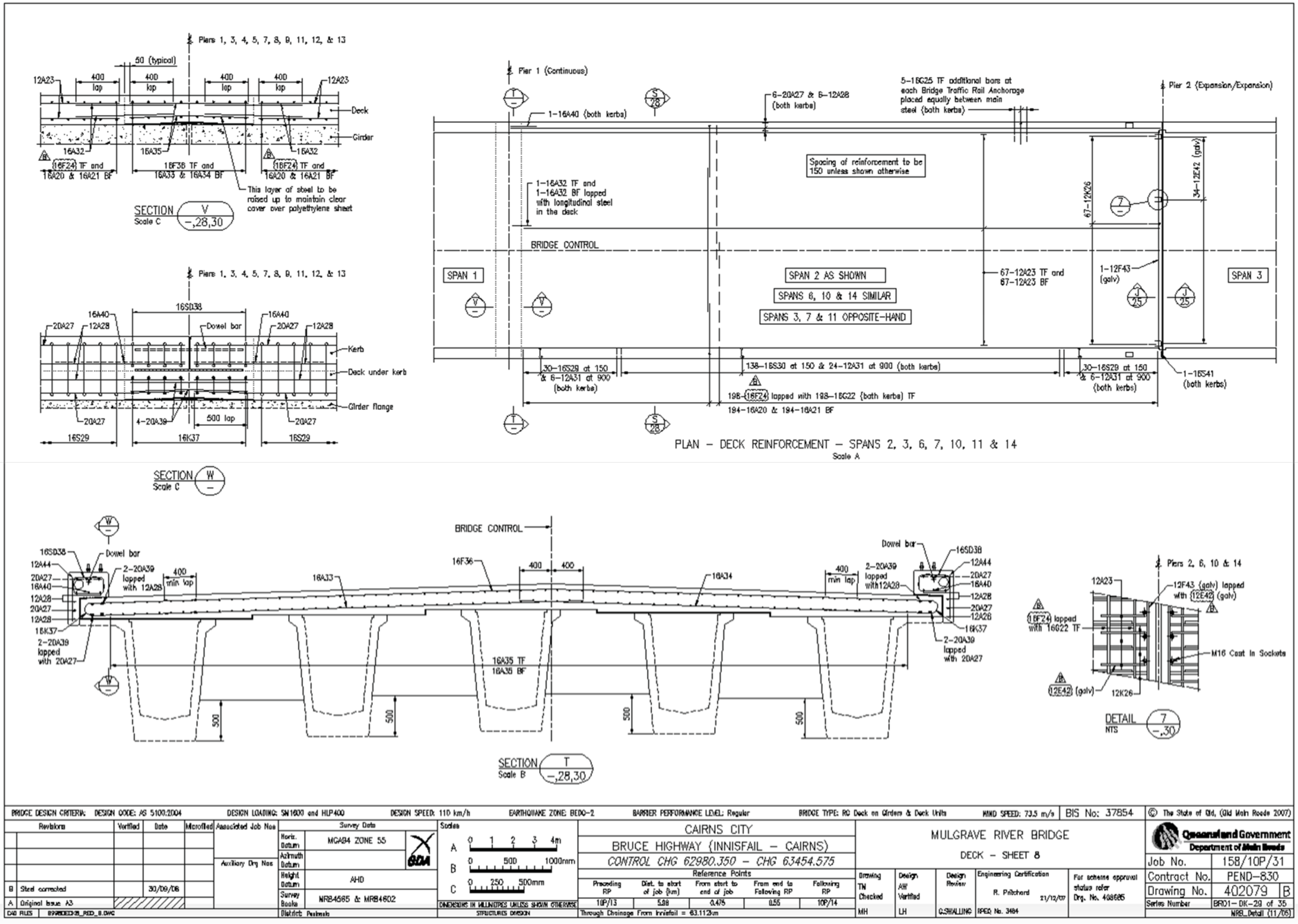
Appendix B – Example Deck Drawings – Sheet 6



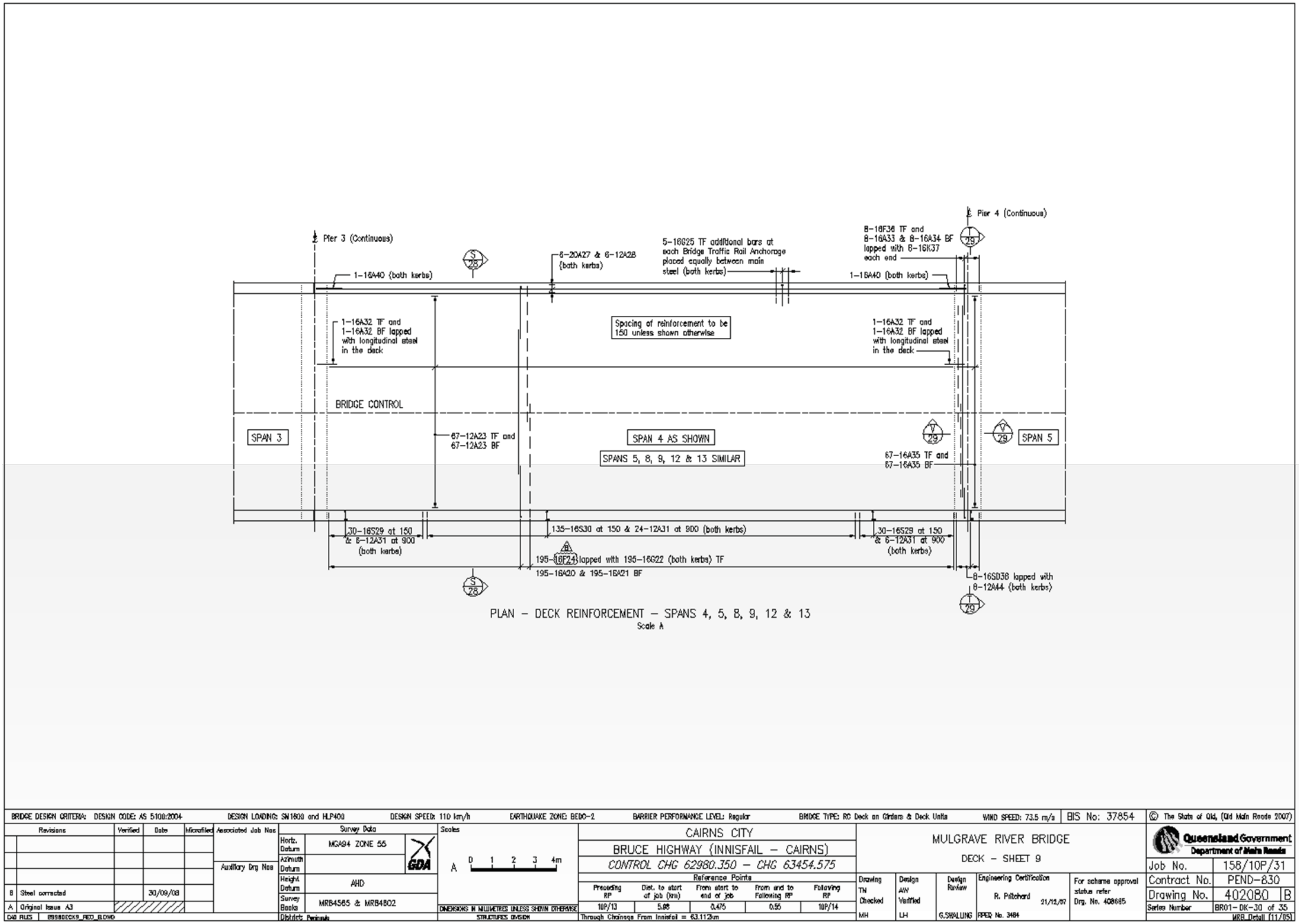
Appendix B – Example Deck Drawings – Sheet 7



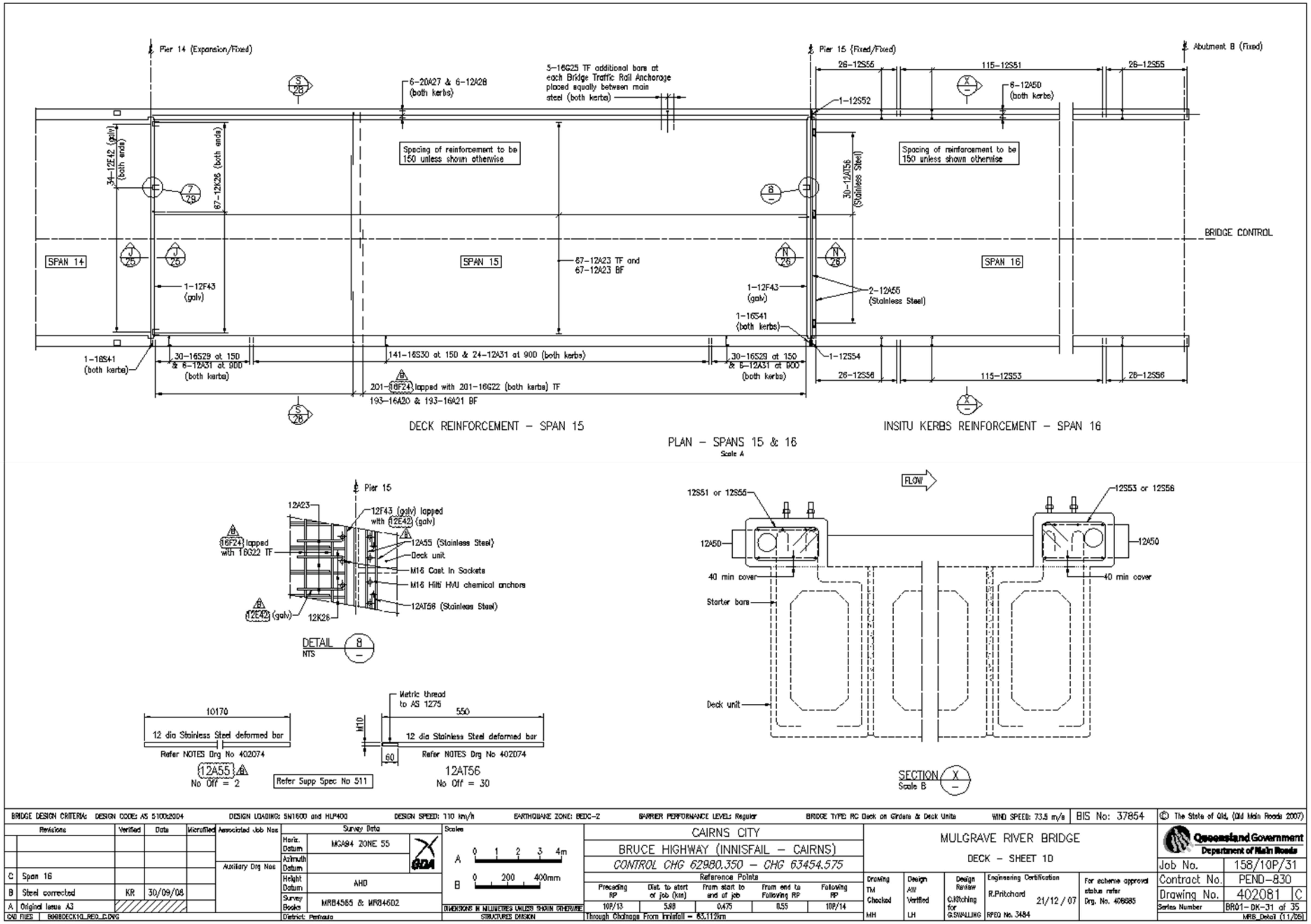
Appendix B – Example Deck Drawings – Sheet 8



Appendix B – Example Deck Drawings – Sheet 9



Appendix B – Example Deck Drawings – Sheet 10



Drafting and Design Presentation Standards
Volume 3: Structural Drafting Standards

Chapter 18: Expansion Joints and Miscellaneous Details

November 2011

Queensland Government

Chapter 18 Amendments

Revision register

Issue/Rev No.	Reference Section	Description of Revision	Authorised by	Date
1	–	First Issue.	Manager (Structural Drafting)	April 2011
2	–	Document name change.	Manager (Structural Drafting)	Nov 2011
	18.3	Add sections on expansion joint installation width and gap between decks		

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Appendix B – Example Miscellaneous Details Drawings 8

Appendix C – Example Drain Drawings 10

Figure 18.3-1 Flush (F) Seal Minimum Closed Gap 2

Figure 18.3-2 Draped (D) Seal Minimum Closed Gap 2

Figure 18.4-1 Example Lampstandard Bracket and Anchorage Details 6

Appendix A – Example Expansion Joint Detail Drawing 7

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Appendix B – Example Miscellaneous Detail Drawings – Sheet 2 9

Appendix C – Example Drain Drawings – Sheet 1 10

Appendix C – Example Drain Drawings – Sheet 2 11

Appendix C – Example Drain Drawings – Sheet 3 12

18 Expansion Joints and Miscellaneous Details

18.1 Glossary of terms

For a complete glossary of terms refer Chapter 1 – *Introduction.*

18.2 Figures and examples shown in this volume

The figures and examples shown in this volume are for presentation purposes only, and may contain some details that are now superseded. These details have been included for ease of reference, to illustrate typical solutions, and to show the required standard of drafting presentation. The details are not to be used without an engineering check and certification by a Structural RPEQ to confirm that the details are appropriate for the specific project.

18.3 Bridge Expansion Joints

Bridge expansion joint systems come in a variety of types and shapes. The expansion component of the system may be a flexible filler material, a flexible neoprene gland or a finger joint. For details of the Department of Transport and Main Roads' approved expansion joint systems refer to the *Bridge Components* on the departmental website.

The most common expansion joint system used on departmental bridges is an extruded aluminium joint with a neoprene gland. This joint consists of two aluminium sections bolted across the bridge. If the bridge has a concrete deck, the sections are bolted to M16 cast in sockets which are cast into the deck. If the bridge does not have a deck, the sections are bolted directly to stainless steel M16 cast in sockets which are cast into the PSC deck units. A neoprene gland slotted into each section completes the expansion joint.

Many of the details that are required to produce expansion joint drawings have been standardised and are shown on standard deck design sheets which have been developed in Bridge Design Branch and are used as the standard for design and presentation in the production of departmental bridge drawings. Engineers may use these standard details, modifying them to be project specific, and issue them as design sheets. Drafters use the standard sheets in their AutoCAD form to produce detailed deck drawings. Refer Chapter 17 – *Cast Insitu Kerbs and Decks, Appendix A Deck Design Sketches*. For an example drawing refer *Appendix A Example Expansion Joint Detail Drawing*.

Neoprene Gland Size

The size of the gland needs to be considered on a project specific basis. It is usually determined by the amount of expansion that the joint is designed to accommodate, however, departmental policy is to use a 125 gland as standard, even though it may be over designed. This allows for construction tolerance, it means that the gland may not need to be removed during bearing replacement, and it is better suited to skewed bridges. This gland can accommodate approximately 125 mm of expansion. Refer Chapter 17 – *Cast Insitu Kerbs and Decks, Appendix A Deck Design Sketches – Sheet 1*.

Neoprene Gland Type

The type of the gland needs to be considered on a project specific basis. The neoprene gland can be manufactured as a flush (*F*) seal or a draped (*D*) seal.

A flush seal is superior as it keeps road grit from falling into the joint and clogging it up. The drawback with the flush gland is that it does not suit bridges with a large skew. Therefore a flush seal shall be used on bridges skewed up to and including 20˚.

For bridges skewed greater than 20˚ and up to and including 45˚, a draped seal shall be used.

For bridges skewed greater than 45˚ the expansion joint system shall be considered on an individual basis. The options include using a draped seal, a finger joint, or a continuous relieving slab. Refer Chapter 17 – *Cast Insitu Kerbs and Decks, Appendix A Deck Design Sketches – Sheet 1*.

Expansion Joint Installation Width

Typically the installation width for a 125 gland is 50 mm, however, this must always be confirmed by the Design Engineer to ensure it allows for sufficient expansion and contraction. *F* seal glands require a minimum closed gap to allow room for the gland. Typically this gap is 20 mm. This must be considered when the installation gap is designed. Refer Figure 18.3-1 *Flush (F) Seal Minimum Closed Gap.*

Figure 18.3-1 Flush (F) Seal Minimum Closed Gap

D seal glands are not as bulky as *F* seal glands, and can therefore close to zero gap. Refer Figure 18.3-2 *Draped (D) Seal Minimum Closed Gap*.

Figure 18.3-2 Draped (D) Seal Minimum Closed Gap

Gap Between Decks

Depending on the size of the gland and thickness of the deck wearing surface, the gland will usually hang below the top face of the deck. The gap between decks shall allow for a gland thickness of 20 mm when the joint is closed. Typically the gap is designed to be 50 mm, however, this must always be confirmed by the Design Engineer to ensure it allows for sufficient contraction of the joint.

M10 Cast in Sockets for Deep Epoxy Mortar under an Extruded Aluminium Expansion Joint System

For bridges without a cast insitu deck, the effects of crossfall and hog may result in particularly deep DWS thicknesses at abutments and piers. Because the top of an extruded aluminium expansion joint finishes flush with the top of the DWS, an expansion joint bolted directly onto deck units may need to be seated on a deep layer of epoxy mortar.

When the thickness of epoxy mortar beneath the expansion joint exceeds 70 mm, the epoxy mortar shall be reinforced. In Chapter 17 – *Cast Insitu Kerbs and Decks, Appendix A Deck Design Sketches* this is referred to as deep DWS. Epoxy mortar that does not need to be reinforced is referred to as shallow DWS.

Reinforcing the epoxy mortar is done with stainless steel 12AT bars which are screwed into stainless steel M10 sockets cast in the deck units and bent on site. Refer Chapter 17 – *Cast Insitu Kerbs and Decks, Appendix A Deck Design Sketches – Sheets 1, 2 and 9*. On bridges with a crowned running surface, the thickness of the epoxy mortar may be such that the 12AT bars are not required on some of the outer deck units.

M16 Cast in Sockets for Attachment of an Extruded Aluminium Expansion Joint System

The stainless steel M16 cast in sockets which an extruded aluminium expansion joint bolts onto shall be spaced at 150 mm centres when they are cast into a concrete deck. If they are cast directly into deck units, the spacing will be determined by the prestressing strands and the holding down bolt hole recess. The M16 cast in sockets shall be positioned inside a reinforcing bar to add strength to the joint. Refer Chapter 17 – *Cast Insitu Kerbs and Decks, Appendix A Deck Design Sketches – Sheets 1, 2 and 9*.

Expansion Joint Washer

Deck units with a slotted holding down bolt hole for expansion require a galvanised slotted washer to guide the holding down bolt as the unit moves. Refer Chapter 17 – *Cast Insitu Kerbs and Decks, Appendix A Deck Design Sketches – Sheet 1*.

Expansion Joint Cover Plate

For aesthetics, the gaps in the kerbs/parapets at an expansion joint shall be covered with a stainless steel cover plate. The plates are fabricated from stainless steel because the holes in them are drilled on site. The plate must be attached to the bridge on the side of the expansion joint which faces the oncoming traffic. Should a vehicle slide into the plate, this will reduce damage to both the plate and vehicle. For gaps no larger than 150 mm, the plate shall be 3 mm thick stainless steel and does not need to be located inside a recess. For gaps larger than 150 mm, the plate shall be 10 mm thick and sit inside a 10 mm deep recess. Refer Chapter 17 – *Cast Insitu Kerbs and Decks, Appendix A Deck Design Sketches – Sheet 1*.

18.4 Miscellaneous Details

A Miscellaneous Details drawing is used to show details that are not suited to other major drawings, for example, the Girder or Deck drawings. These details are so small in drawing size that they do not warrant their own specific drawing. Therefore, they are combined together on the Miscellaneous Details drawing. Typically these details are for expansion joints, cover plates, lamp standard brackets, and other minor pieces of steelwork. Refer *Appendix B – Example Miscellaneous Details Drawings*.

If a particular detail does not fit easily on a major drawing, it may be able to be moved to the Miscellaneous Details drawing provided that it is not an integral part of the major drawing.

A Miscellaneous Details drawing is not required for all bridge types. The following are typical guidelines for straightforward bridges only, and the need for a Miscellaneous Details drawing shall be assessed on a project specific basis:

Deck Unit Bridge with Cast Insitu Kerbs without an Expansion Joint

A Miscellaneous Details drawing is not required.

Deck Unit Bridge with Cast Insitu Kerbs with an Expansion Joint

A Miscellaneous Details drawing is required and shall show the following details:

- Expansion joint details
- Cover plate details
- Expansion joint washer details.

It is acceptable to show these details on the Cast Insitu Kerbs drawing rather than creating an additional Miscellaneous Details drawing. This will result in one full drawing sheet rather than two drawings that are half blank.

Deck Unit Bridge with a Reinforced Concrete Deck without an Expansion Joint

A Miscellaneous Details drawing is not required.

Deck Unit Bridge with a Reinforced Concrete Deck with an Expansion Joint

A Miscellaneous Details drawing is required and shall show the following details:

- Cover plates
- Expansion joint washers.

The expansion joint details should go on the Deck drawings because they show the interaction between the M16 cast in sockets and the reinforcing steel that goes around them.

Girder Bridge with a Reinforced Concrete Deck without an Expansion Joint

A Miscellaneous Details drawing is required and shall show the following details:

- Restraint angles and wedges. Refer Chapter 14 – *Prestressed Concrete Girders, 14.6 Miscellaneous Girder Components*
- Bearing restraint plates. Refer Chapter 14 – *Prestressed Concrete Girders, 14.6 Miscellaneous Girder Components*
- Layout diagrams for the girder anchorages and bearing restraint plates (if the complexity of the bridge requires them). Refer Chapter 14 – *Prestressed Concrete Girders, 14.6 Miscellaneous Girder Components*
- Girder anchorages. Refer Chapter 14 – *Prestressed Concrete Girders, 14.6 Miscellaneous Girder Components*

Girder Bridge with a Reinforced Concrete Deck with an Expansion Joint

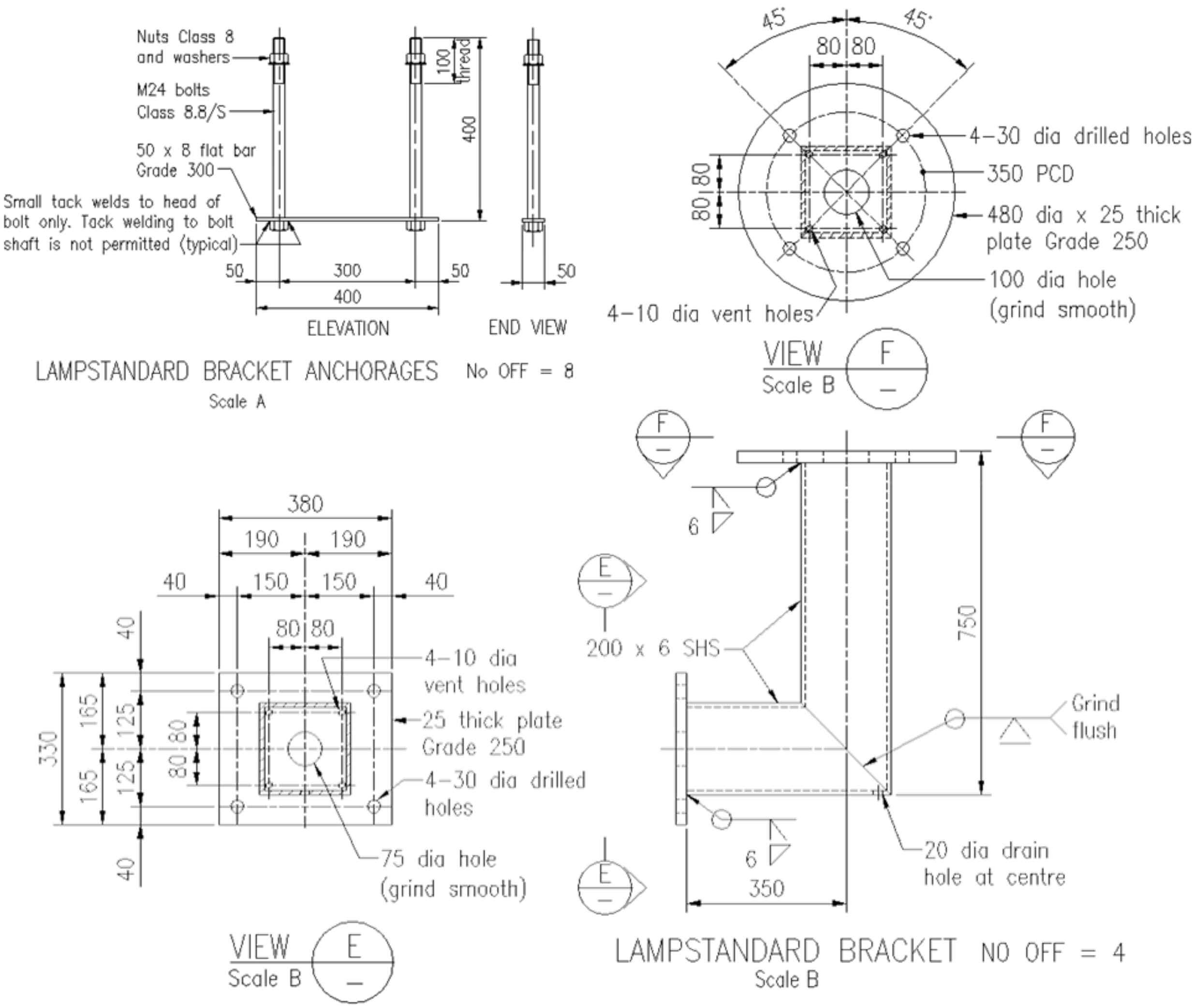
A Miscellaneous Details drawing is required and shall show the following details:

- Restraint angles and wedges. Refer Chapter 14 – *Prestressed Concrete Girders, 14.6 Miscellaneous Girder Components*
- Bearing restraint plates. Refer Chapter 14 – *Prestressed Concrete Girders, 14.6 Miscellaneous Girder Components*
- Layout diagrams for the girder anchorages and bearing restraint plates (if the complexity of the bridge requires them). Refer Chapter 14 – *Prestressed Concrete Girders, 14.6 Miscellaneous Girder Components* and Chapter 11 – *General Arrangements, Figure 11.7.5 – Girder Layout Diagram*.
- Girder anchorages. Refer Chapter 14 – *Prestressed Concrete Girders, 14.7 Girder Anchorage Details*
- Cover plates
- The expansion joint details should go on the Deck drawings because they show the interaction between the M16 cast in sockets and the reinforcing steel that goes around them.

Additional Items that may need to be shown on the Miscellaneous Details Drawings

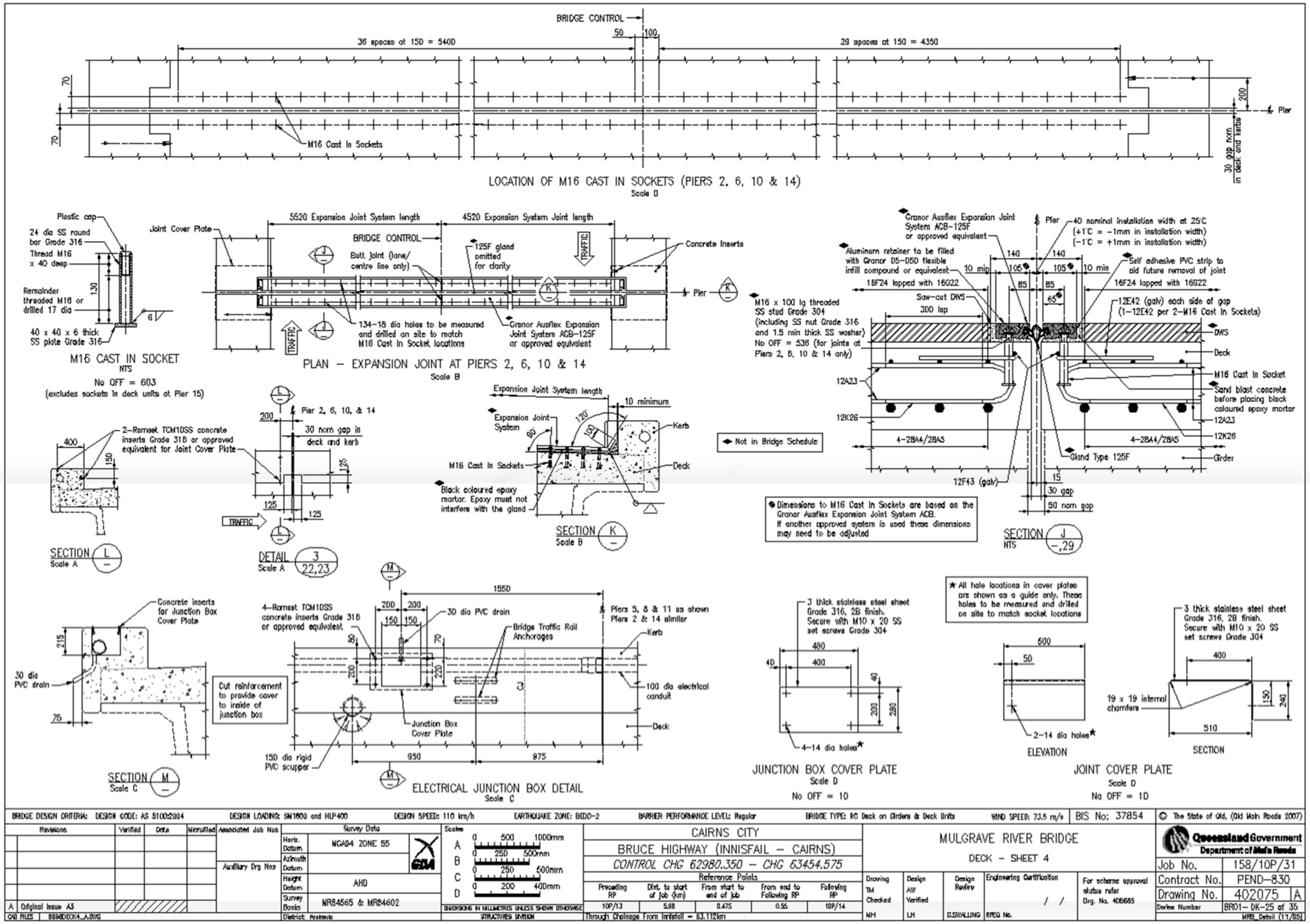
- Junction box cover plates. Refer Chapter 17 – *Cast Insitu Kerbs and Decks, 17.13 Junction Boxes*
- Lampstandard brackets and anchorages. For an example of the details required, refer Figure 18.4-1 *Example Lampstandard Bracket and Anchorage Details*
- Fabrication details for steelwork
- Layout diagrams for steelwork
- Service brackets
- Collection and disposal of stormwater from the bridge. Refer *Appendix C Example Drain Drawings*

Figure 18.4-1 Example Lampstandard Bracket and Anchorage Details



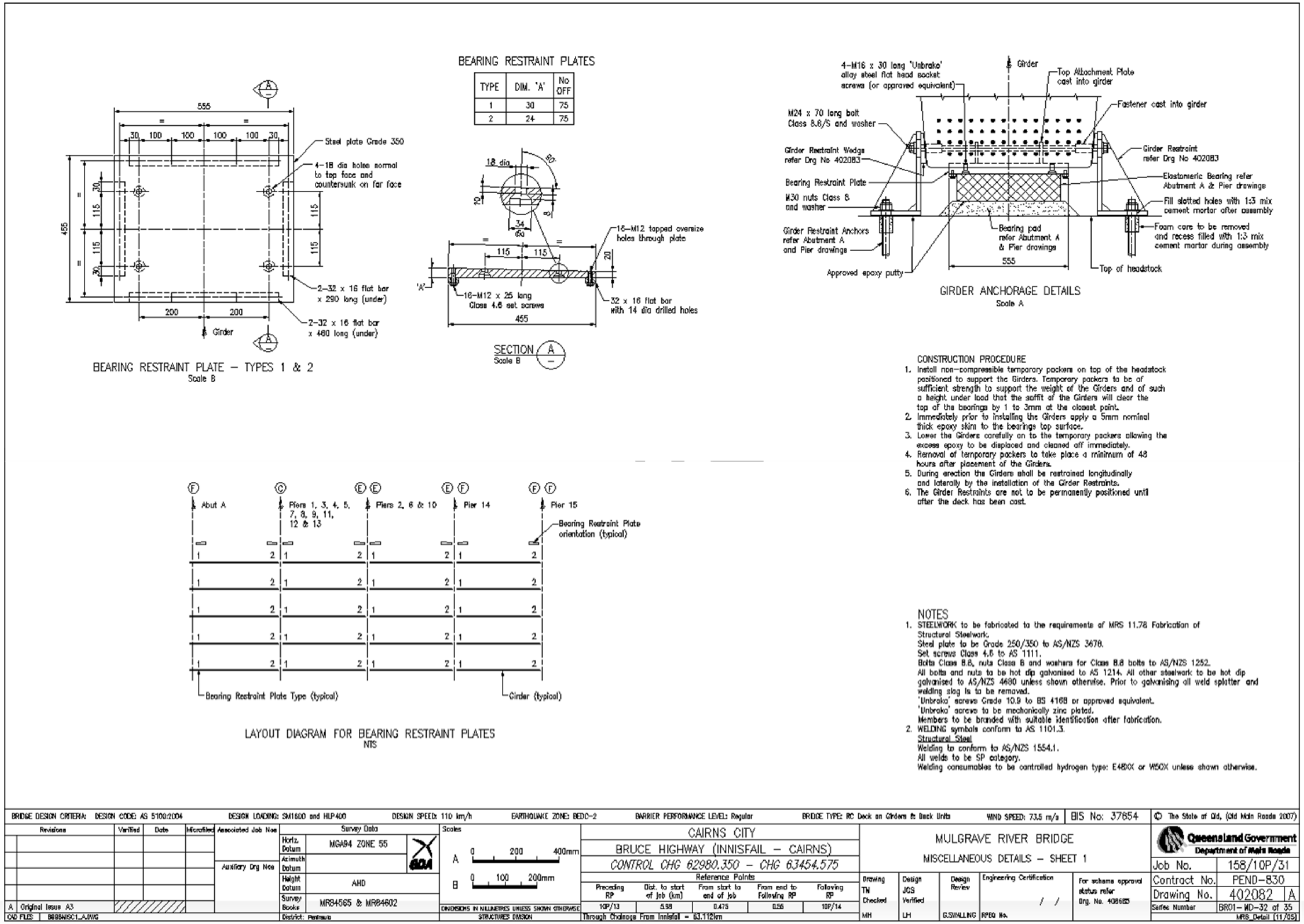
Appendix A – Example Expansion Joint Detail Drawing

Appendix A – Example Expansion Joint Detail Drawing

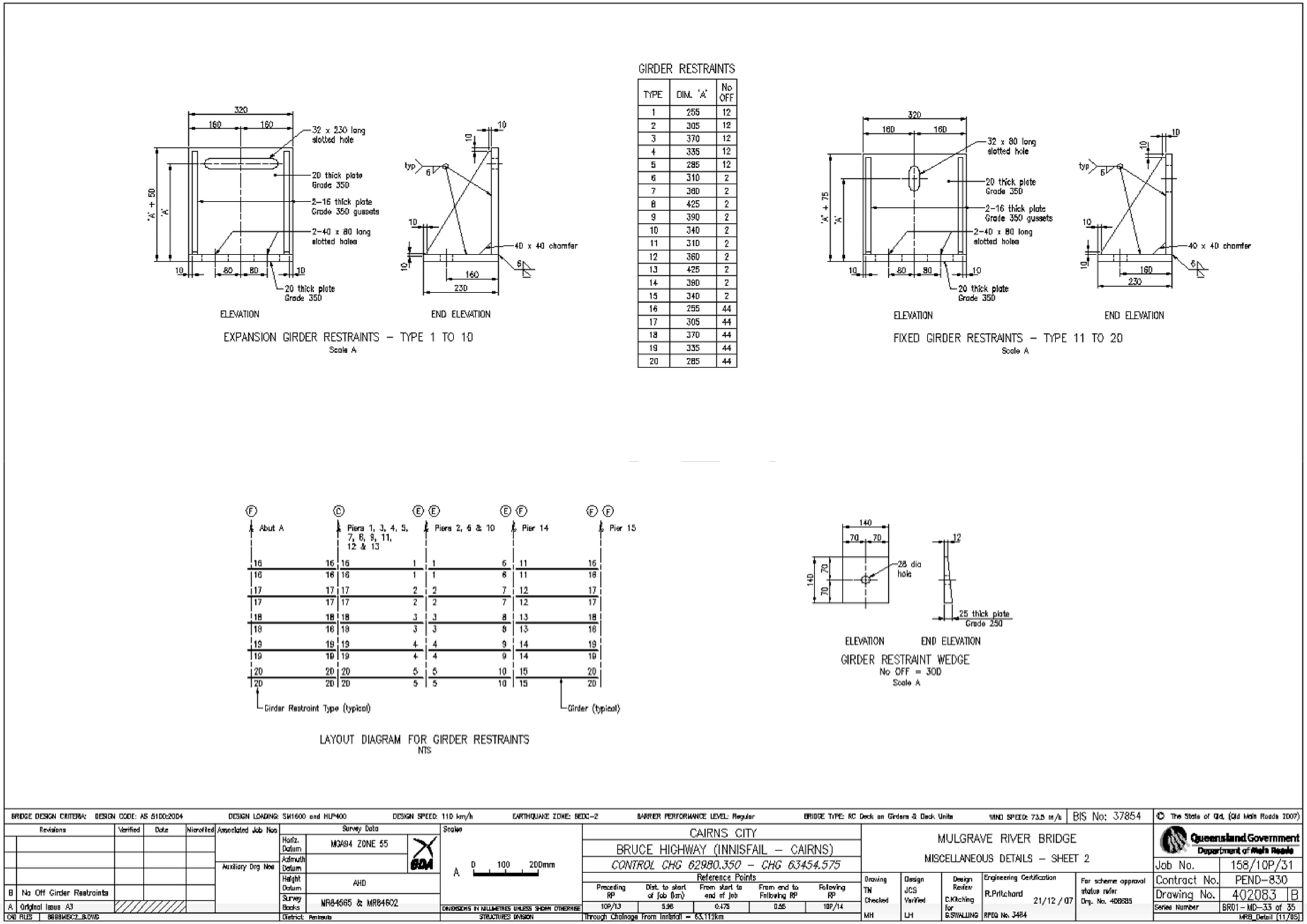


Appendix B – Example Miscellaneous Details Drawings

Appendix B – Example Miscellaneous Detail Drawings – Sheet 1



Appendix B – Example Miscellaneous Detail Drawings – Sheet 2

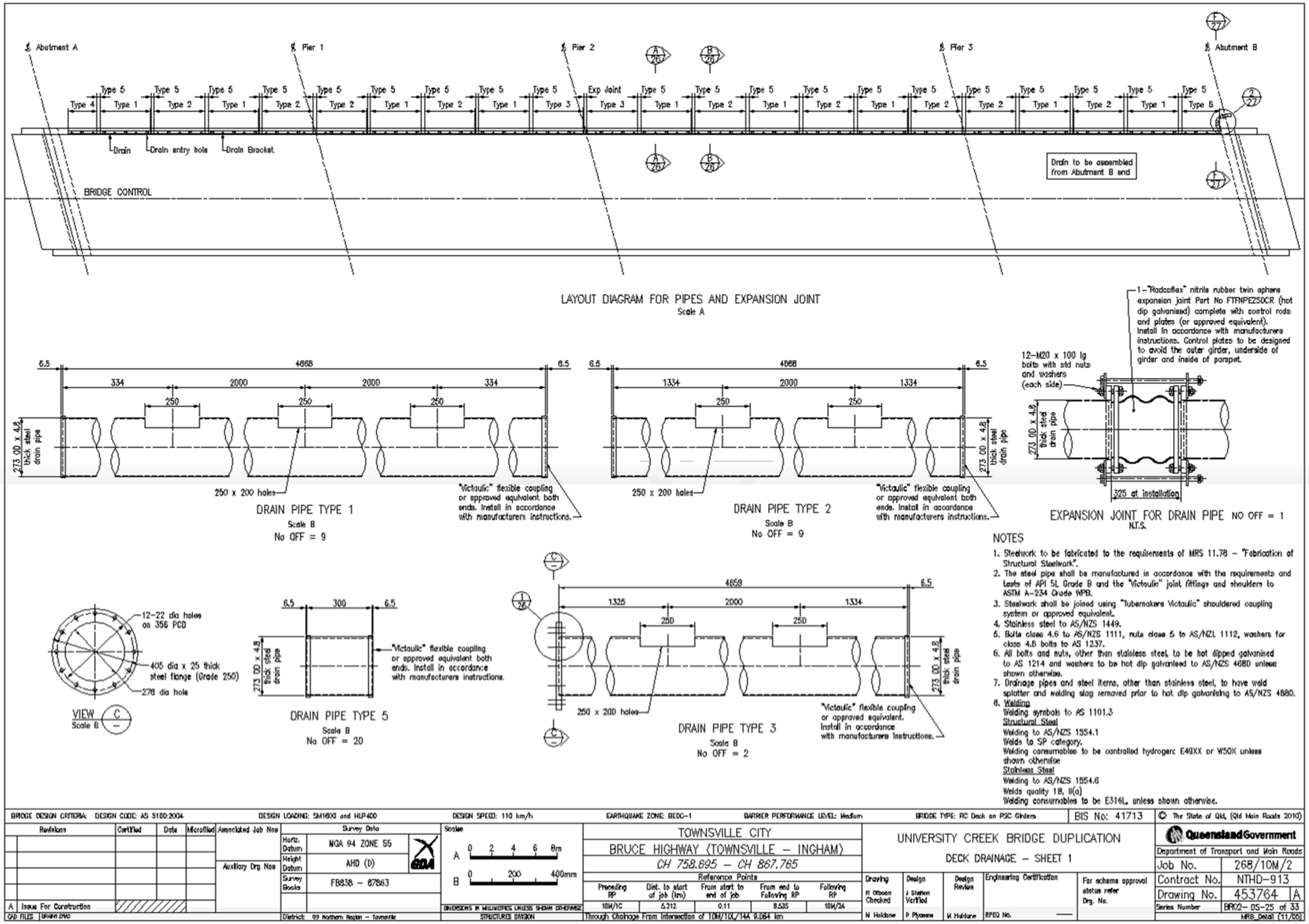


GIRDER RESTRAINTS

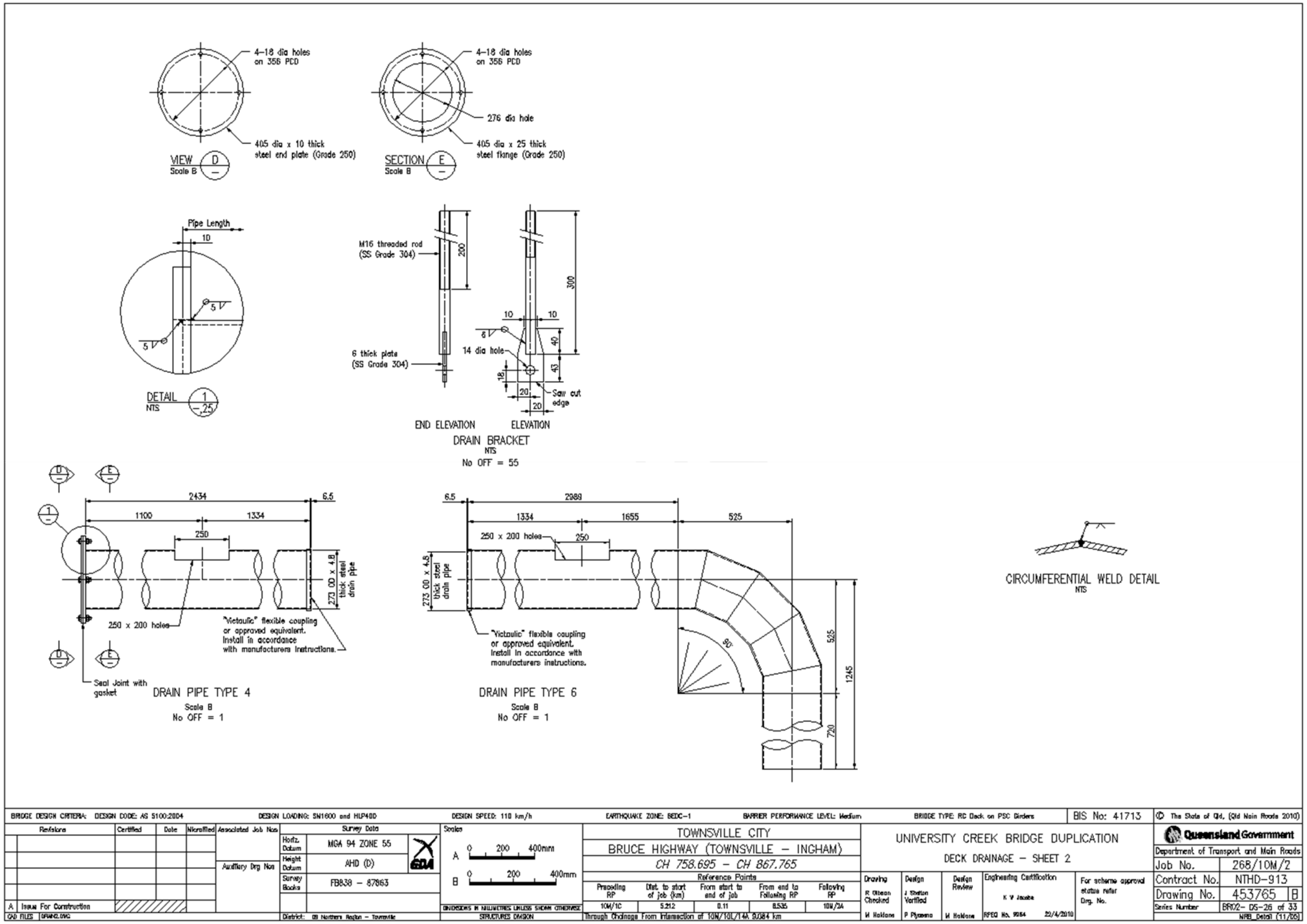
TYPE	DIM. 'A'	No OFF
1	255	12
2	305	12
3	370	12
4	335	12
5	285	12
6	310	2
7	360	2
8	425	2
9	390	2
10	340	2
11	310	2
12	360	2
13	425	2
14	390	2
15	340	2
16	255	44
17	305	44
18	370	44
19	335	44
20	285	44

Appendix C – Example Drain Drawings

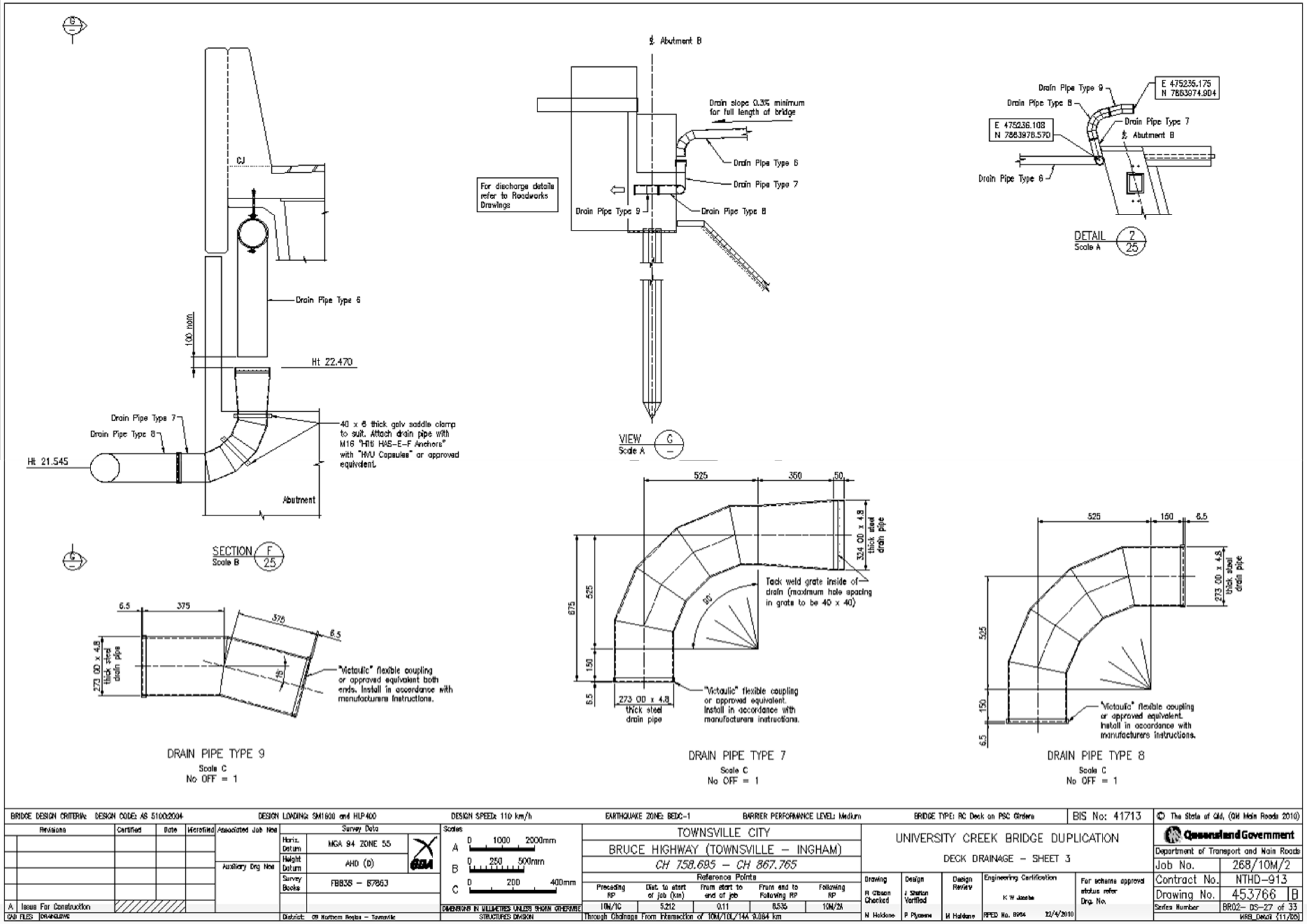
Appendix C – Example Drain Drawings – Sheet 1



Appendix C – Example Drain Drawings – Sheet 2



Appendix C – Example Drain Drawings – Sheet 3



Drafting and Design Presentation Standards
Volume 3: Structural Drafting Standards

Chapter 19: Bridge Barriers

November 2011

Queensland Government

Chapter 19 Amendments

Revision register

<table>
<tr><th>Issue/Rev No.</th><th>Reference Section</th><th>Description of Revision</th><th>Authorised by</th><th>Date</th></tr>
<tr><td>1</td><td>–</td><td>First Issue.</td><td>Manager (Structural Drafting)</td><td>April 2011</td></tr>
<tr><td rowspan="6">2</td><td>–</td><td>Document name change.</td><td rowspan="6">Manager (Structural Drafting)</td><td rowspan="6">Nov 2011</td></tr>
<tr><td>–</td><td>Bridge traffic rails replaced with bridge traffic barrier.</td></tr>
<tr><td>19.3</td><td>Add section on barrier height transition one on 10.</td></tr>
<tr><td>19.4</td><td>Gaps at fixed and continuous joints shall be 20 mm nominal at 25°C. Maximum rail length shall be 8.2 m. Maximum post spacing for bridges with a concrete deck shall be 2.45 m.</td></tr>
<tr><td>19.5</td><td>Gaps at fixed and continuous joints shall be 20 mm nominal at 25°C. Maximum rail length shall be 8.2 m.</td></tr>
<tr><td>19.6</td><td>Balusters spaced at 125 mm clear gap max.</td></tr>
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19 Bridge Barriers

19.1 Glossary of terms

For a complete glossary of terms refer Chapter 1 – *Introduction.*

19.2 Figures and examples shown in this volume

The figures and examples shown in this volume are for presentation purposes only, and may contain some details that are now superseded. These details have been included for ease of reference, to illustrate typical solutions, and to show the required standard of drafting presentation. The details are not to be used without an engineering check and certification by a Structural RPEQ to confirm that the details are appropriate for the specific project.

19.3 General

All barriers on new bridges are designed to the requirements of AS 5100 *Bridge Design*. Additional information may be found in *TMR Road Planning and Design Manual, 8.2.7 Bridge Barriers and Transitions*.

The most common barrier types on bridges used by the Department of Transport and Main Roads are as follows:

- Bridge traffic barriers (aluminium or steel)
- Bridge safety rails (aluminium or steel) – including bicycle safety rails where needed
- Balustrades (aluminium or steel) – including bicycle safety rails where needed
- Single slope reinforced concrete barriers.

On bridges with a footway, the type of barriers used either side of it is dependent on what the footway is used for. Where the footway is expected to carry a large number of cyclists, the footway shall be referred to as a bikeway and bicycle safety rails will be required. Agreement on the need for bicycle safety rails shall be made with the relevant departmental region before the bridge design begins because the bridge will be wider if bicycle safety rails are needed. Bicycle safety rails are required to prevent cyclists from snagging their handlebars or pedals on the bridge barriers. For minimum footway and bikeway widths refer *TMR Design Criteria for Bridges and other Structures*.

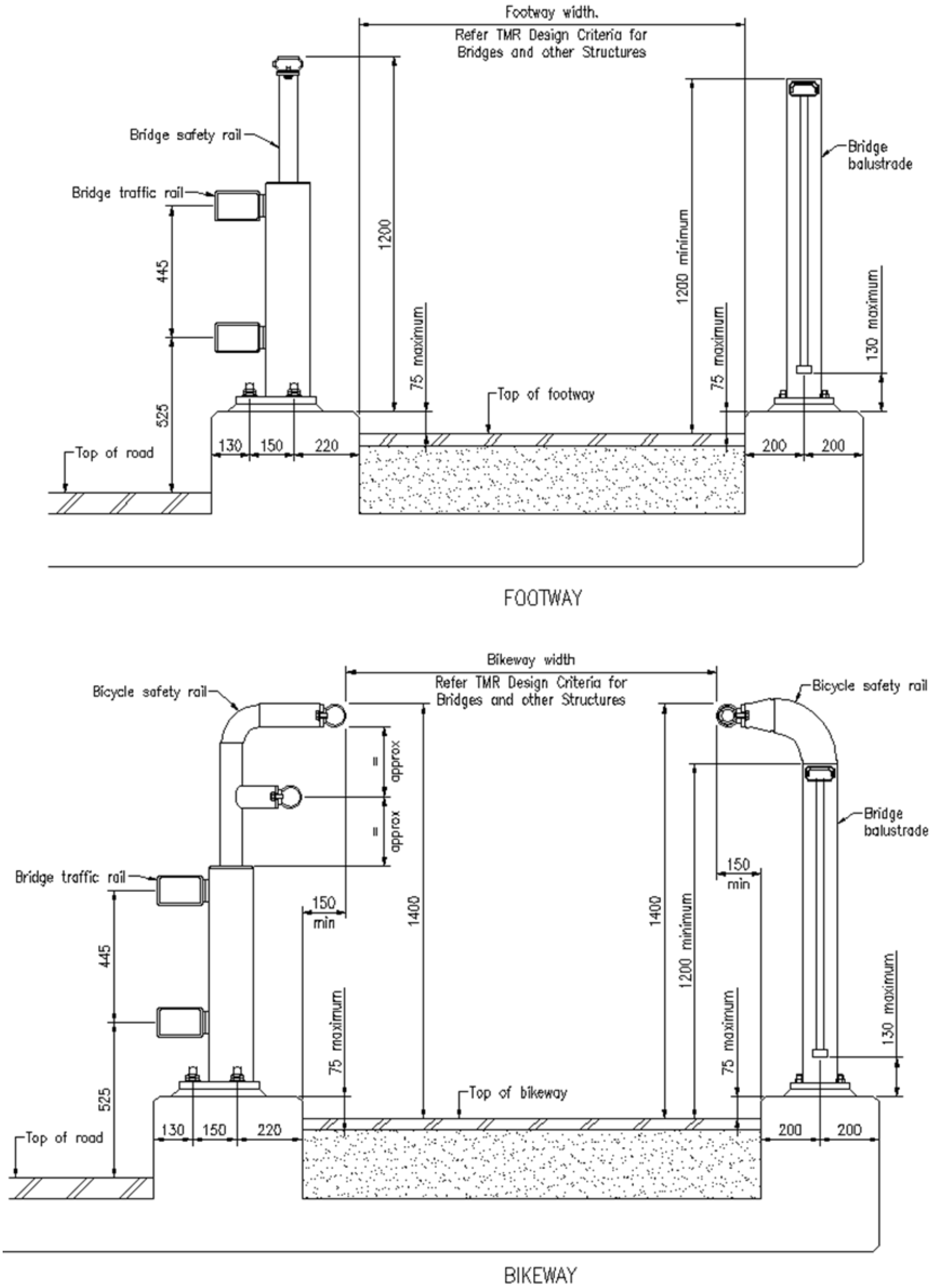
Figure 19.3-1 *Barrier Types* illustrates the various barrier types and their height requirements.

Additional consideration shall be given to the *Crime Prevention through Environmental Design Guidelines for Queensland*, *The Building Code of Australia* and AS 1428 *Design for Access and Mobility* for topics including, but not limited to:

- Wheelchair access
- Landings and additional rails for longitudinal grades > 3%.

Transitions in barrier height shall be at a maximum steepness of one vertical to 10 horizontal. This is to reduce the chance of a vehicle snagging on the barrier, or it being launched into the air because the barrier acts as a ramp. TMR Standard Drawing 1486 *Single Slope Concrete Barrier* and some other similar standard drawings will be amended shortly to show the correct transition slope. Details that are copied from these standard drawings onto project specific drawings shall be modified to show the correct transition.

Figure 19.3-1 Barrier Types



19.4 Aluminium or Steel Bridge Traffic Barriers

Bridge traffic barriers are manufactured from either aluminium or steel. They shall be designed to the requirements of AS 5100. Their performance level can be low, regular, or medium. The performance level required is determined my many factors, including, but not limited to:

- The type of vehicles to be contained
- Total traffic volumes and volumes of vehicles relevant to alternative performance levels

- Road alignment and operating speed
- Bridge width and offset from the traffic lanes to the barrier
- Divided, undivided and one way roads
- The cost of providing and maintaining a bridge barrier and bridge approach barrier system of specified performance level(s)
- The consequences of a vehicle penetrating or vaulting the barrier.

Aluminium traffic barriers are used in special circumstances only such as in tidal splash zones, or for aesthetic purposes. The department does not have an approved product or Standard Drawing for this type of barrier; therefore details must be developed on a project specific basis. Manufacturers such as 'Tollfab' may have standard rail types which could be suitable, however it must be demonstrated to the department that the barrier design is in accordance with AS 5100. Refer *Appendix A Example Aluminum Bridge Traffic Barrier Drawing*.

Refer to TMR Standard Drawings 1508, 1509 and 1510 for standard details and design criteria for regular performance level, steel bridge traffic barriers. Refer *Appendix B Example Steel Bridge Traffic Barrier Drawings*.

Design Criteria (Regular performance Level, Steel Bridge Traffic Barrier Only)

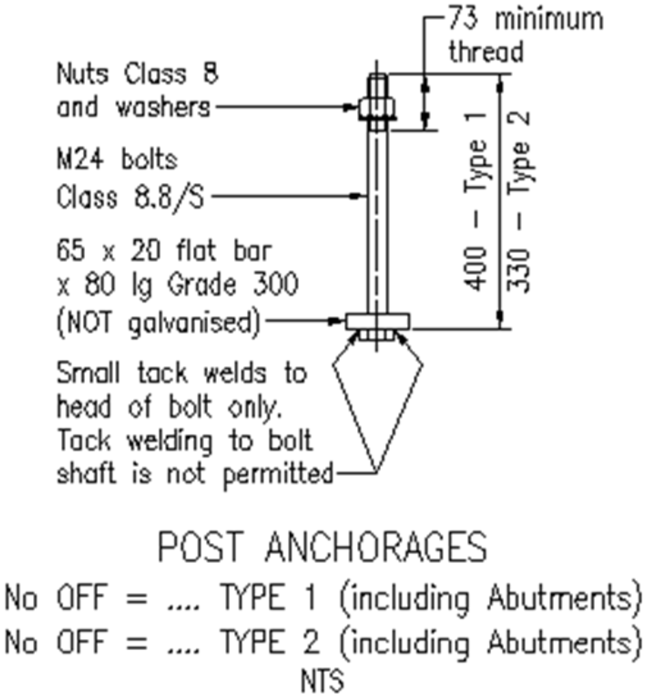
The following criteria must be met when designing the rail types and post spacing:

- Deck unit bridges with cast insitu kerbs – Spacing of intermediate posts shall be 2.05 m maximum, except over the pier and abutment centrelines, where there may be a single spacing of up to 2.8 m
- Bridges with a concrete deck – Spacing of intermediate posts shall be 2.45 m maximum
- Spacing of an end post and its adjacent intermediate post shall be 1.2 m maximum
- The spacing between three adjacent posts shall not exceed 4.9 m; that is, an average of 2.45 m
- The joint between rails shall be 20 mm nominal at fixed joints and 40 mm nominal at expansion joints
- Only one joint is allowed between successive posts
- Each rail must be supported by at least two posts
- One joint shall be provided at each abutment and pier location
- The barrier shall transition to full height at one on 10 from the top of the approach guardrail to the top of the bridge traffic rail
- Rail lengths shall be 8.2 m maximum.

Post Anchorages (Regular performance Level, Steel Bridge Traffic Barrier Only)

Post anchorage details shall be shown on the Bridge Traffic Barrier drawings because they are fabricated with the barrier. In the cost estimate they shall be bundled together into one item. Refer Figure 19.4-1 *Post Anchorage* for standard details.

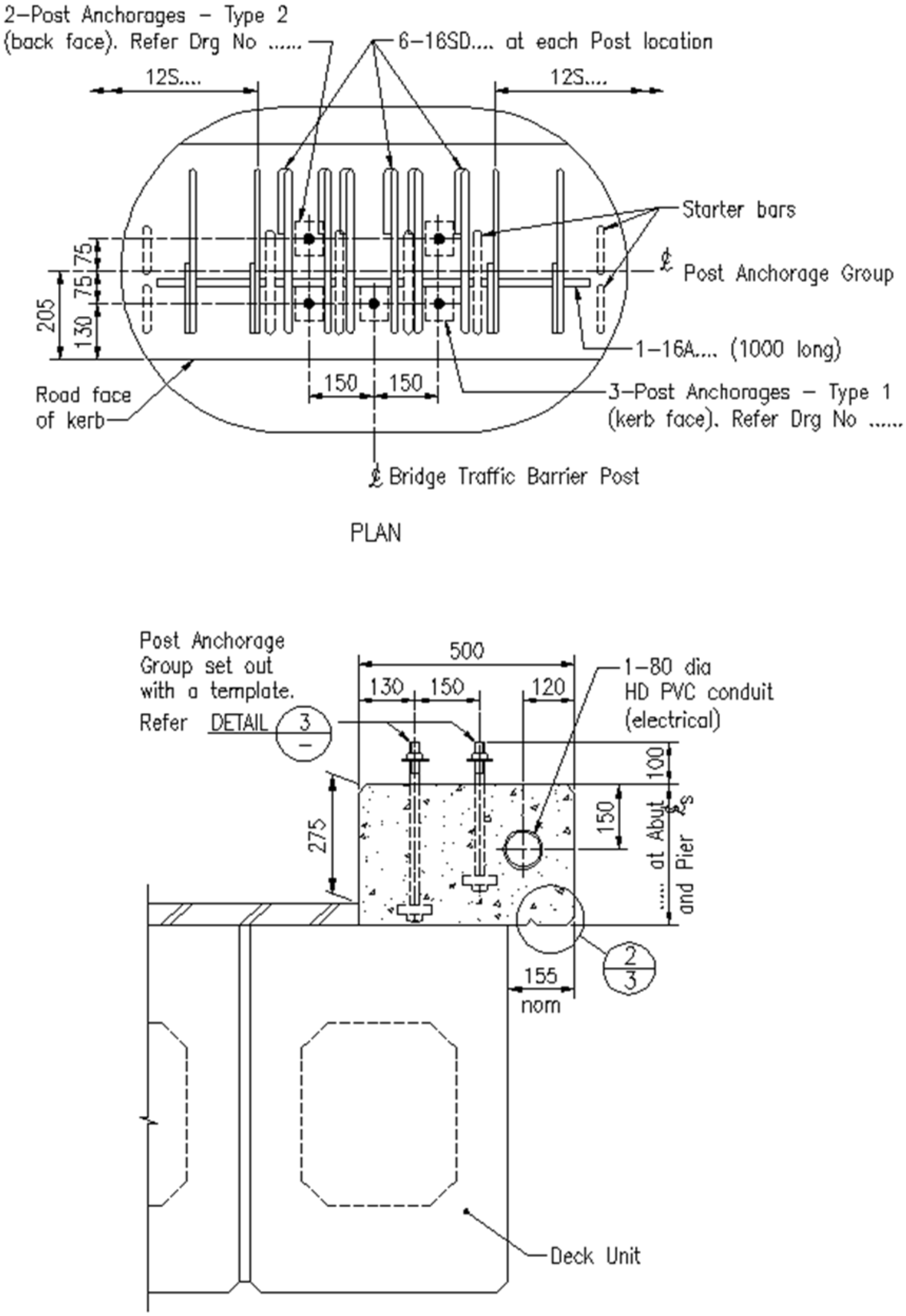
Figure 19.4-1 Post Anchorage Detail (Regular Performance)



The setting out details for the anchorages shall be shown on the Cast Insitu Kerb/Deck drawings. It is important to show that the anchorage with three 400 mm long bolts (Type 1) is placed closest to the road face of the kerbs and wingwalls and the anchorage with two 330 mm long bolts (Type 2) is placed at the back. To ensure that the bridge traffic rails line up within tolerance to the front face of the kerb, the anchorages must be set back 130 mm and 280 mm from the road face of the kerbs and wingwalls. The anchorages shall protrude 100 mm. On bridges with a concrete deck and scuppers, the anchorages (and hence the posts) shall avoid the scupper recesses. Refer Figure 19.4-2 *Bridge Traffic Barrier Post Anchorage Setting Out Detail*.

330 mm long bolts are specified at the back of the post. These bolts are used because fabricators have large quantities that have been bought and tested. Once these stockpiles have been reduced, 400 mm long bolts will be specified at both the front and back of the post.

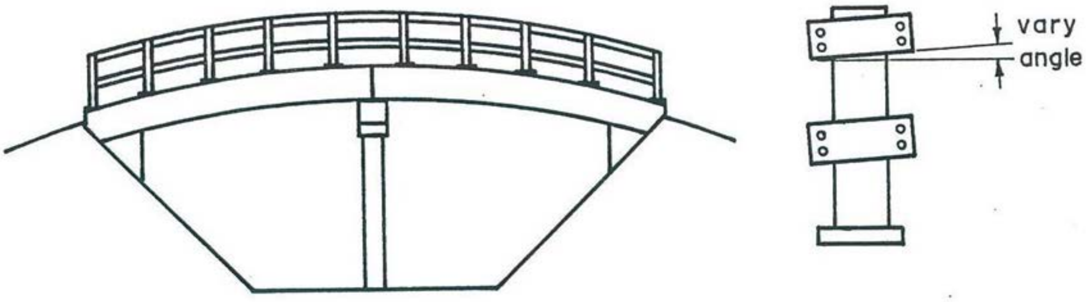
Figure 19.4-2 Bridge Traffic Barrier Post Anchorage Setting Out Detail (Regular Performance)



Orientation of Posts

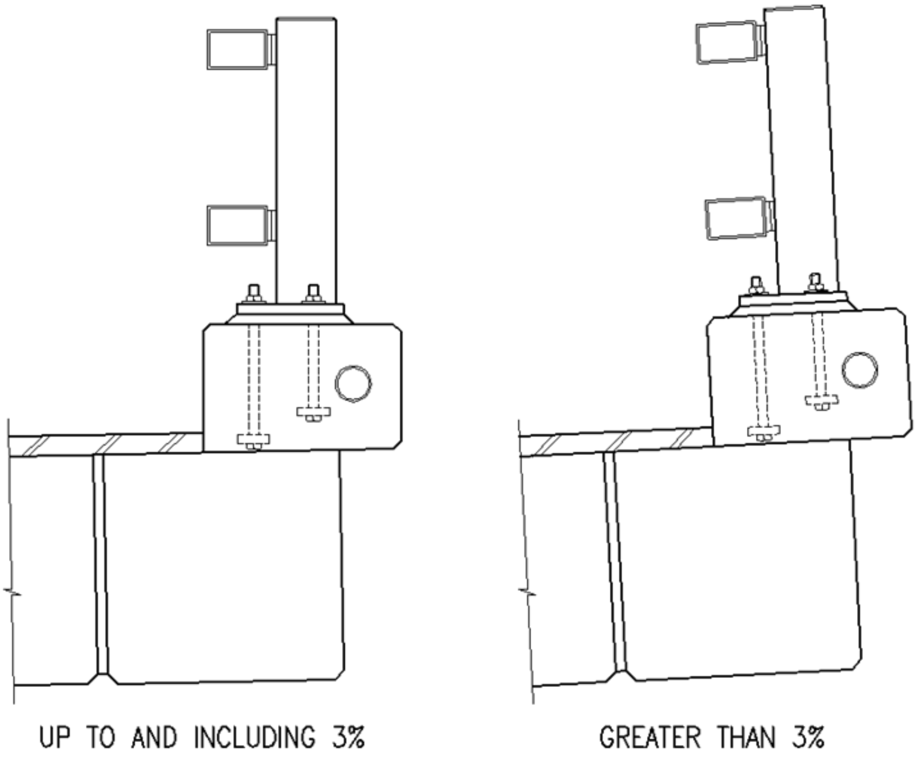
In the longitudinal direction, posts are to be set normal to the grade of the bridge, except on small radius vertical curves where the posts may need to be vertical. On small radius curves the fitment of the bolts and holes must be thoroughly checked to determine if the posts need to be vertical. Refer Figure 19.4-3 *Post Orientation on Small Radius VC*.

Figure 19.4-3 Post Orientation on Small Radius VC



In the transverse direction, posts are to be set vertical except on bridges where the deck super elevation/crossfall slope exceeds three per cent. In these cases posts are to be set normal to the super elevation/crossfall. Refer Figure 19.4-4 *Post Orientation in Transverse Direction*.

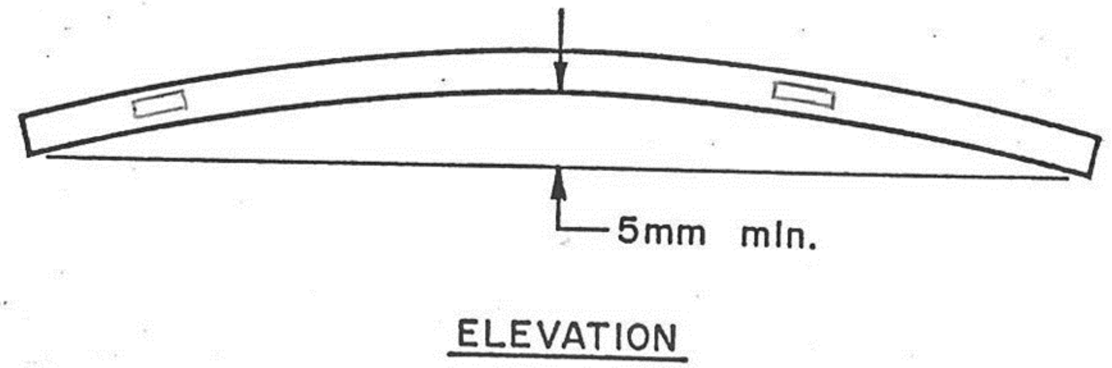
Figure 19.4-4 Post Orientation in Transverse Direction



Bending of Rails for Vertical Curves

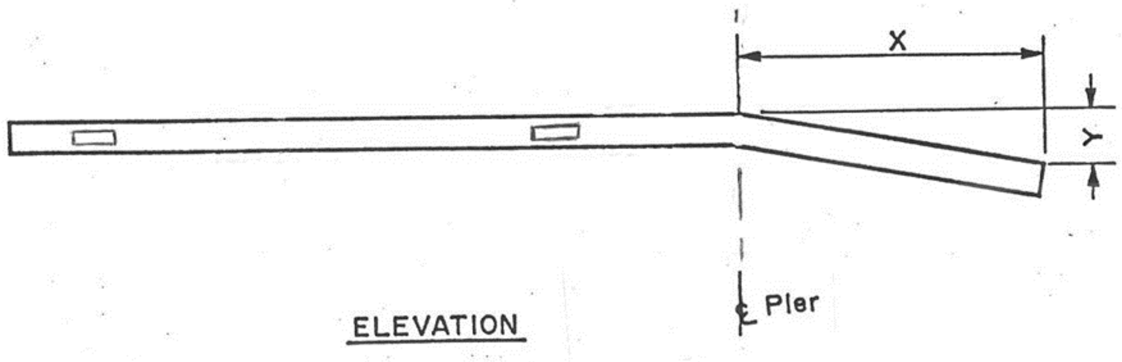
On bridges with a RC deck or cast insitu kerbs where the top face of the kerb follows the actual VC, rails shall be bent to match the curve when the mid-offset dimension exceeds 5 mm. Refer Figure 19.4-5 *Rail Bent for VC*.

Figure 19.4-5 Rail Bent for VC



On bridges with a VC or changing grade and with linear kerbs, rails shall be bent at the pier and abutment centrelines if necessary. Refer Figure 19.4-6 *Rail Bent for Linear Change of Grade Vertically*.

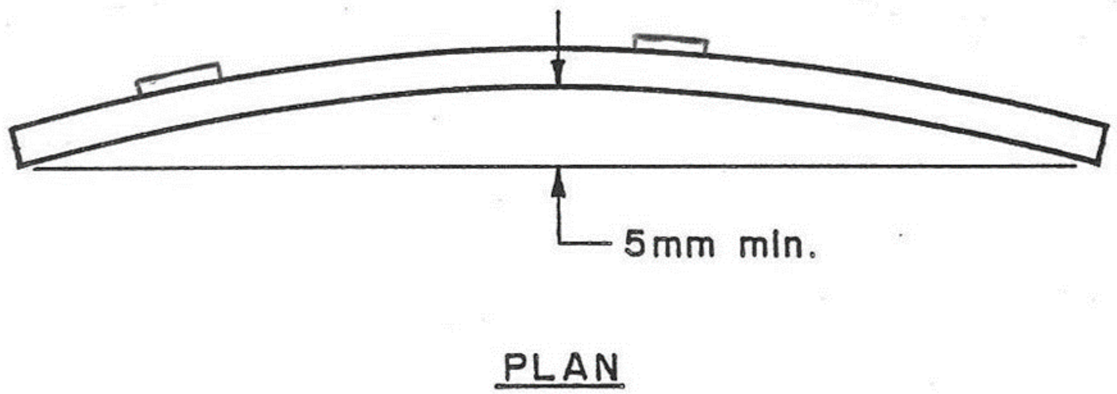
Figure 19.4-6 Rail Bent for Linear Change of Grade Vertically



Bending of Rails for Horizontal Curves

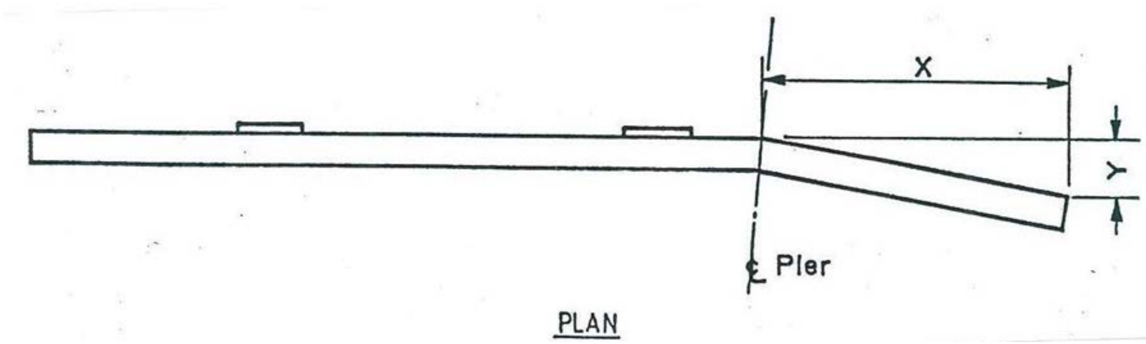
On bridges with a RC deck where the road face of the kerb follows the actual HC, rails shall be bent to match the curve where the mid-offset dimension exceeds 5 mm. Refer Figure 19.4-7 *Rail Bent for HC*.

Figure 19.4-7 Rail Bent for HC



On bridges with a HC and with linear kerbs, rails shall be bent at the pier and abutment centrelines if necessary. Refer Figure 19.4-8 *Rail Bent for linear change of Direction Horizontally*.

Figure 19.4-8 Rail Bent for linear change of Direction Horizontally



19.5 Bridge Safety Rails

Bridge safety rails are used to add additional height to the barrier which is positioned between a footway and a road. If the barrier is positioned between a bikeway and a road, the additional height shall be achieved with the addition of a bicycle safety rail, refer 19.7 *Bicycle Safety Rails*.

Bridge safety rails can be manufactured from aluminium or steel.

Aluminium bridge safety rails are used in special circumstances only e.g. in tidal splash zones, or for aesthetic purposes. They are used in conjunction with aluminium bridge traffic barriers or concrete barriers. The department does not have an approved product or Standard Drawing for this type of barrier; therefore details must be developed on a project specific basis. Refer *Appendix C Example Aluminium Bridge Safety Barrier Drawing*.

Steel bridge safety rails are used in conjunction with steel traffic barriers or concrete barriers. Refer to TMR Standard Drawing No 1511 for details of the standard steel bridge safety rail design for when it is attached to a steel bridge traffic barrier. Refer *Appendix D Example Steel Bridge Safety Barrier Drawing*.

Design Criteria

The following criteria must be met when designing the barrier types and post spacing:

- If the bridge safety rail is attached to concrete parapet the post spacing shall be 3 m maximum.
- If the bridge safety rail is attached to a bridge traffic barrier the post spacing shall match those of the bridge traffic barrier.
- The joint between rails shall be 20 mm nominal at 25°C at fixed and continuous joints and 40 mm at 25°C at expansion joints.
- Only one joint is allowed between successive posts.
- One joint shall be provided at each abutment and pier location.
- The bridge safety rail shall transition to full height at one on 10 from the top of the bridge traffic barrier to the top of the bridge safety rail.
- Rail lengths shall be 8.2 m maximum.
- The top of the bridge safety rail shall be 1.2 m above the top of kerb.

Orientation of Posts

Follow the theory for bridge traffic barriers, refer *19.4 Aluminium or Steel Bridge Traffic Barriers*.

Bending of Rails for Vertical Curves

Follow the theory for bridge traffic rails, refer *19.4 Aluminium or Steel Bridge Traffic Barriers*.

Bending of Rails for Horizontal Curves

Follow the theory for bridge traffic rails, refer *19.4 Aluminium or Steel Bridge Traffic Barriers*.

19.6 Bridge Balustrades

Bridge balustrades are used as the external barrier for footways. Balustrades for bikeways shall have a bicycle safety rail attached on top, refer *19.7 Bicycle Safety Rails*.

Bridge balustrades can be manufactured from aluminium or steel.

Aluminium balustrade is used in special circumstances only such as in tidal splash zones, or for aesthetic purposes. The department does not have a Standard Drawing for this type of barrier; therefore details must be developed on a project specific basis. Manufacturers such as 'Tollfab' may have standard rail types which may be suitable. Refer *Appendix E Example Aluminium Bridge Balustrade Drawing*.

Refer TMR Standard Drawing 1512 *Bridge Balustrade* for details of the standard steel balustrade design and *Appendix F Example Steel Bridge Balustrade Drawings*.

Design Criteria

The following criteria must be met when designing the balustrade panel types and post spacing:

- Spacing of posts shall be 2 m maximum.
- The joint between rails shall be 40 mm nominal.
- Only one joint is allowed between successive posts.
- One joint shall be provided at each abutment and pier location.
- Panel lengths shall be 4 m maximum.
- Balusters shall be spaced at 125 mm clear gap maximum.
- The top of the balustrade shall be 1.2 m minimum above the footway.

Orientation of Panels

In the longitudinal direction, the rails shall follow the grade while the balusters and posts are always vertical.

In the transverse direction the panels are to be set vertical.

Bending of Rails for Vertical and Horizontal Curves

Follow the theory for bridge traffic barriers, refer *19.4 Aluminium or Steel Bridge Traffic Barriers.*

19.7 Bicycle Safety Rails

Bicycle safety rails are required to prevent cyclists from snagging their handlebars or pedals on the bridge barriers.

Bicycle safety rails are manufactured from either aluminium or steel.

Aluminium bicycle safety rails are used in special circumstances only such as in tidal splash zones. The department does not have an approved product or Standard Drawing for this type of barrier; therefore details must be developed on a project specific basis.

The department is currently developing Standard Drawings for steel Bicycle Safety Rails.

Refer *Appendix G Example Steel Bridge Traffic Barrier with Bicycle Safety Rail Drawing*.

Design Criteria

The following criteria must be met when designing the bicycle safety rails:

- The rail is attached to either the bridge traffic barrier posts or the balustrade posts.
- The rail shall protrude 150 mm past the kerb face.
- The joint between rails shall be 40 mm nominal.
- Only one joint is allowed between successive posts.
- One joint shall be provided at each abutment and pier location.
- The bicycle safety rail shall transition to full height at one on 10 from the top of the bridge traffic barrier to the top of the bridge safety rail.
- Rail lengths shall be 6.5 m maximum.
- The top of the bicycle safety rail shall be 1.4 m above the top of the bikeway.

Bending of Rails for Vertical and Horizontal Curves

Follow the theory for bridge traffic barriers, refer *19.4 Aluminium or Steel Bridge Traffic Barriers*.

19.8 Re-railing Existing Bridges

To improve vehicle safety, old bridges are often fitted with new bridge traffic barriers. The department does not have a Standard Drawing for this type of barrier; therefore details must be developed on a project specific basis. An engineering design shall determine the attachment details and post spacing. If the Barrier Performance Level does not satisfy AS 5100, the actual level shall be noted in the title block, for example, '50% of AS 5100.1 *Low Performance Level*'.

The posts are usually attached to the bridge with bolts and/or chemical anchors. Refer Figure 19.8-1 *Example Re-railing (1)* and Figure 19.8-2 *Example Re-railing (2)* for two examples of attachment details.

Figure 19.8-1 Example Re-railing (1)

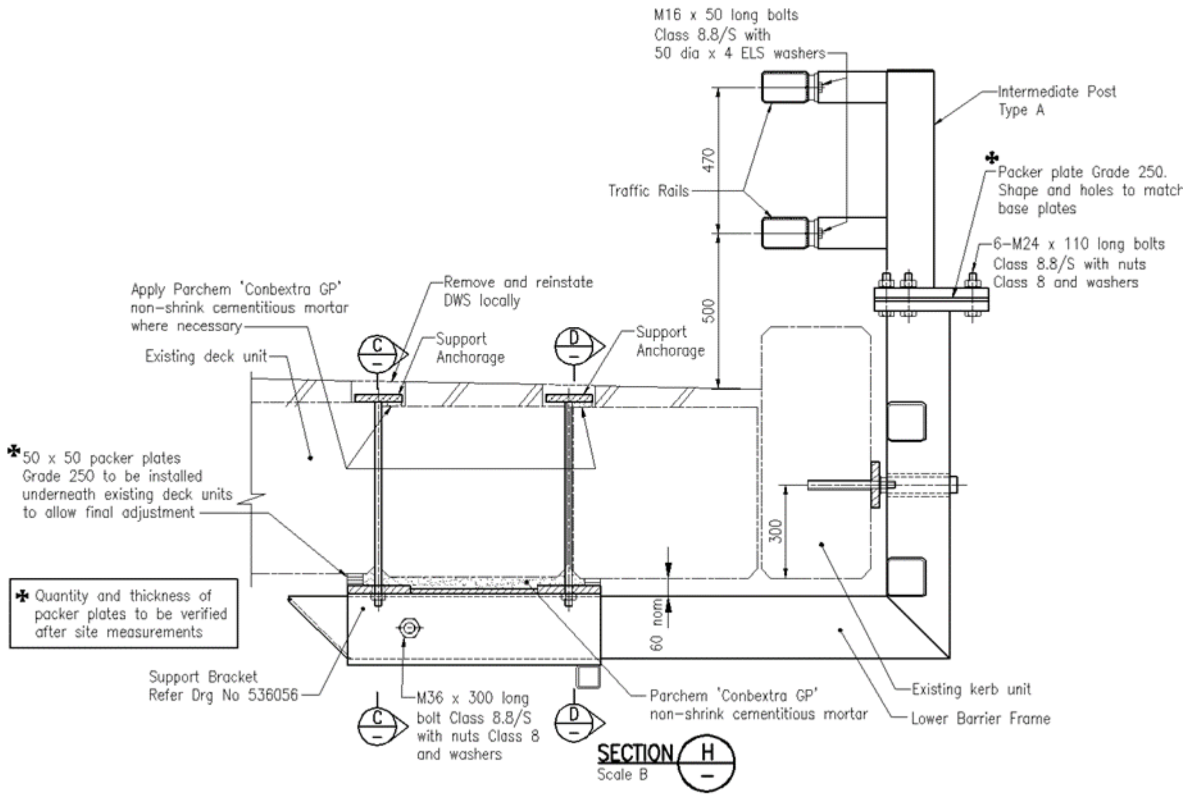
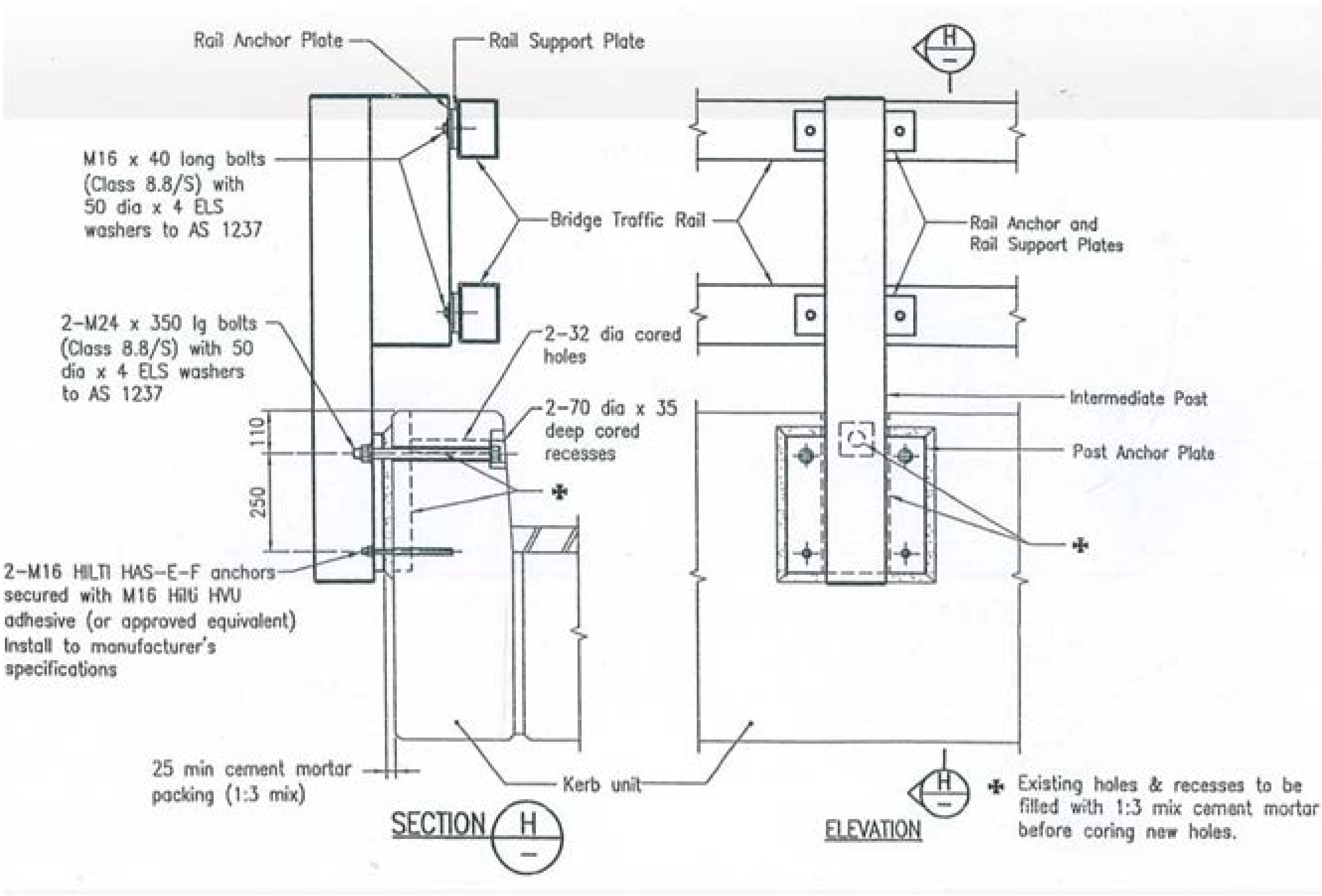
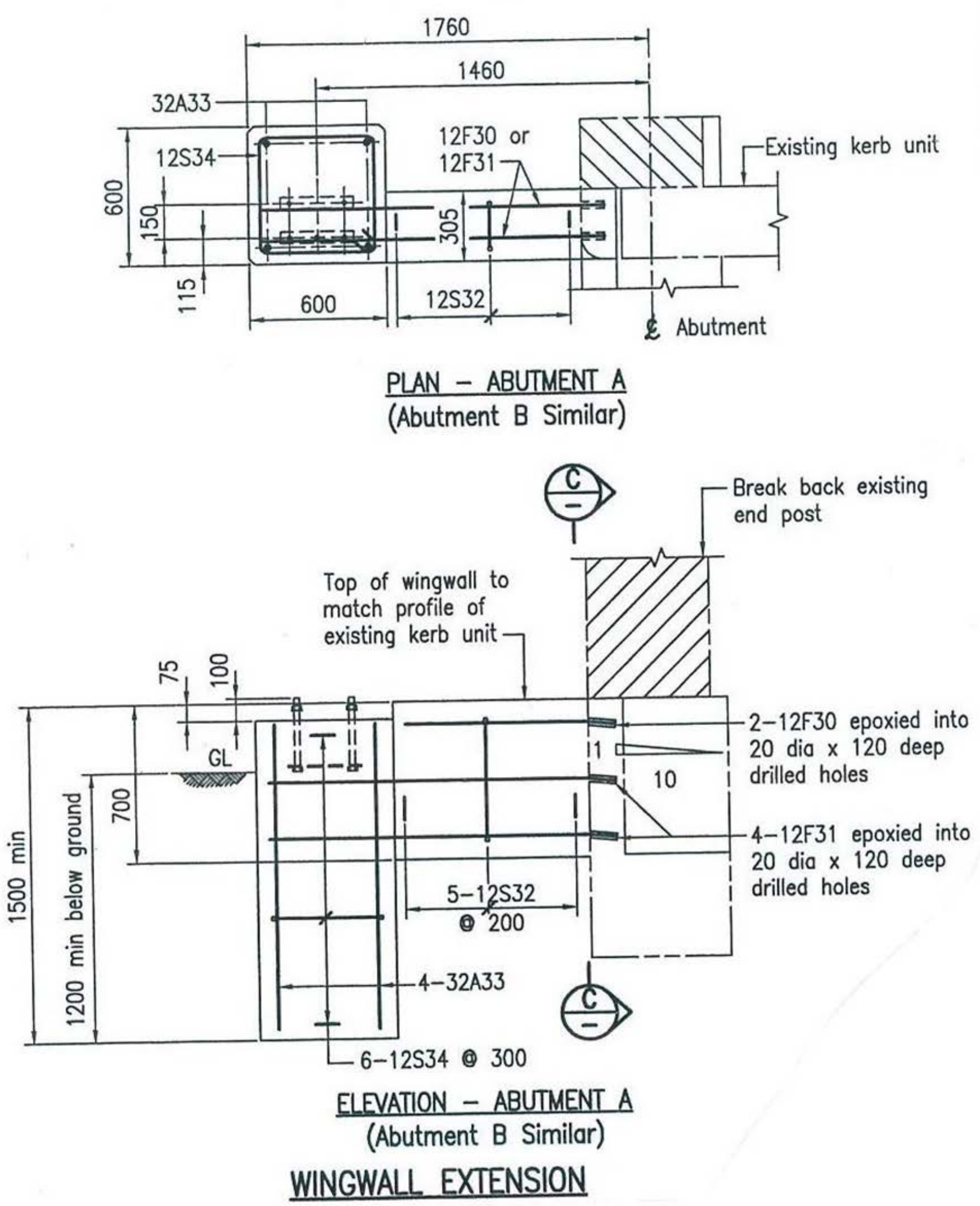


Figure 19.8-2 Example Re-railing (2)



Usually the existing wingwalls need to be extended to provide an anchorage for the bridge traffic barrier end posts to be attached. Refer Figure 19.8-3 *Example Wingwall Extension* for typical details.

Figure 19.8-3 Example Wingwall Extension



19.9 Single Sloped Concrete Barriers

This section shall be read in conjunction with Chapter 17 – *Cast Insitu Kerbs and Decks*.

Overpass bridges crossing roads or railway have concrete barriers rather than steel bridge traffic barrier. This is to help prevent debris falling off the bridge onto traffic below. Bridges on major roads and those on small horizontal radius curves may also be required to have concrete barriers.

To decrease construction time and road/railway closures, precast barrier panels are often used on overpass bridges. The precast panels must be more than 100 mm thick. The cast insitu portion of the barrier must be wide enough to allow for vibration of the concrete. The back face of the barrier is precast, and then erected on the bridge deck. The front face of the barrier is then cast insitu. The precast barrier brackets must allow for height adjustment while providing secure attachment to the deck. Many different systems may be used, an example is shown in Figure 19.9-1 *Precast Barrier Panel*, and another example is shown in *Appendix H Example Precast Barrier Panel and Deck Drawings*.

To reduce cracking in concrete barriers, contraction joints are usually placed approximately every 4 m. Refer Figure 19.9-2 *Contraction Joint*.

Often a concrete barrier will transition to a concrete barrier off the bridge. For details of concrete barriers refer to TMR Standard Drawing Nos 1460 to 1473 inclusive.

Figure 19.9-1 Precast Barrier Panel

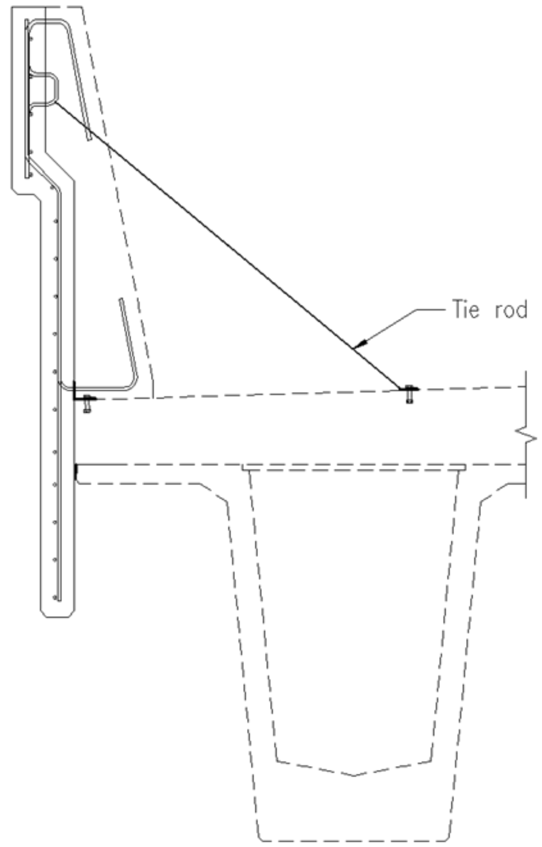
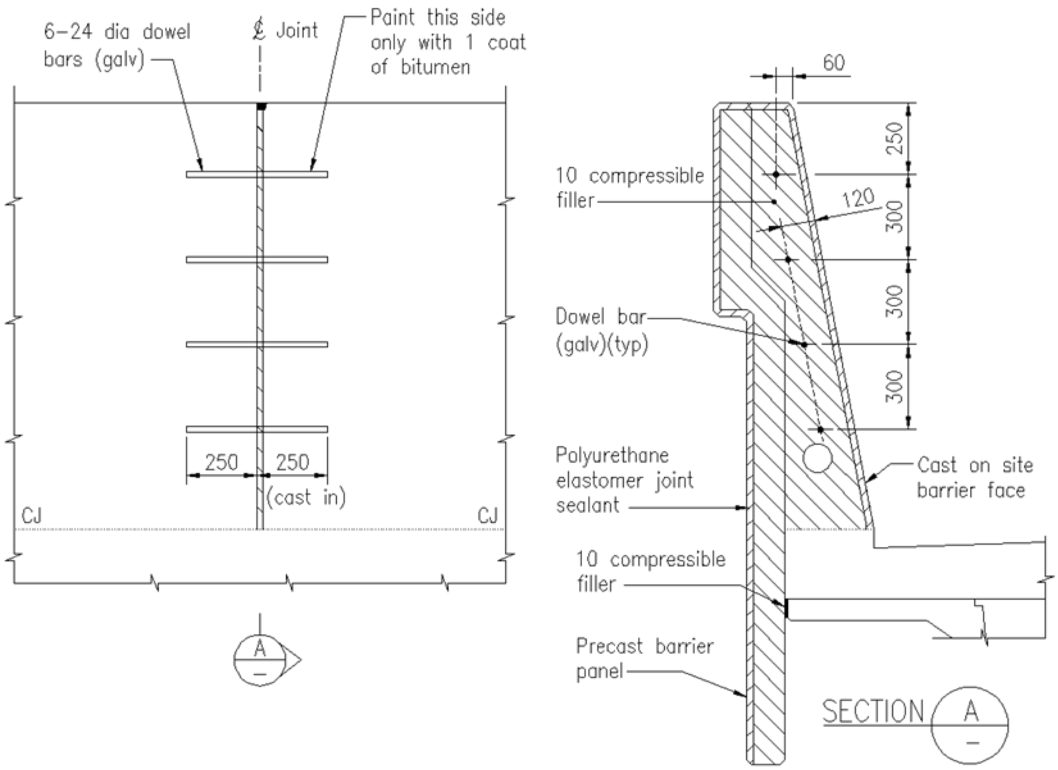


Figure 19.9-2 Contraction Joint



19.10 Protection Screens

Overpass bridges may require protection screens. For requirements refer to AS 5100, *TMR Technical Guidelines for the Treatment of Overhead Structures – Objects Thrown or Dropped* and the departmental policy *Reduction of Risk from Objects Thrown from Overpass Structures onto Roads*.

Protection screens shall be positioned behind a plane parallel to the barrier face or a minimum of the working width behind the barrier.

The designer must do a risk assessment to determine their necessity. Important factors to consider include:

- the design speed of the underpass road
- the volume of traffic on the underpass
- the volume of vehicle traffic on the overpass and more importantly, the volume of pedestrian traffic on the overpass
- if the bridge is for pedestrians only
- if the bridge is near a school, park or playground
- the lighting of the bridge
- the presence of vandalism or gangs near the bridge.

Refer *Appendix I – Example Protection Screen Drawings*.

19.11 Railway Overbridge Barriers

In addition to AS 5100, bridges over QR railways shall be designed in accordance with the following relevant QR Standard Drawings and the following QR documents:

- MCE-SR-001 Queensland Railways – *Requirements for the Design of Road Overbridges*
- MCE-SR-006 Queensland Railways – *Requirements for the Design of Footbridges*
- MCE-SR-007 Queensland Railways – *Design and Selection Criteria for Road/Rail Interface Barriers*
- MCE-SR-012 Queensland Railways – *Railway Track Clearances*
- MCE-SR-015 Queensland Railways – *Protection of Supporting Elements Adjacent to Railways.*

In regards to barrier design, MCE-SR-007 is the overriding document.

After determining the rail status and road class, use MCE-SR-007, Table 5 – *Road Bridge over Railway Barrier Selection* to select the appropriate barrier type and height.

The barrier must also comply with MCE-SR-007, *Appendix 3 Barrier Transitions Road Bridge over Railway Corridor*.

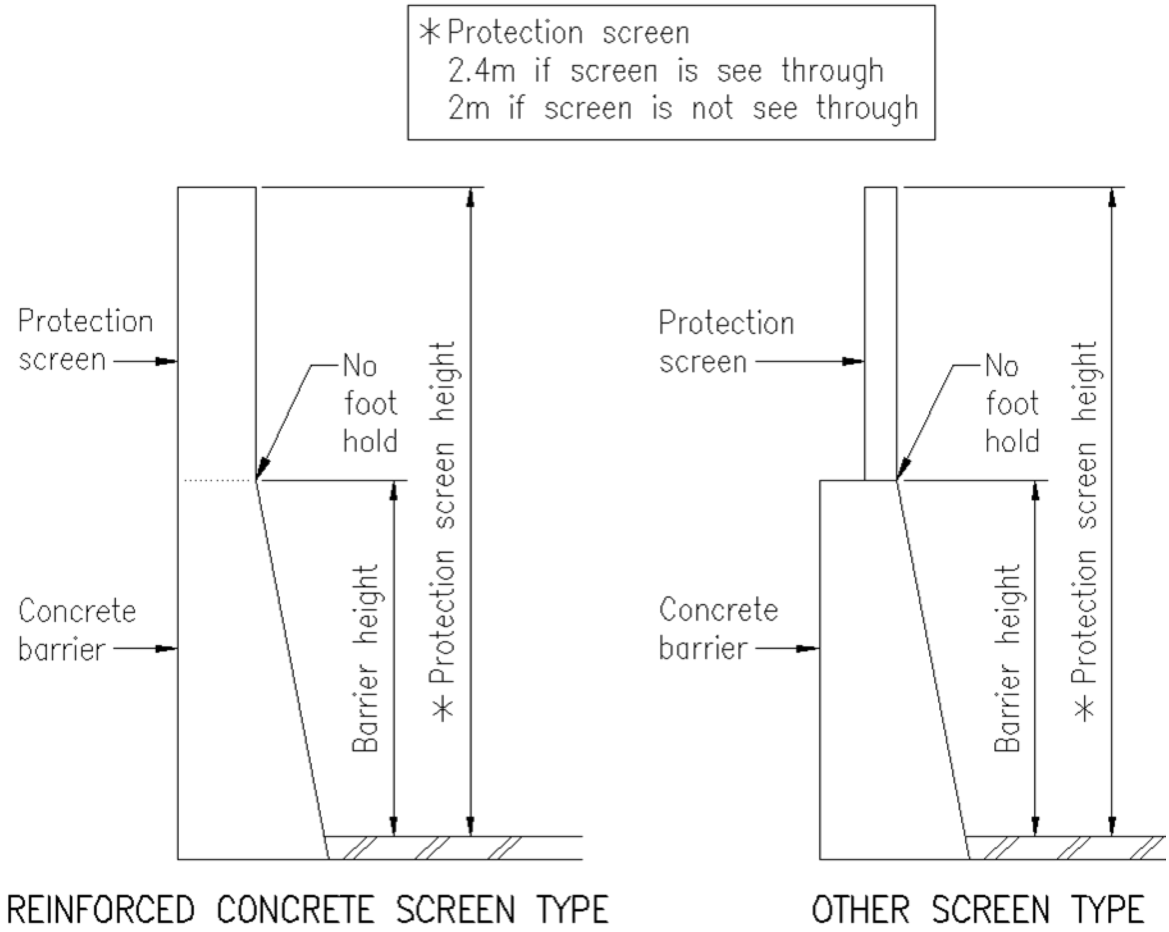
Design Criteria for Barriers on Bridges over QR Railway that are not Electrified

Some important design criteria include the following:

- Bridge barrier type must be concrete barrier to prevent debris falling into the rail corridor.
- The concrete barrier will be 1.1 m or 1.5 m high depending on the performance level. The barrier shall transition to full height at one on 10.
- Protection screens are required on top of the concrete barrier.
- If the protection screen is not see through, the top of the screen shall be 2 m minimum above the road surface. The screen can be either additional concrete cast on top of the barrier or steel made from an approved product such as plate, welded wire mesh, perforated sheet of louvre mesh. Note that louvre mesh is considered see through and shall be orientated so that a person standing on the bridge looking through the openings will see the sky rather than the ground.
- If the protection screen is see through, the top of the screen shall be 2.4 m minimum above the road surface. The screen can be either additional concrete cast on top of the barrier or steel plate.
- The concrete barrier and protection screen shall be smooth faced so as not to be readily climbable.
- The protection screen shall extend at full height for a minimum of 3 m (horizontally) either side of the track centre line on both sides of the bridge.

Refer Figure 19.11-1 *Typical Barriers (Non Electrified Railway).*

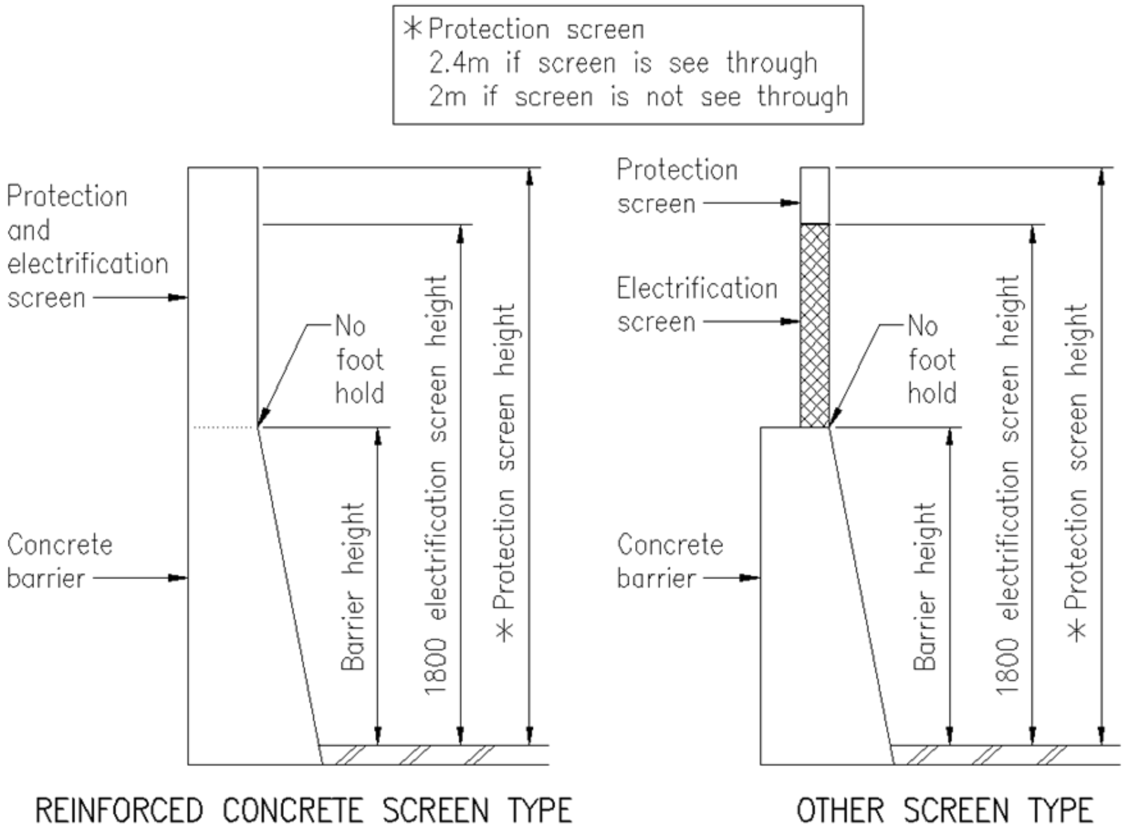
Figure 19.11-1 Typical Barriers (Non Electrified Railway)



Additional Design Criteria for Barriers on Bridges over QR Railway that is Electrified

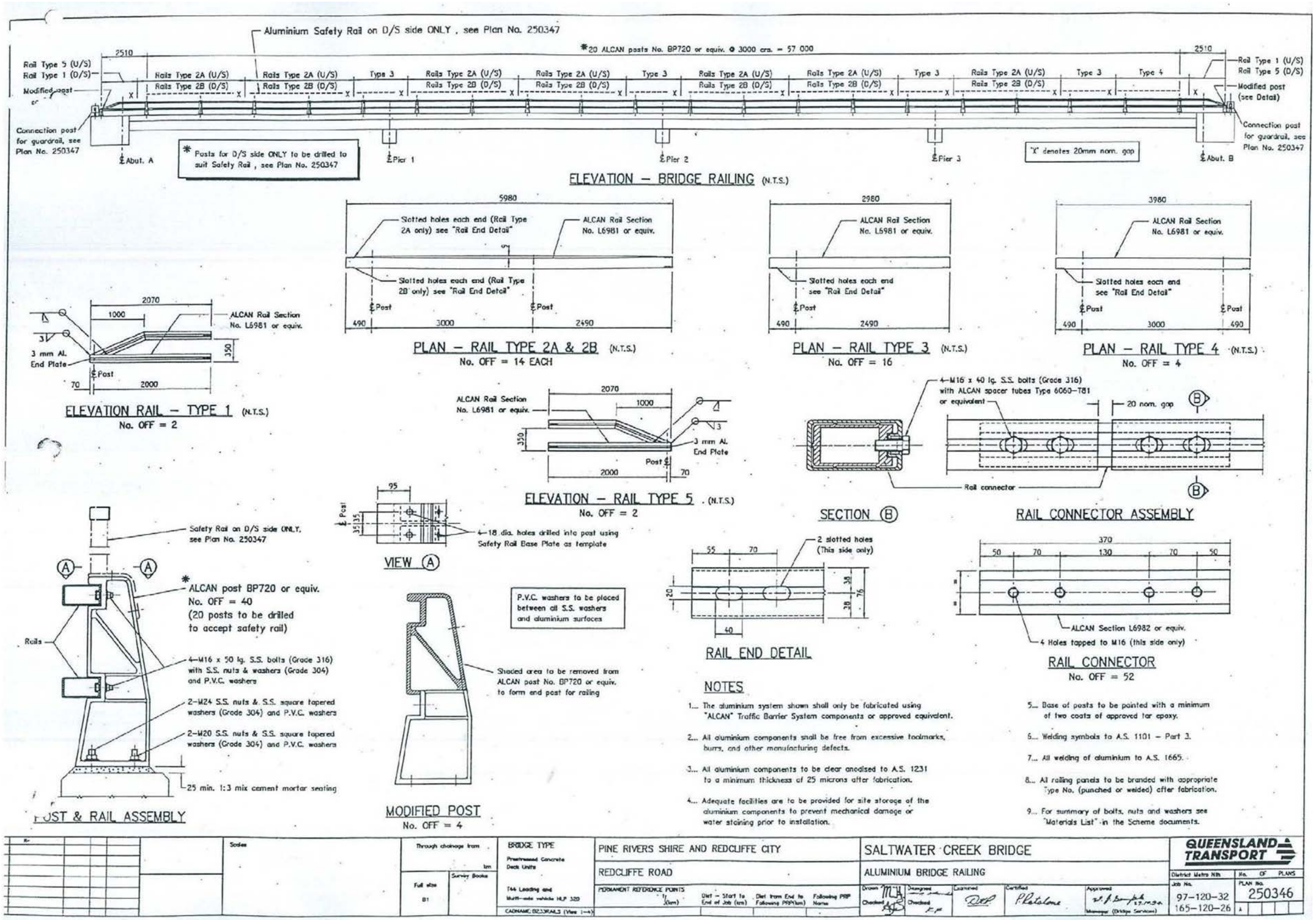
Railway that is electrified requires special electrification screening 1.8 m minimum in height. Electrification screening has smaller allowable openings than protection screening. The electrification screen shall extend at full height for a minimum of 3 m (horizontally) either side of the track centre line and/or overhead line equipment on both sides of the bridge. Refer Figure 19.11-2 *Typical Barriers (Electrified Railway).*

Figure 19.11-2 Typical Barriers (Electrified Railway)



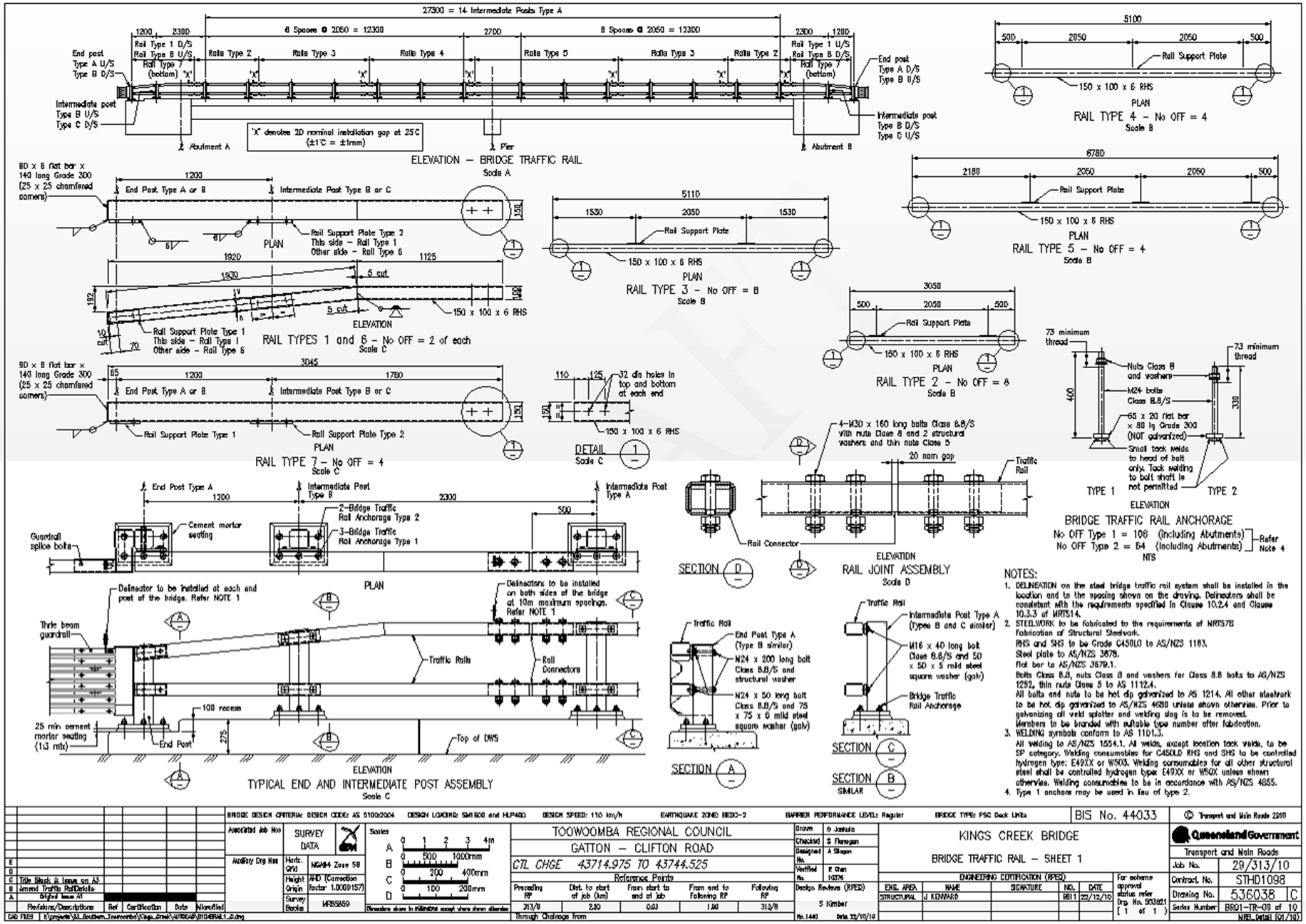
Appendix A – Example Aluminum Bridge Traffic Barrier Drawing

Appendix A – Example Aluminum Bridge Traffic Barrier Drawing

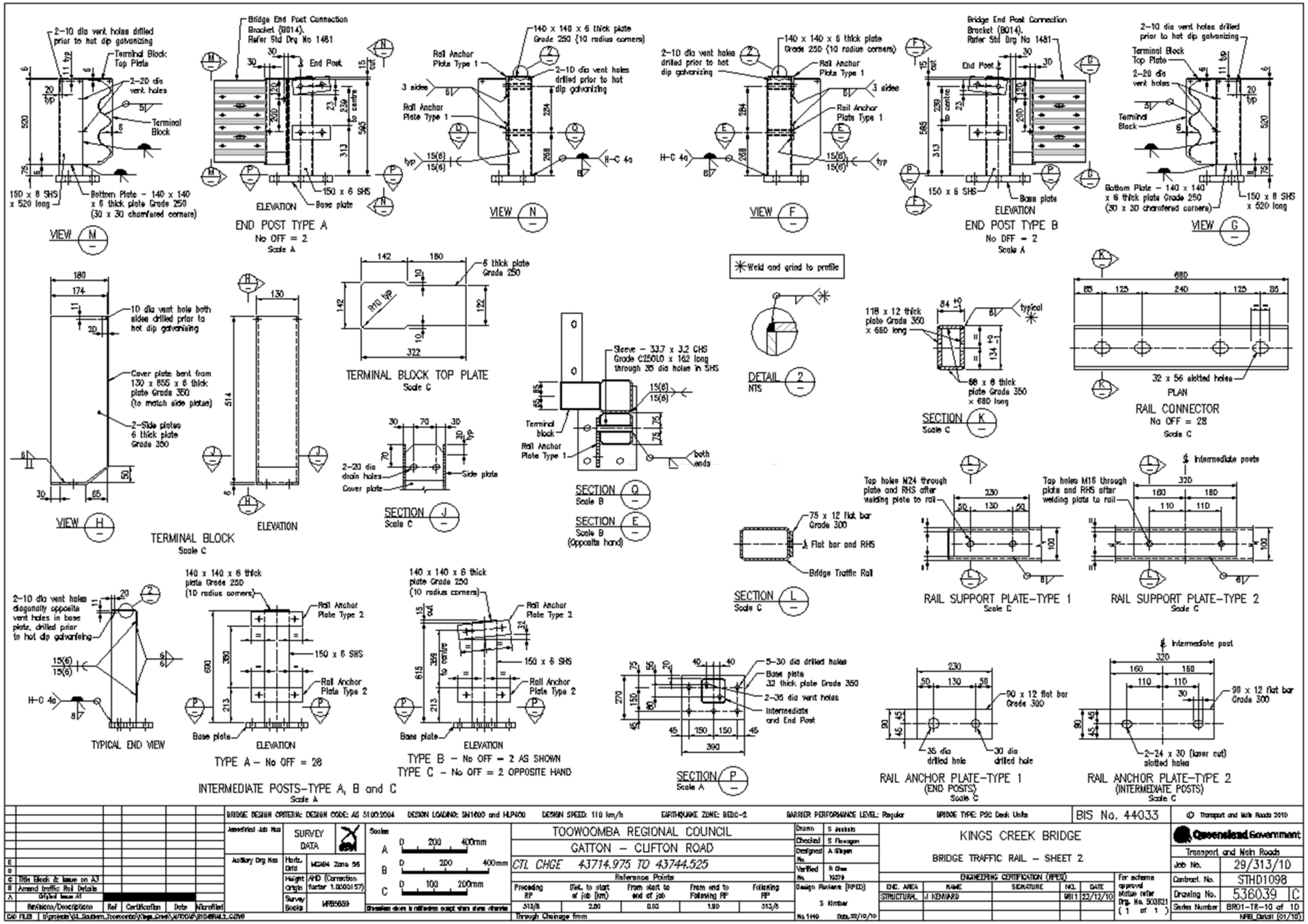


Appendix B – Example Steel Bridge Traffic Barrier Drawings

Appendix B – Example Steel Bridge Traffic Barrier Drawings – Sheet 1

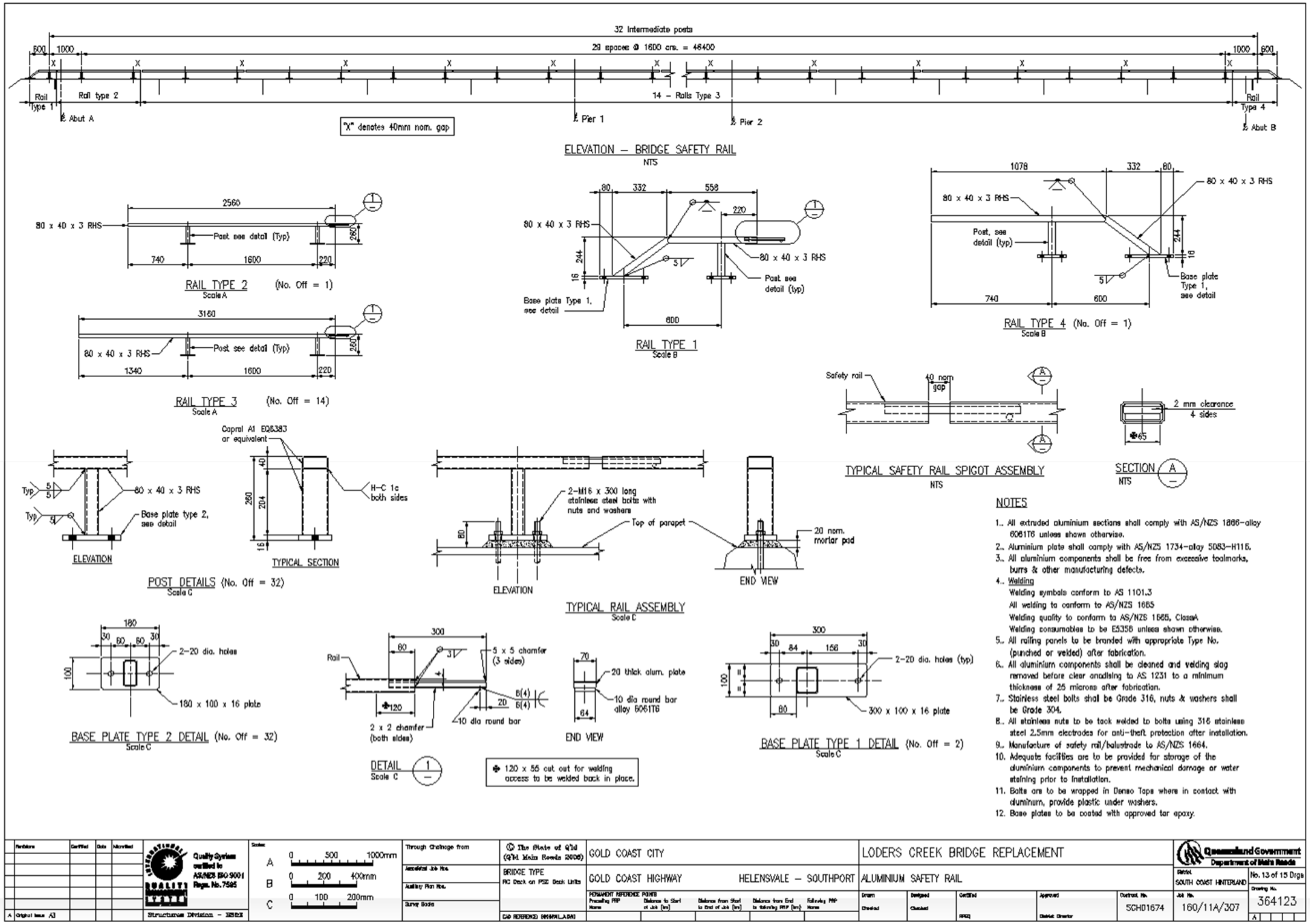


Appendix B – Steel Bridge Traffic Barrier – Sheet 2



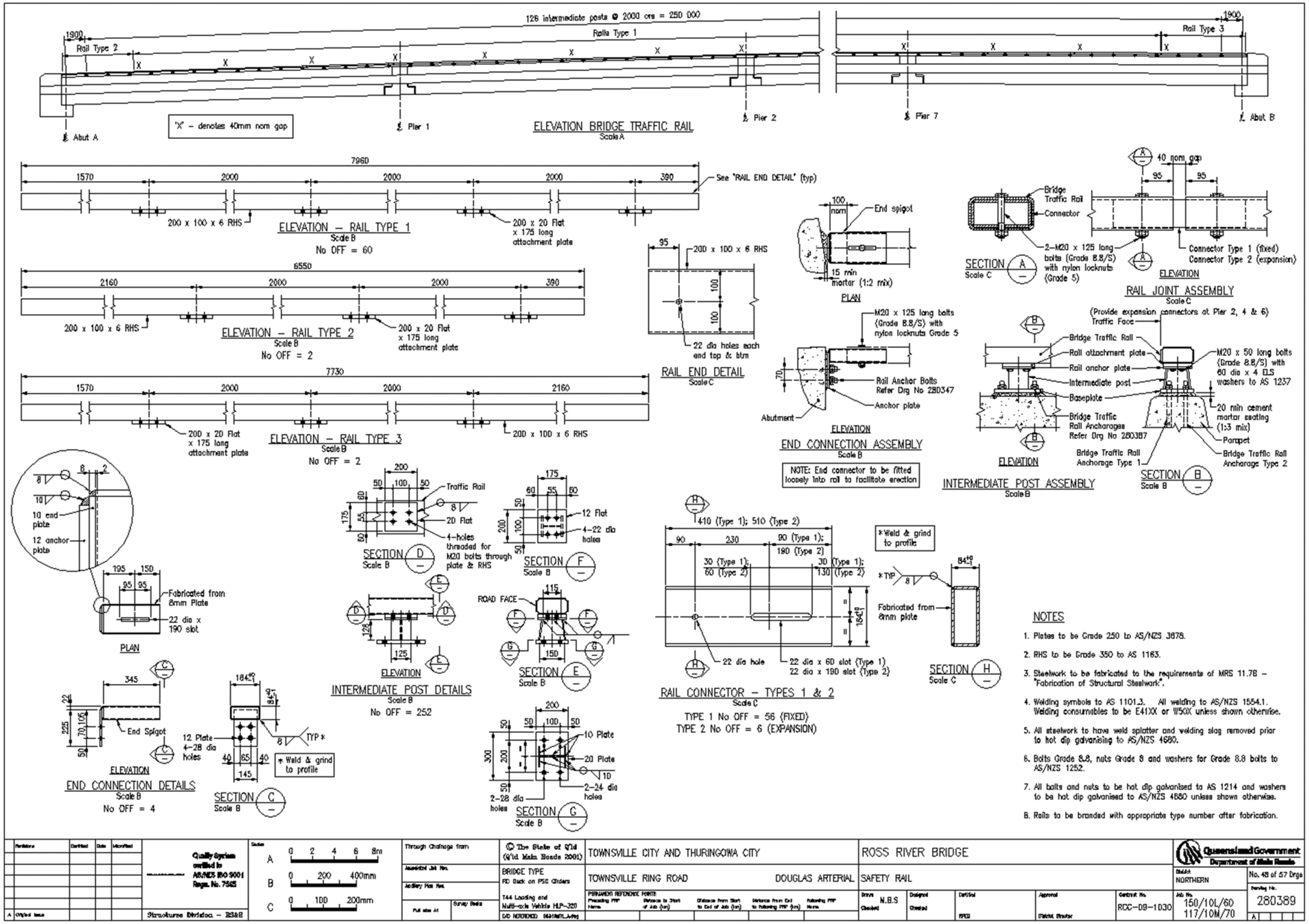
Appendix C – Example Aluminium Bridge Safety Barrier Drawing

Appendix C – Aluminium Bridge Safety Barrier Drawing



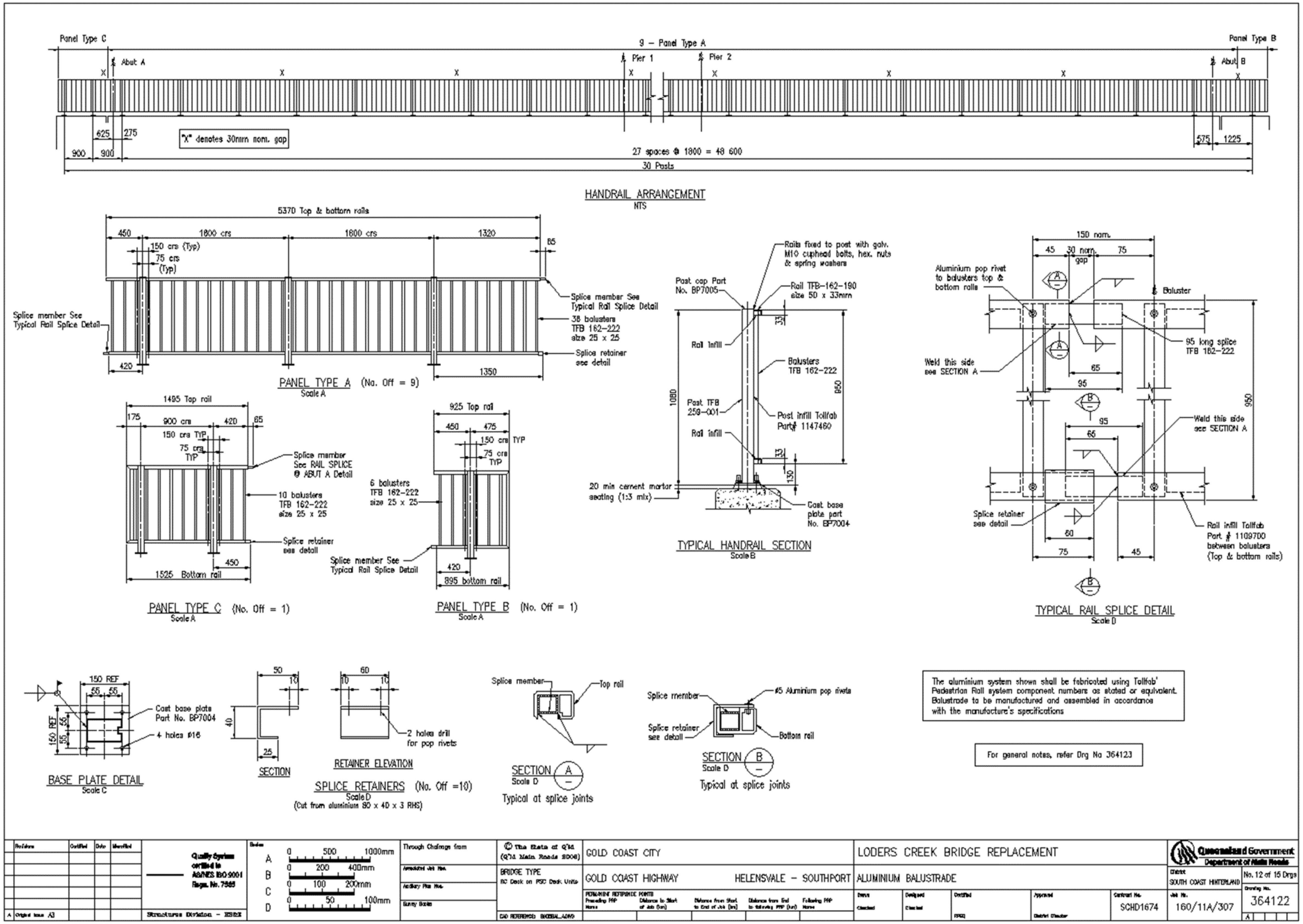
Appendix D – Example Steel Bridge Safety Barrier Drawing

Appendix D – Example Steel Bridge Safety Barrier Drawing



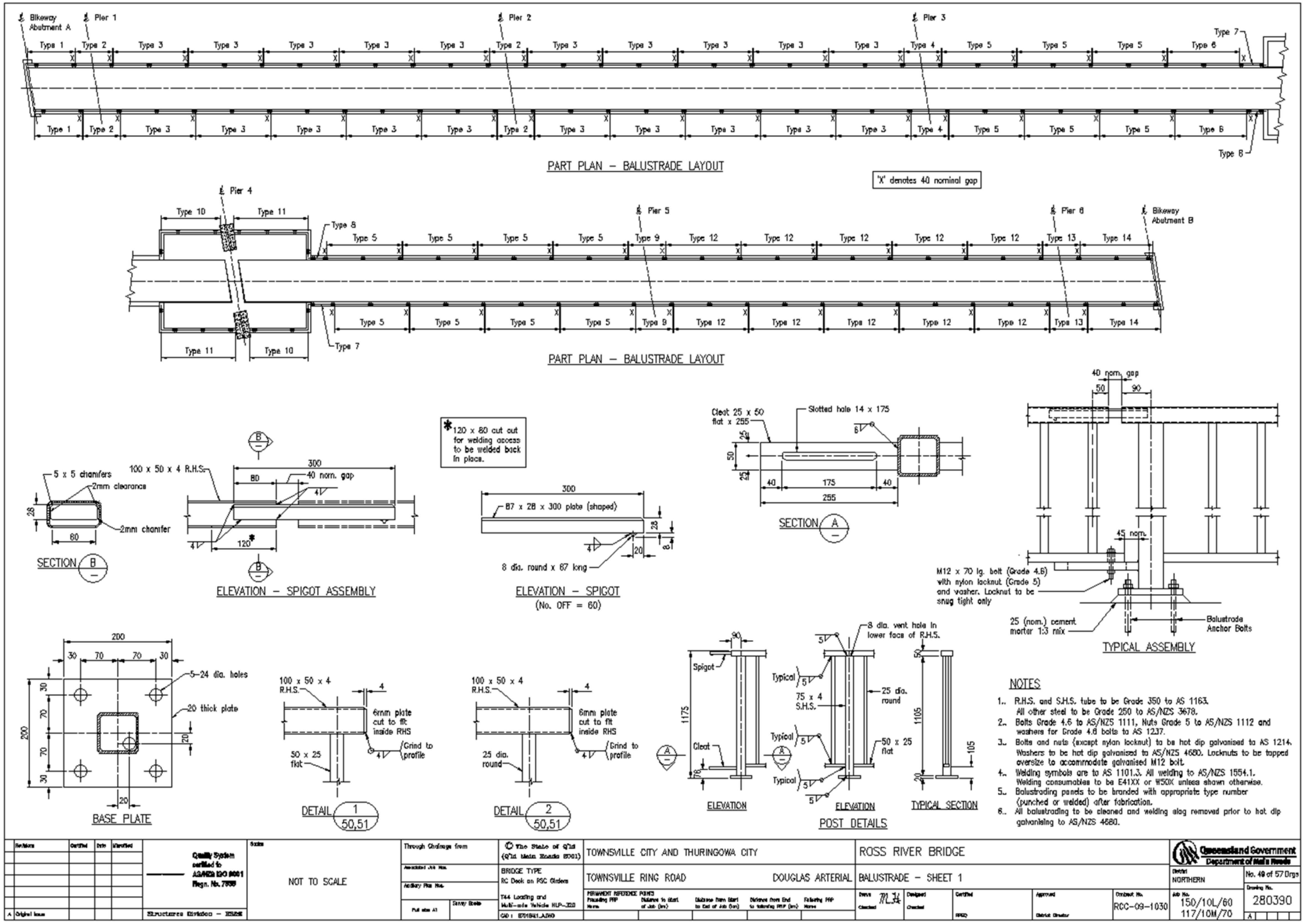
Appendix E – Example Aluminium Bridge Balustrade Drawing

Appendix E – Example Aluminium Bridge Balustrade Drawing

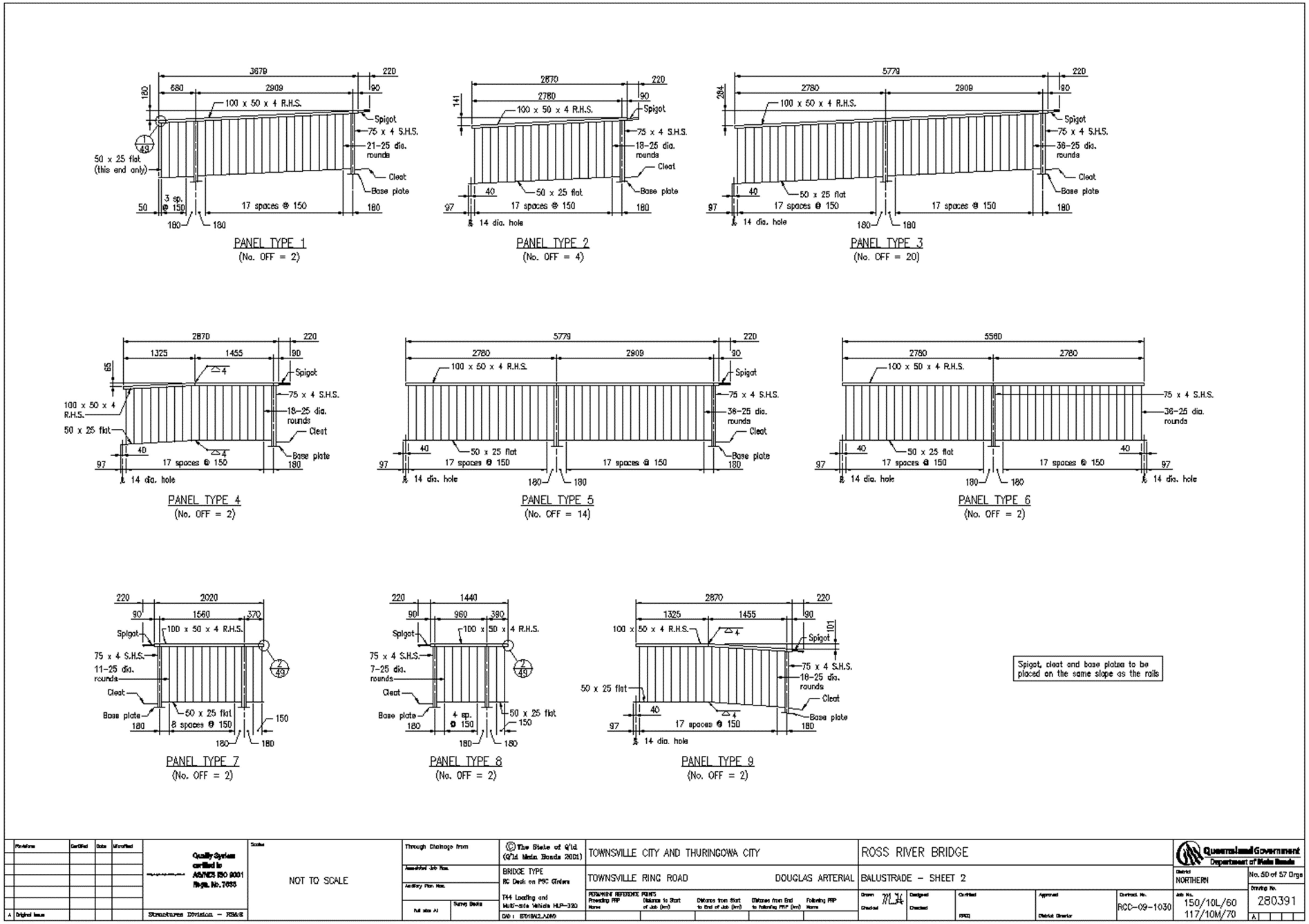


Appendix F – Example Steel Bridge Balustrade Drawing

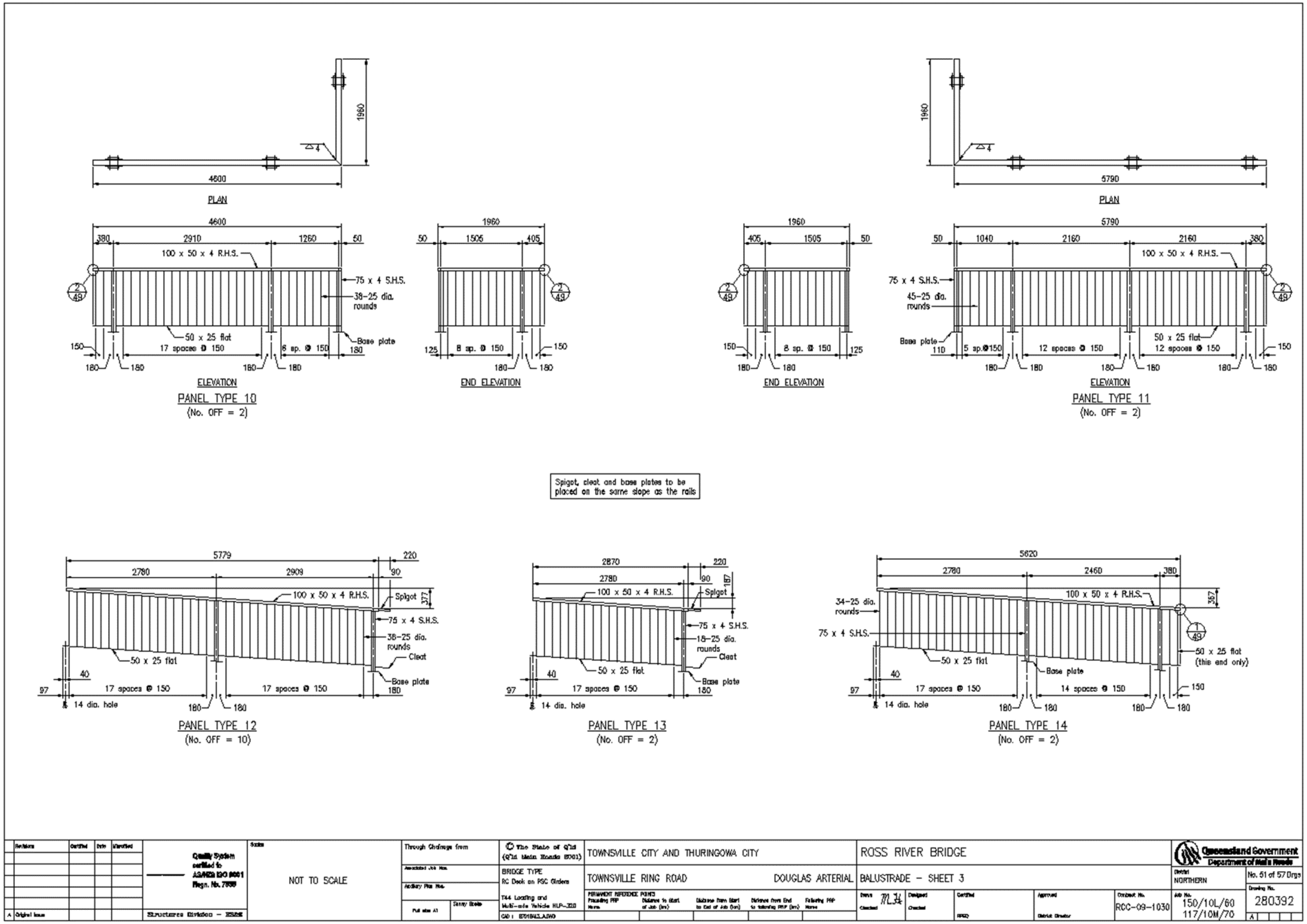
Appendix F – Example Steel Bridge Balustrade Drawing – Sheet 1



Appendix F – Example Steel Bridge Balustrade Drawing – Sheet 2

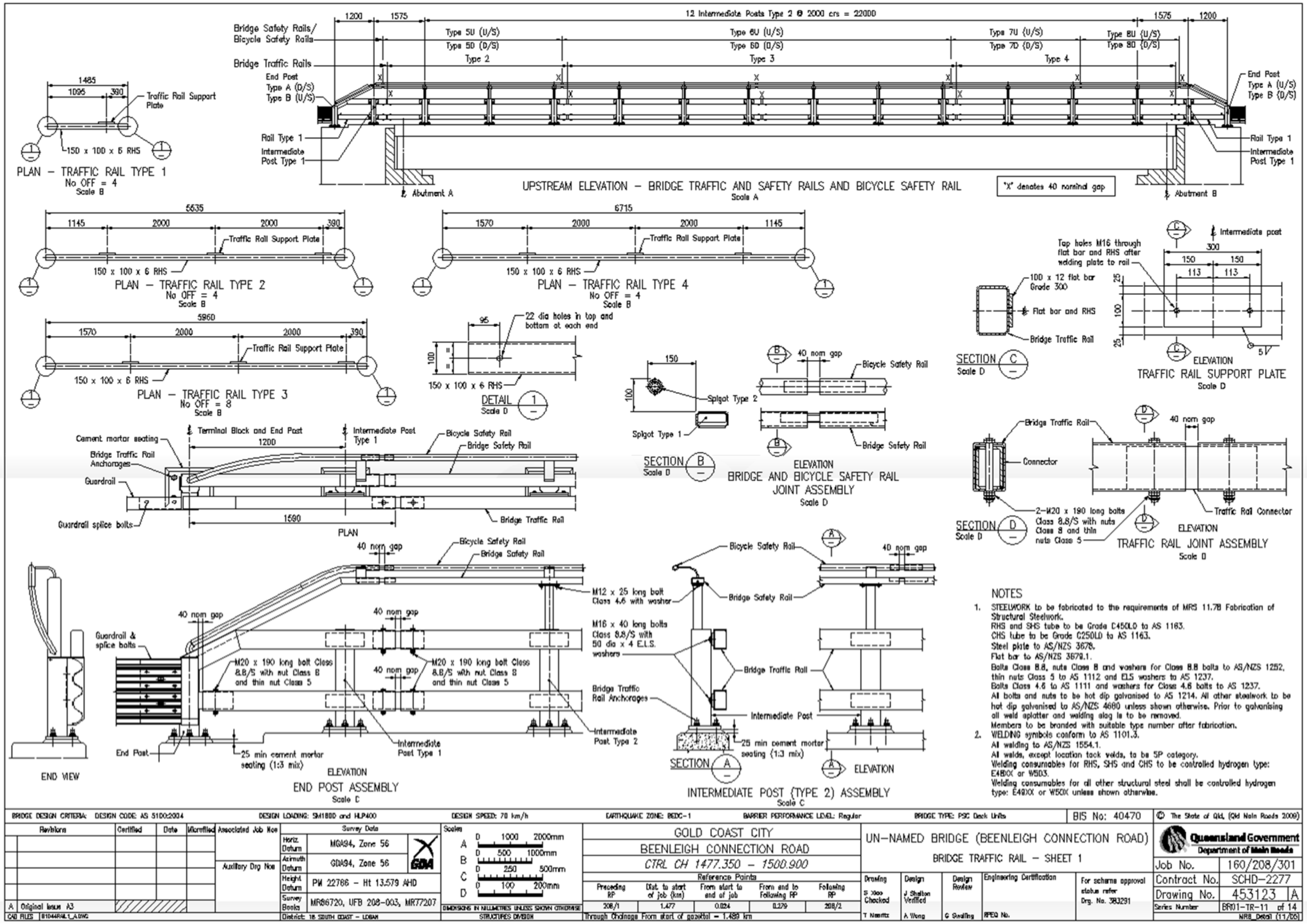


Appendix F – Example Steel Bridge Balustrade Drawing – Sheet 3

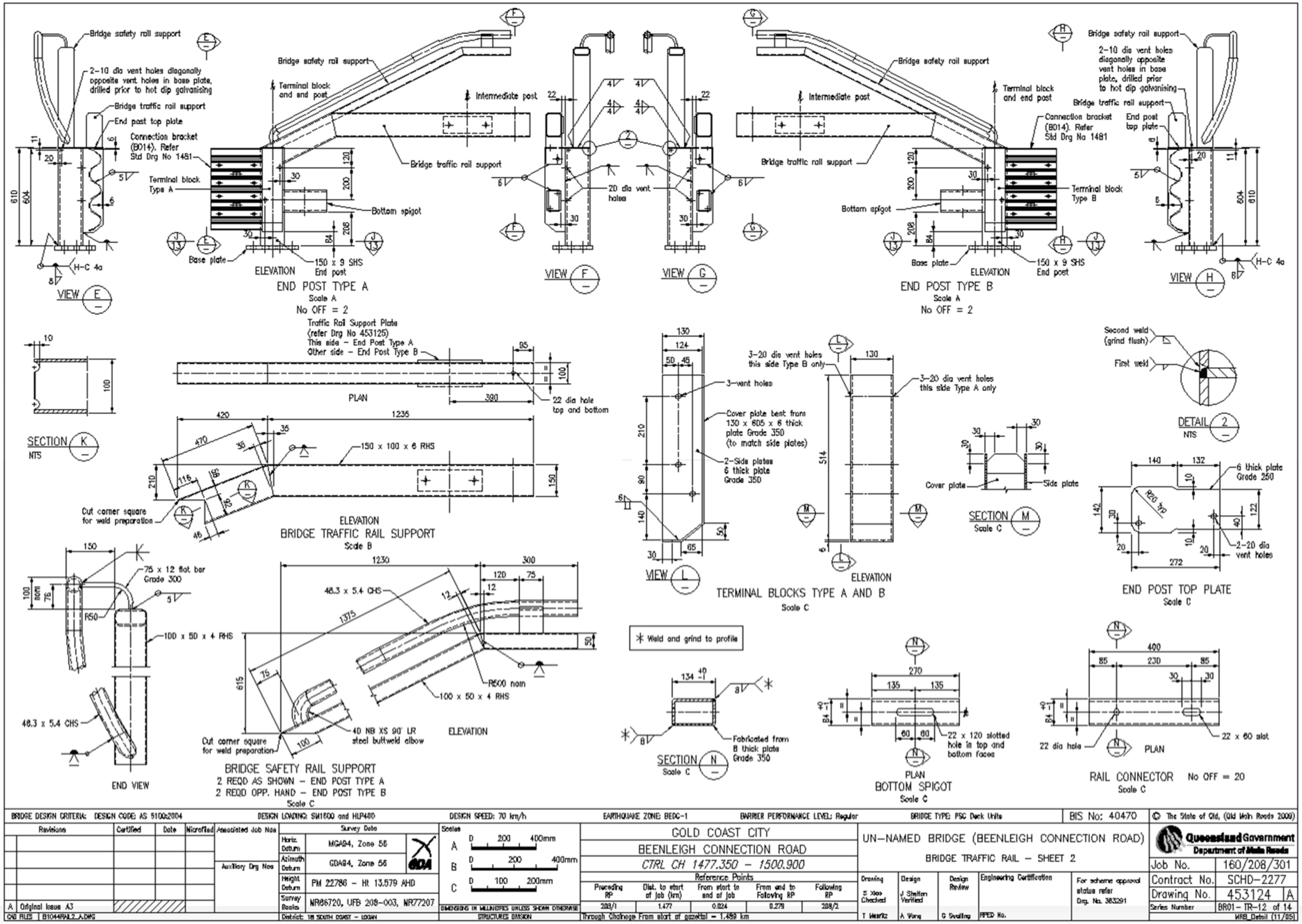


Appendix G – Example Steel Bridge Traffic Barrier with Bicycle Safety Rail Drawing

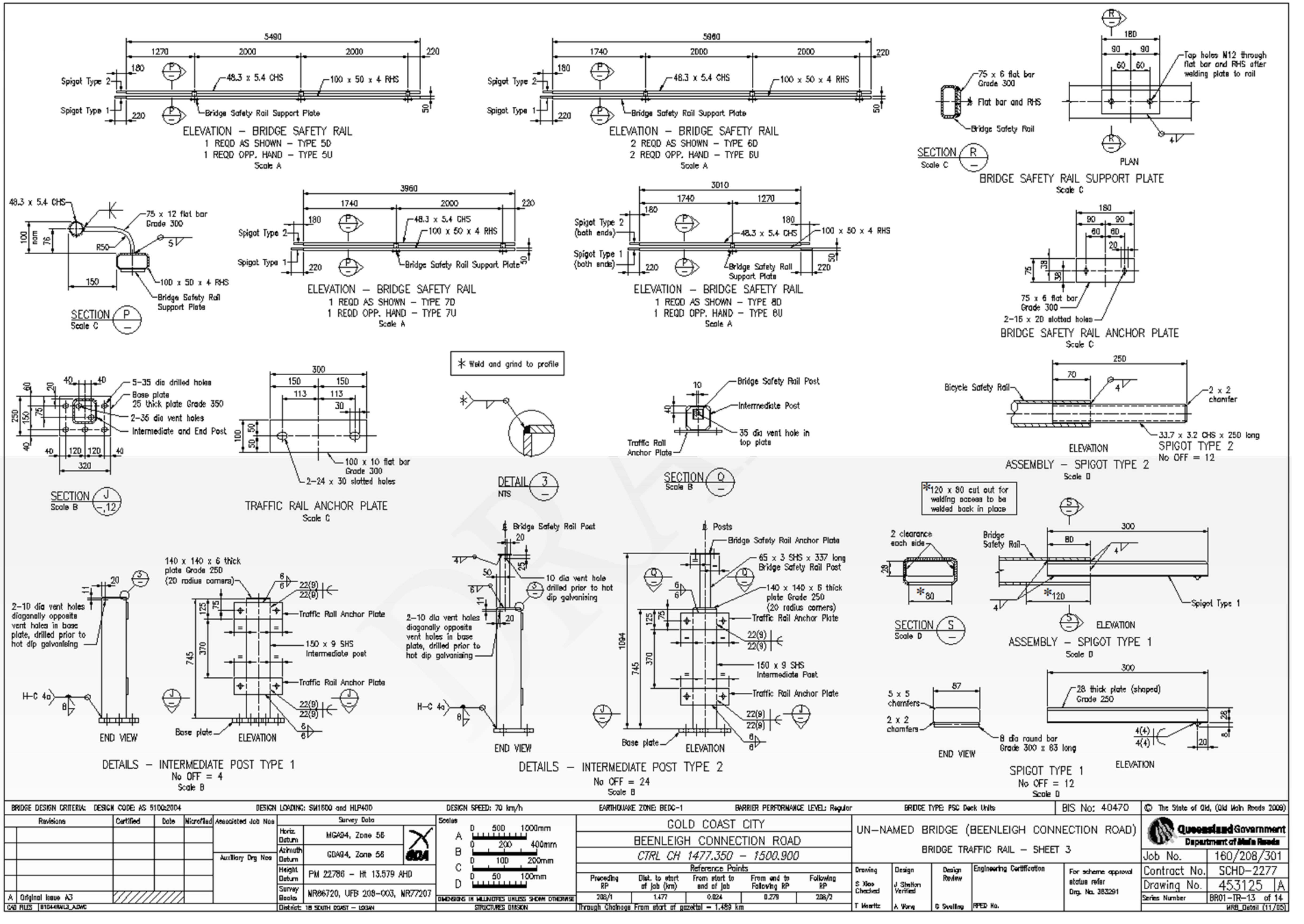
Appendix G – Example Steel Bridge Traffic Barrier with Bicycle Safety Rail Drawing – Sheet 1



Appendix G – Example Steel Bridge Traffic Barrier with Bicycle Safety Rail Drawing – Sheet 2

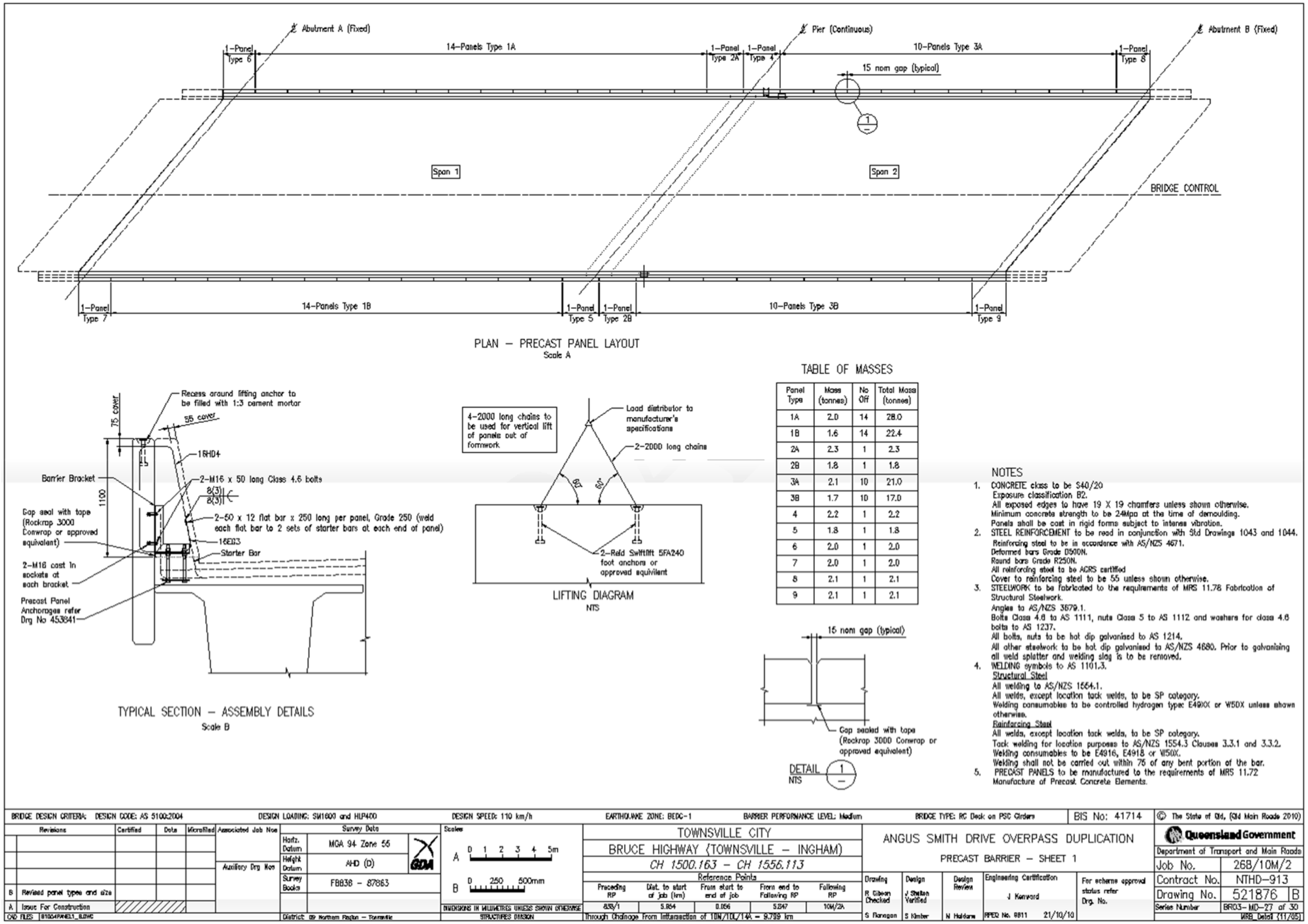


Appendix G – Example Steel Bridge Traffic Barrier with Bicycle Safety Rail Drawing – Sheet 3

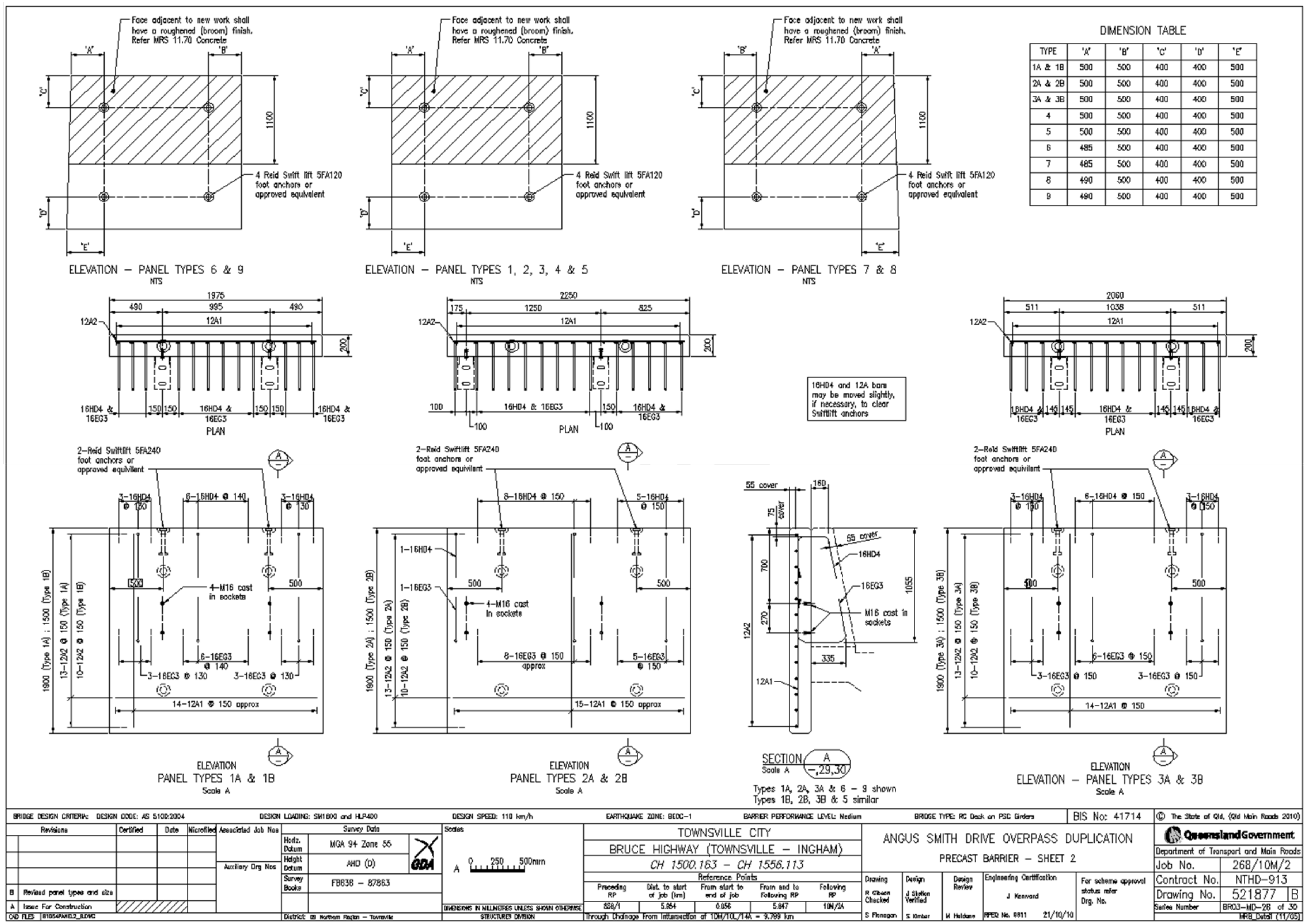


Appendix H – Example Precast Barrier Panel and Deck Drawings

Appendix H – Example Precast Barrier Panel and Deck Drawings – Sheet 1

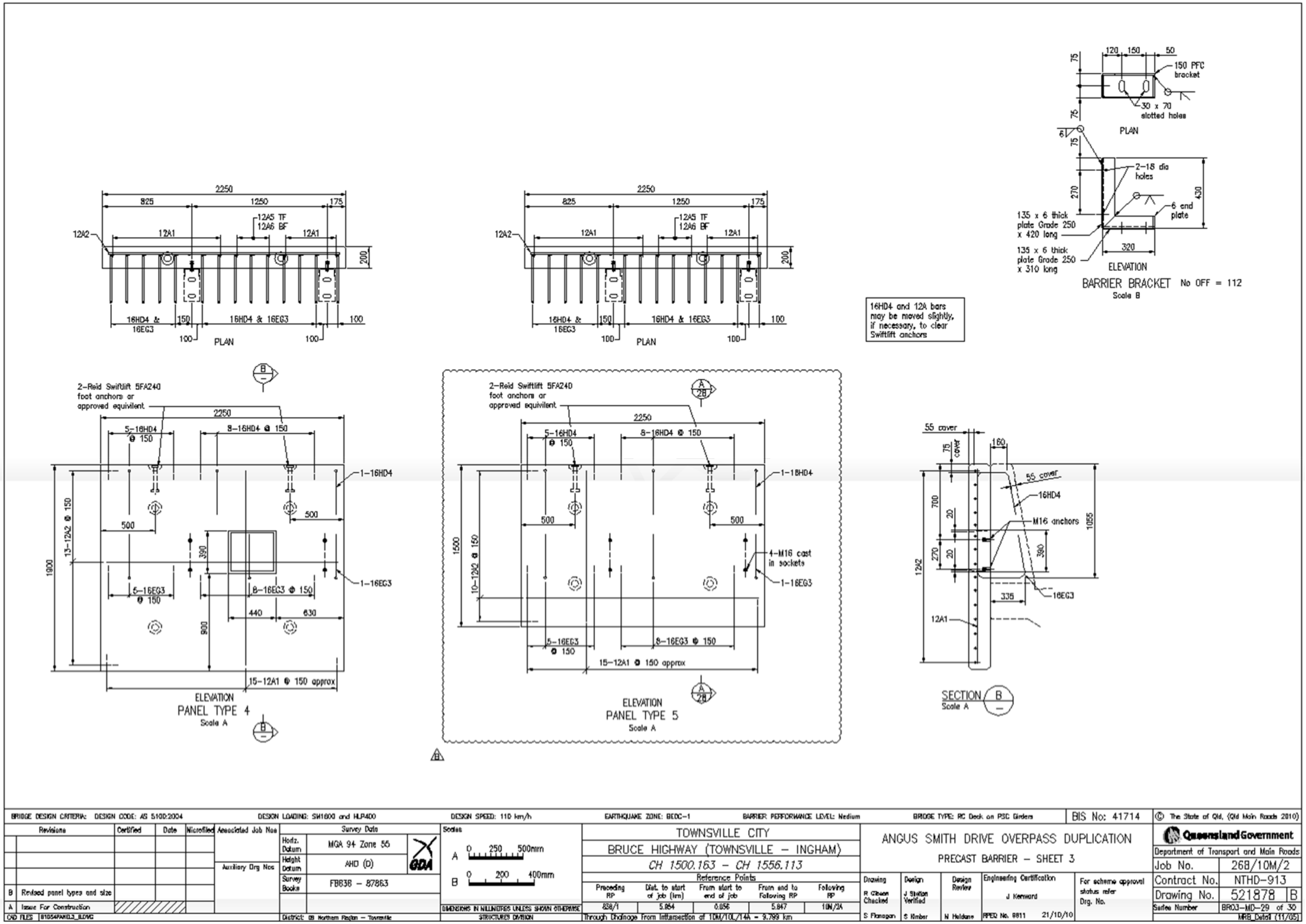


Appendix H – Example Precast Barrier Panel and Deck Drawings – Sheet 2

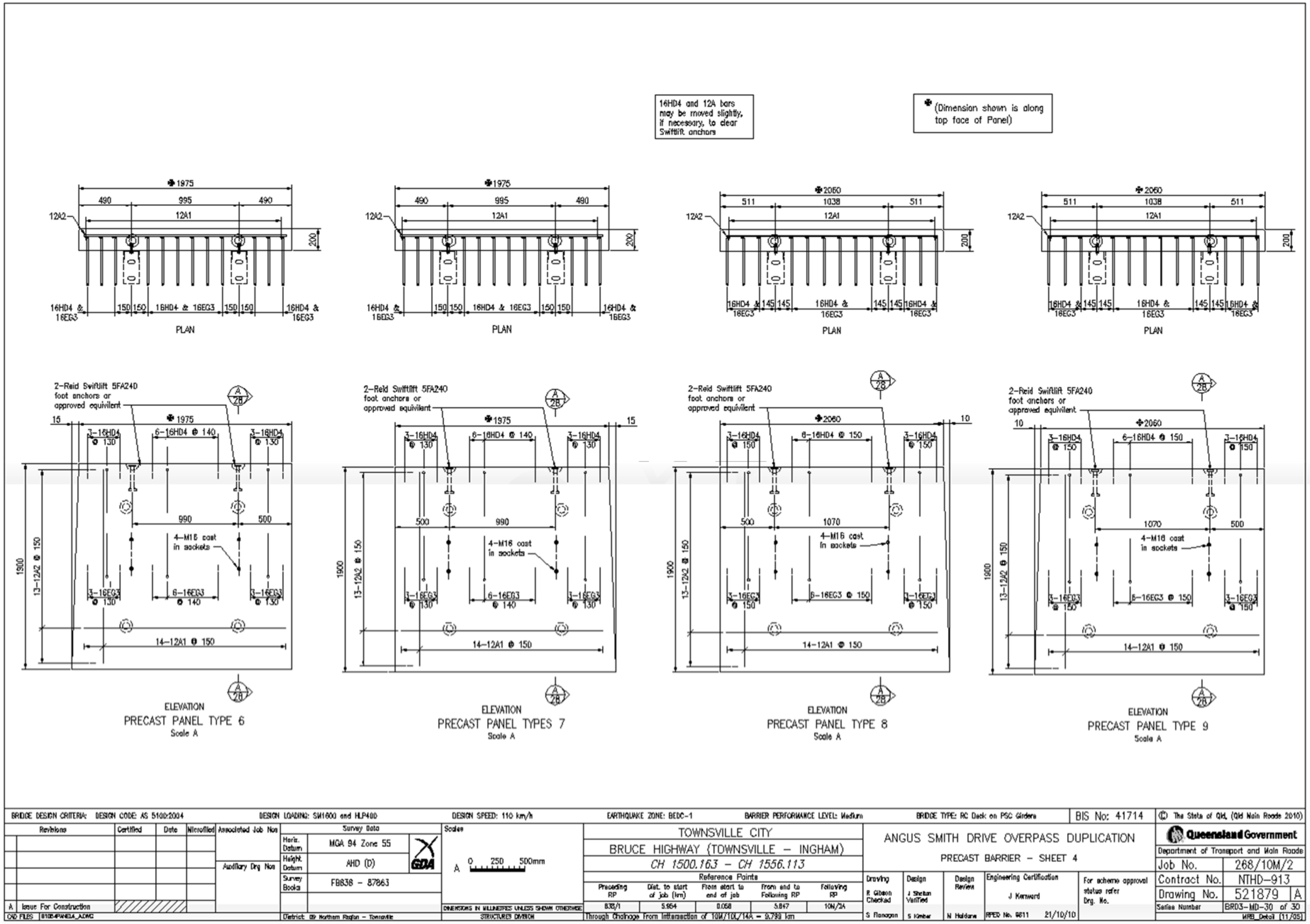


TYPE	'A'	'B'	'C'	'D'	'E'
1A & 1B	500	500	400	400	500
2A & 2B	500	500	400	400	500
3A & 3B	500	500	400	400	500
4	500	500	400	400	500
5	500	500	400	400	500
6	485	500	400	400	500
7	485	500	400	400	500
8	490	500	400	400	500
9	490	500	400	400	500

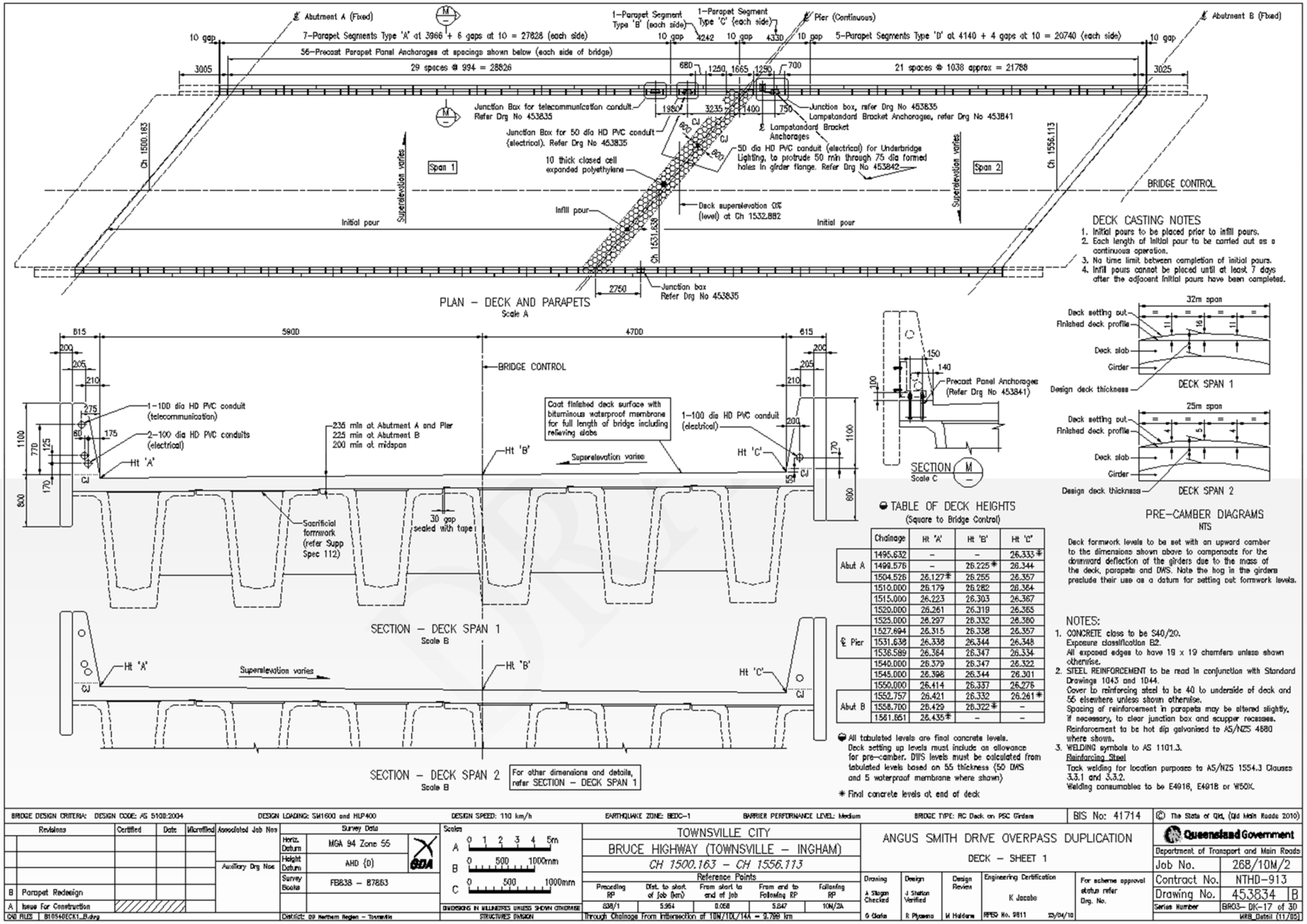
Appendix H – Example Precast Barrier Panel and Deck Drawings – Sheet 3



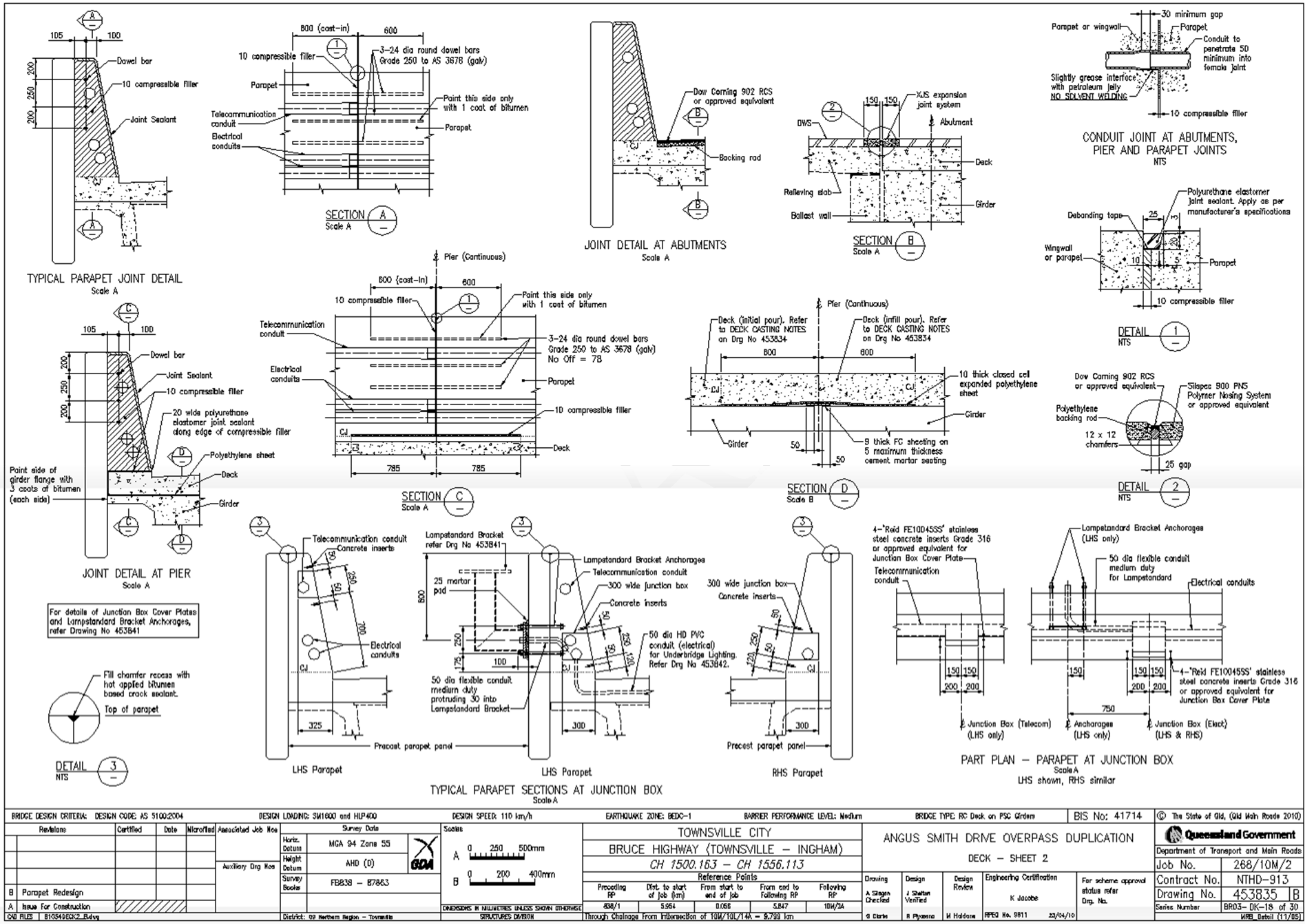
Appendix H – Example Precast Barrier Panel and Deck Drawings – Sheet 4



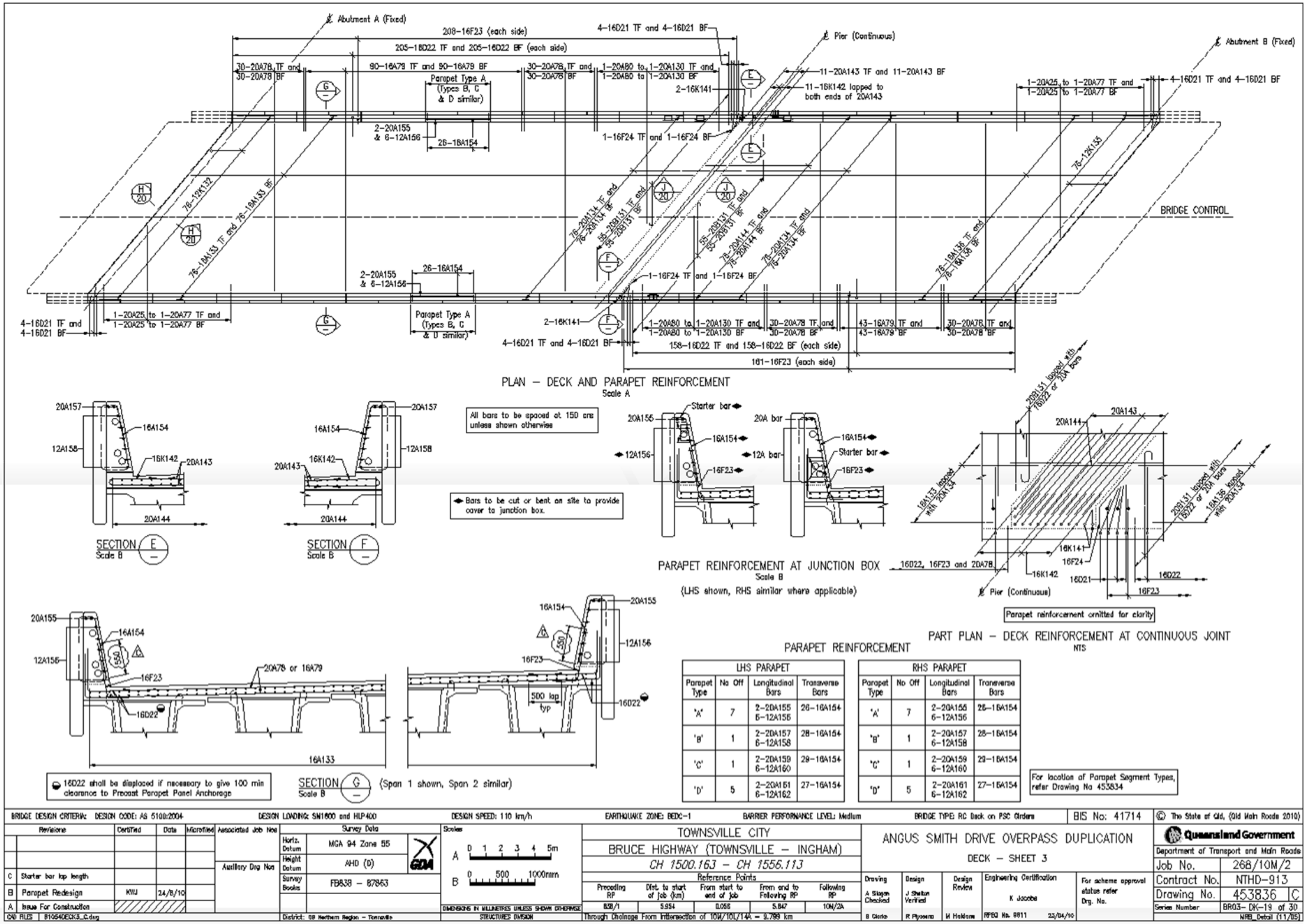
Appendix H – Example Precast Barrier Panel and Deck Drawings – Sheet 5



Appendix H – Example Precast Barrier Panel and Deck Drawings – Sheet 6

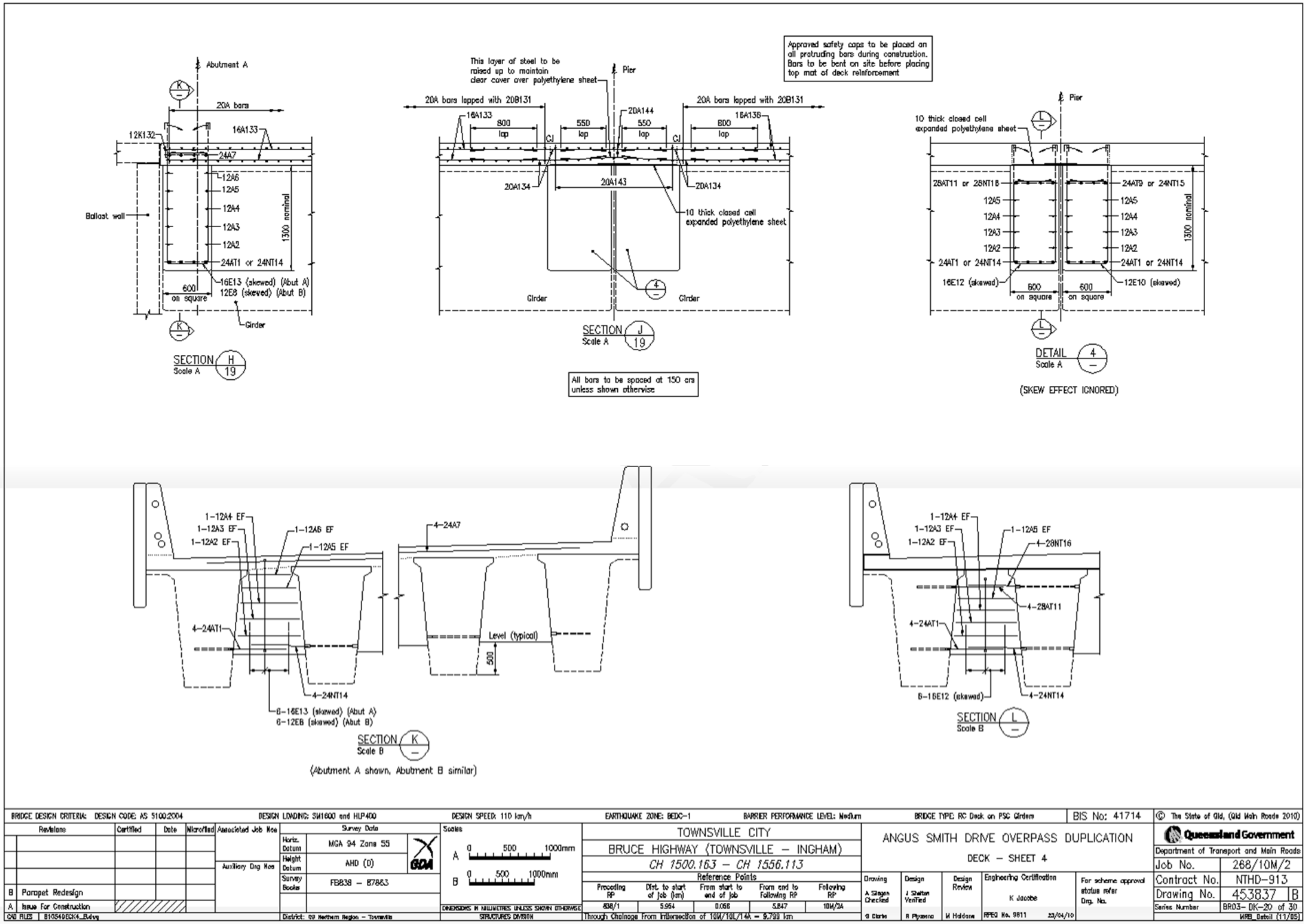


Appendix H – Example Precast Barrier Panel and Deck Drawings – Sheet 7



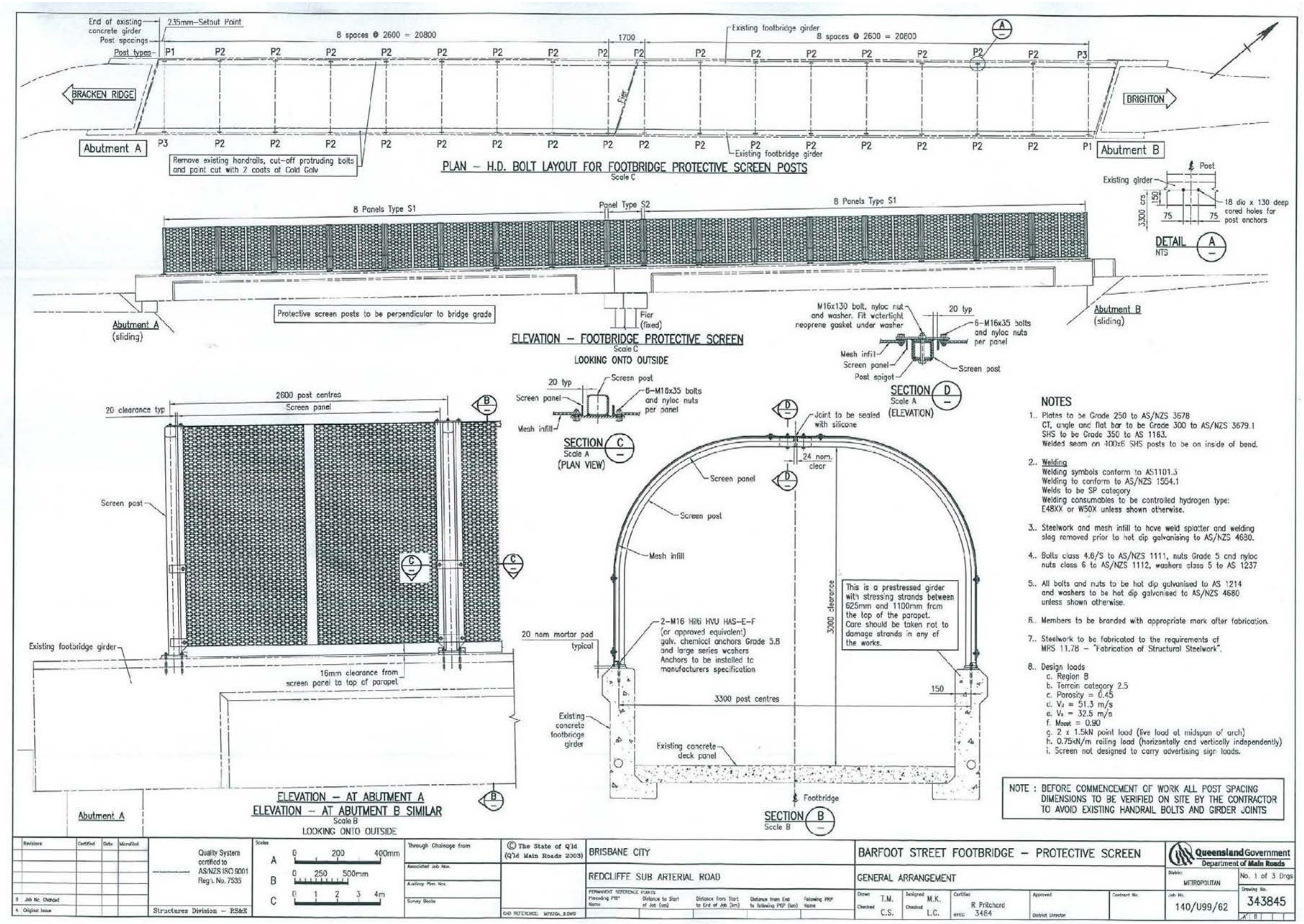
LHS PARAPET				RHS PARAPET			
Parapet Type	No Off	Longitudinal Bars	Transverse Bars	Parapet Type	No Off	Longitudinal Bars	Transverse Bars
'A'	7	2-20A155 6-12A156	26-16A154	'A'	7	2-20A155 6-12A156	26-16A154
'B'	1	2-20A157 6-12A158	28-16A154	'B'	1	2-20A157 6-12A158	28-16A154
'C'	1	2-20A159 6-12A160	29-16A154	'C'	1	2-20A159 6-12A160	29-16A154
'D'	5	2-20A161 6-12A162	27-16A154	'D'	5	2-20A161 6-12A162	27-16A154

Appendix H – Example Precast Barrier Panel and Deck Drawings – Sheet 8

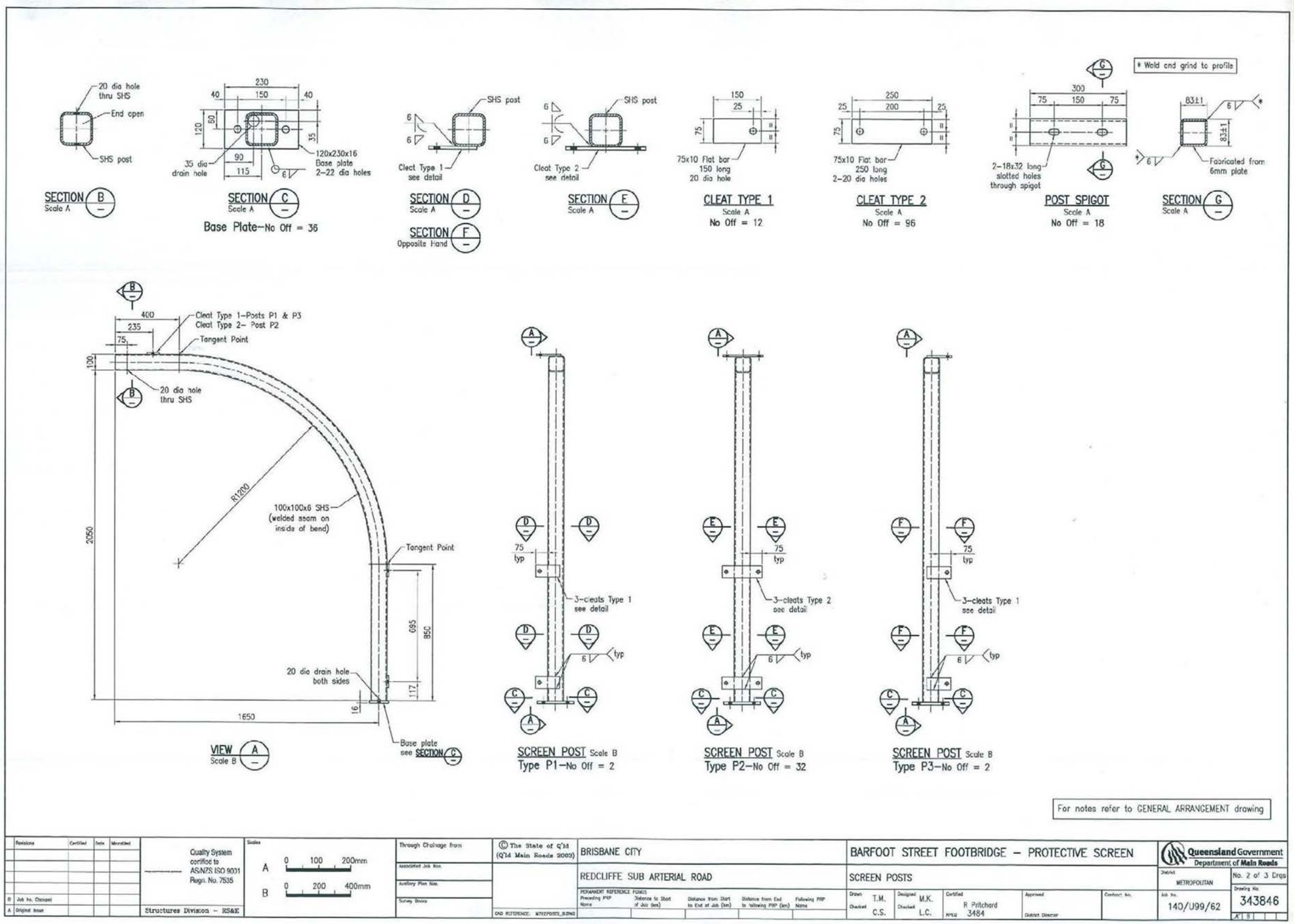


Appendix I – Example Protection Screen Drawings

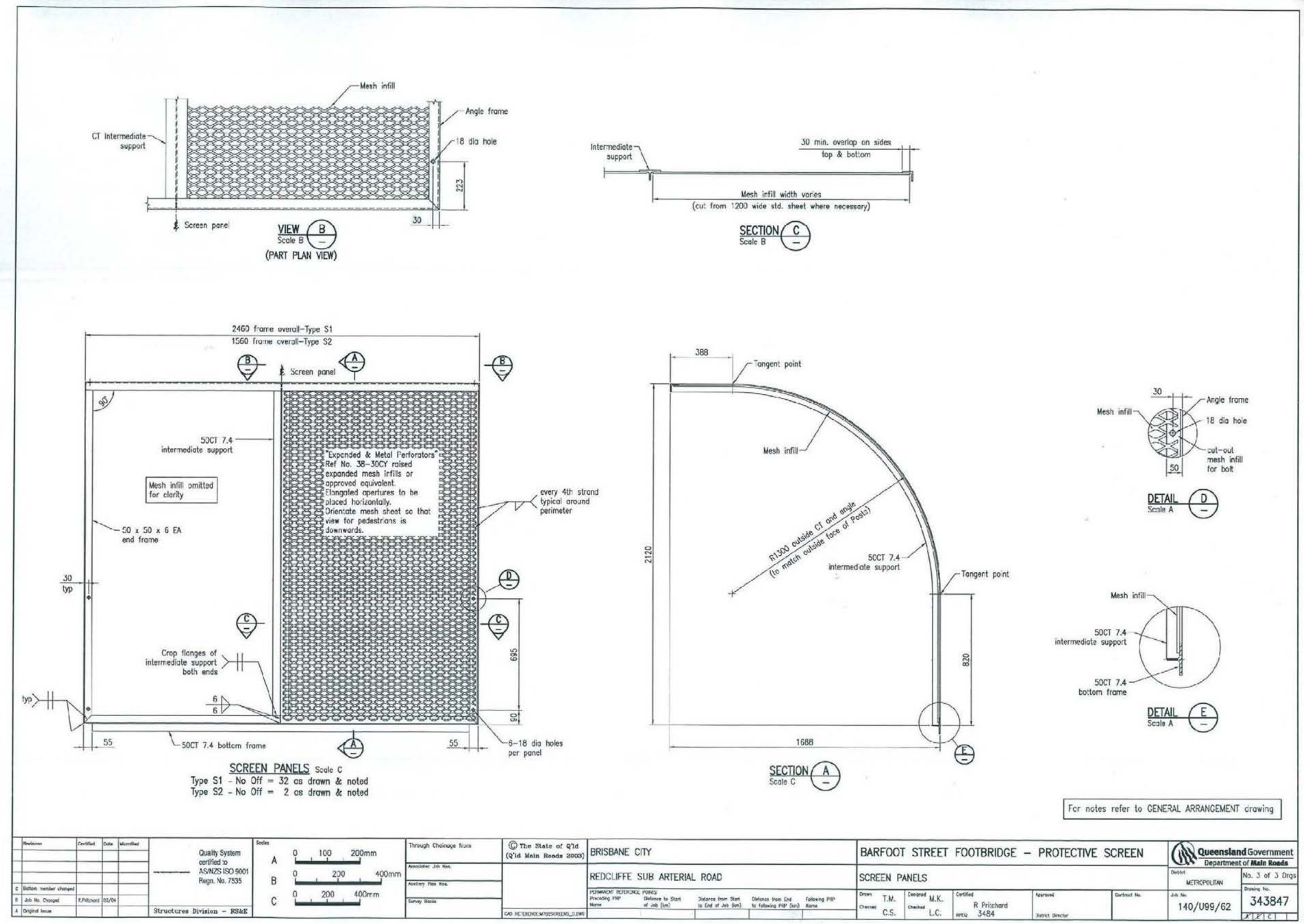
Appendix I – Example Protection Screen Drawings – Sheet 1



Appendix I – Example Protection Screen Drawings – Sheet 2



Appendix I – Example Protection Screen Drawings – Sheet 3



Drafting and Design Presentation Standards
Volume 3: Structural Drafting Standards

Chapter 20: Electronic Project Model (EPM)

December 2020

Queensland Government

Translating and interpreting assistance

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Chapter 20 Amendments

Revision register

Issue/Rev No.	Reference Section	Description of Revision	Authorised by	Date
1	–	First Issue.	Manager (Structural Drafting)	April 2011
2	–	Document name change.	Manager (Structural Drafting)	Nov 2011
3	–	General review	Team Leader (Structural Drafting)	Dec 2020

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20 Electronic Project Model (EPM)

20.1 Glossary of terms

For a complete glossary of terms refer Chapter 1 – *Introduction.*

20.2 Figures and examples shown in this volume

The figures and examples shown in this volume are for presentation purposes only, and may contain some details that are now superseded. These details have been included for ease of reference, to illustrate typical solutions, and to show the required standard of drafting presentation. The details are not to be used without an engineering check and certification by a Structural RPEQ to confirm that the details are appropriate for the specific project.

20.3 Introduction

This procedure outlines the method to produce 3D Electronic Project Models (EPMs) which are used by surveyors to set out bridges during construction. An EPM is an electronic drawing showing reference points on the bridge from where construction shall be set out.

Whilst this chapter describes outcomes based on the use of Autocad software it is recognised that projects developed using alternative software will also be used.

20.4 File Format

The file is to be supplied in AutoCAD format. This file can be imported into any civil / survey software package that the end user may have, for example, 12D, Terramodel and so on.

20.5 Coordinates and Drawing Units

All points shall be given an X, Y and Z coordinate value. All points are to be drawn in project coordinates (Real World Coordinates as termed in AutoCAD).

Drawing units for the EPM are to be in metres.

20.6 File Name

The file name of the EPM shall be *EXAMPLE_EPM_A.dwg* where *EXAMPLE* is the name of the bridge and *A* is the revision letter.

20.7 Title Block and Revision Details

The Project Name, Job No, Region and date of original issue (Revision A) are to be completed in the title block. The title block shall be drawn in ‘paper space’ in AutoCAD.

Each time a revision is made to the bridge design that affects the EPM, a new revision of the EPM is created and thus details of the revision need to be recorded.

Refer Figure 20.7-1 Title Block.

Figure 20.7-1 Title Block

```
Project Name: EXAMPLE CREEK BRIDGE
Job No: 123/456/789
District: NORTHERN
Datum: GDA94

************************************************************************
IMPORTANT NOTE : PLEASE READ

The data contained in this EPM (electronic
project model) is to be read in conjuction
with the information supplied on the drawings

************************************************************************

ELECTRONIC REVISION BLOCK FOR THE EPM
* REVISION *      DATE      * DESCRIPTION / REASON FOR REVISION *
*    A     * 1 APRIL 2007 * ORIGINAL ISSUE
*    B     *              *
************************************************************************

************************************************************************
******** Dept of Transport & Main Roads – Bridge Design ************
******** All queries about EPM files are to be directed to *************
******** Manager (Structural Drafting) – Bridge Design ***************
************************************************************************
```

20.8 Content of EPM

The bridge components shall be drawn in ‘model space’ in the EPM, and shall show enough detail to allow piles to be set out, and for the concrete works to be formed.

When an EPM is transferred into the surveyor’s software, layers created in AutoCAD transfer across into the software with the same layer name as in AutoCAD. Therefore, parts of the bridge shall be differentiated by appropriate layer naming, allowing the end user to easily identify components. Layer naming shall be limited to a maximum of 24 characters and the naming convention is shown in Figure 20.8-1 *Naming Convention*.

Figure 20.8-1 Naming Convention

ID to indicate layer was created by Department of Transport and Main Roads Design Branch → **MRB** **Formed Holes** ← Name of Component

The following components are to be included in a 3D EPM in real world coordinates.

Bridge Control

Show all points on the Bridge Control at every abutment and pier at the top of road Height. On bridges that are level or on a constant grade, draw a straight AutoCAD line between each point. On bridges with a vertical curve, a ‘string’ shall be imported into the EPM from 12D. The ‘string’ shall have points at 1 m centres along the bridge control, plus points at the abutments and pier centrelines.

Item	AutoCAD Layer Name
Bridge Control	MRB_Bridge_Control

Top of Road Surface at Kerbs

The road surface is not usually part of the EPM unless specifically requested by the client.

If required, draw a ‘string’ on both sides of the bridge where the top of the DWS intersects with the kerb/parapet. The ‘string’ shall have points at 1 m centres along the bridge control.

Item	AutoCAD Layer Name
Top of road surface at each kerb	MRB_DWS

Piles

Assuming that the piles at a particular pier or abutment are equally spaced, the only points that shall be shown are the two outer piles. The coordinate given shall be at the centre-bottom of the pile. It does not matter what type of pile used (octagonal PSC piles, CIP piles, steel piles and so on). When showing a row of piles under a pier or abutment that are equally spaced, a single AutoCAD line shall be drawn between the two outer piles. The Surveyor can divide this line equally to calculate the coordinates of the intermediate piles.

If the piles are not equally spaced, a point for every pile shall be shown.

Item	AutoCAD Layer Name
Centre of piles	MRB_Pile_Bottom

Abutments and Piers

The following items shall be drawn where applicable:

- Soffit of headstocks and wingwalls
- Top of headstock bearing shelves

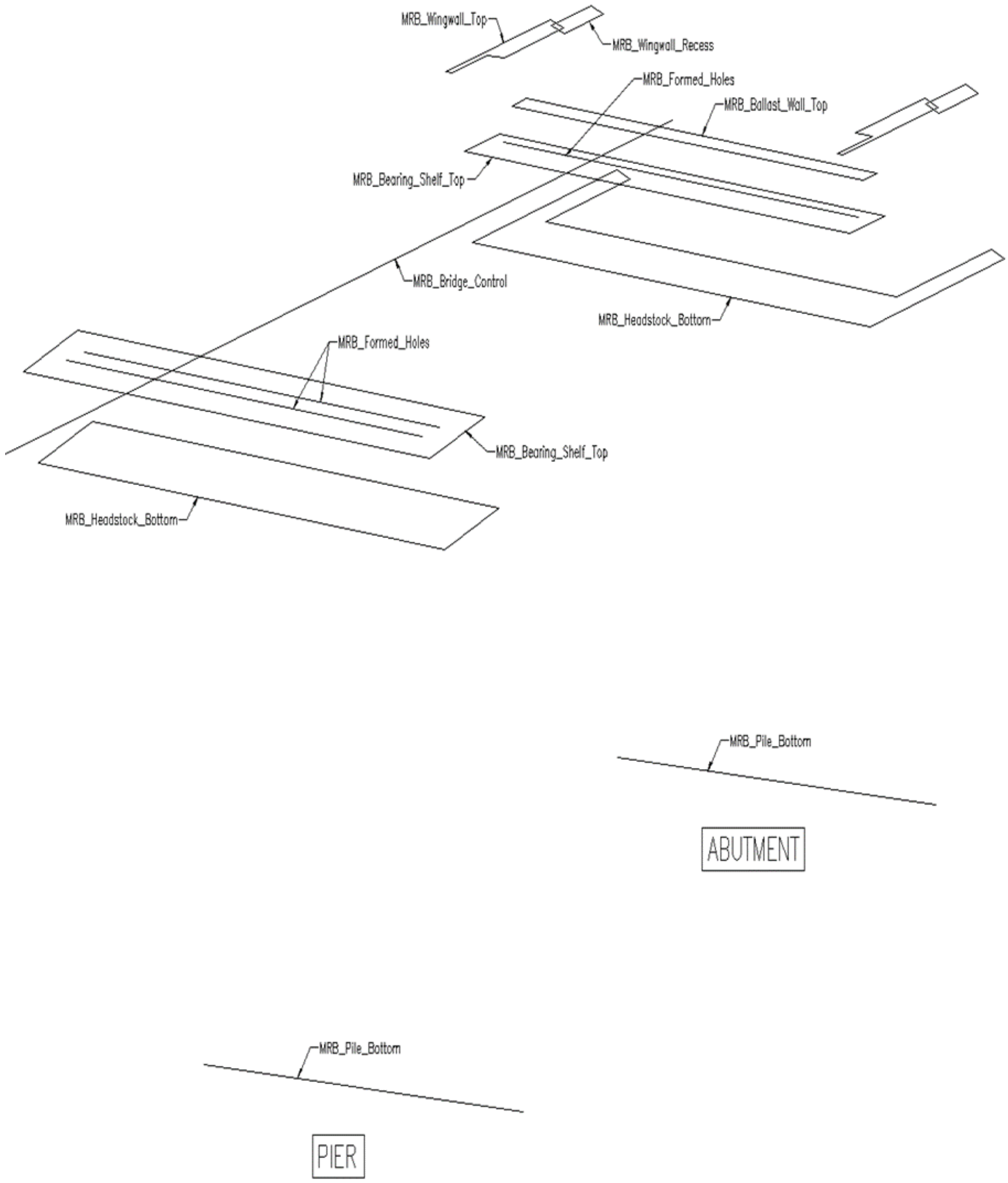
- Top of ballast walls
- Top of wingwalls
- Bridge traffic barrier recesses in wingwalls
- Bottom and top of columns
- Bottom and top of stems
- Soffit and top of pilecaps
- Other features when required
- Formed holes. Assuming that the formed holes are equally spaced, the only points that shall be shown are the two outer holes. The coordinate given shall be at the centre of the hole at bearing shelf height. An AutoCAD line shall be drawn between the two outer holes. The Surveyor can divide this line equally to calculate the coordinates of the intermediate holes. If the holes are not equally spaced, a point for every formed hole shall be shown.
- Bearings. The coordinate given shall be at the centre of the bearing. If the bearing is located in a recess, the Height given shall be at the bottom of the recess. If the bearing is located on pedestals, the Height given shall be at the top of the pedestal. Assuming that the bearings are equally spaced and the height difference between them is constant, the only points that shall be shown are the two outer bearings. If the bearings are not equally spaced, or the Height difference between them is not constant, then every bearing shall be shown.

Item	AutoCAD Layer Name
Headstock soffit outline	MRB_Headstock_Bottom
Top of bearing shelf outline	MRB_Bearing_Shelf_Top
Top of ballast wall outline	MRB_Ballast_Wall_Top
Top of wingwall outline	MRB_Wingwall_Top
Bridge traffic rail recess	MRB_Wingwall_Recess
Bottom of column outline	MRB_Column_Bottom
Bottom of stem outline	MRB_Stem_Bottom
Pilecap soffit outline	MRB_Pilecap_Bottom
Top of pilecap outline	MRB_Pilecap_Top
Centre of formed holes	MRB_Formed_Holes
Centre of bearings	MRB_Bearings

3D EPM Example

Figure 20.8-2 *Example 3D EPM* shows the details required on an EPM. The text shown is for illustration purposes only and shall not be included in the drawing.

Figure 20.8-2 Example 3D EPM



20.9 Checking EPMs

Checking the EPM will mean checking the electronic model created in AutoCAD. Items to be checked may include:

- ❑ EPM units are in metres
- ❑ AutoCAD UCS is set to ‘world’
- ❑ Ensure all items displayed in the EPM are on appropriate layers
- ❑ Bridge Control coordinates, location and span lengths

- ❑ Skew of abutment and pier centrelines
- ❑ Pile locations and dimensions
- ❑ Pilecap, column locations and dimensions
- ❑ Headstock and wingwall locations and dimensions
- ❑ Formed holes and bearing recesses locations and dimensions
- ❑ Heights match those on the drawings
- ❑ Distance between formed holes on adjacent headstocks match the deck unit length (allowing for grade / VC adjustment)

Drafting and Design Presentation Standards
Volume 3: Structural Drafting Standards

Chapter 21: Major Sign Structures

October 2017

Queensland Government

Feedback: Please send your feedback regarding this document to: tmr.techdocs@tmr.qld.gov.au

Chapter 21 Amendments

Revision register

Issue/Rev No.	Reference Section	Description of Revision	Authorised by	Date
1	-	First Issue	Team Leader (Structural Drafting)	Oct 2017

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21 VMS Cantilever Signs

21.1 Glossary of terms

For a complete glossary of terms refer Chapter 1 - *Introduction*.

21.2 Figures and examples shown in this volume

The figures and examples shown in this volume are for presentation purposes only, and may contain some details that are now superseded. These details have been included for ease of reference, to illustrate typical solutions, and to show the required standard of drafting presentation. The details are not to be used without an engineering check and certification by a Structural RPEQ to confirm that the details are appropriate for the specific project.

21.3 Associated publications

- TN174 *Purchasing Guidelines for TMR Major Sign Structures*
- *Design Criteria for Bridges and Other Structures* manual

Note: inclusive of other documents referenced in the above publications

21.4 General

This chapter provides a basis for the minimum detailing requirements of large gantries for installation within the department's road network.

This chapter informs Transport and Main Roads design procurement expectations and requirements of the designer. Gantry design is required to balance WH&S requirements, safety in design and fit for purpose ideals that meet the site specific requirements - including the design environment such as wind speed, earthquake zone, and geotechnical and built environment.

21.5 Design

For Transport and Main Roads Design parameters refer to the *Design Criteria for Bridges and other Structures* Chapter 10 – *Gantries and support structures*.

21.6 Design Components

1. Footing – structural and geotechnical
2. Steel componentry – structural design for impact, wind loading, durability, installation, maintenance and inspection
3. Site specific requirements – clearance, location, barriers, obstructions / clear line of sight, services
4. Electrical
5. WH&S for installation & maintenance (ladders, site access and walkways)

Steel, electrical & WHS componentry may be considered for type approval for certain design parameters such as wind speed zones.

Figure 21.6(a) - Single Post Cantilever Gantry

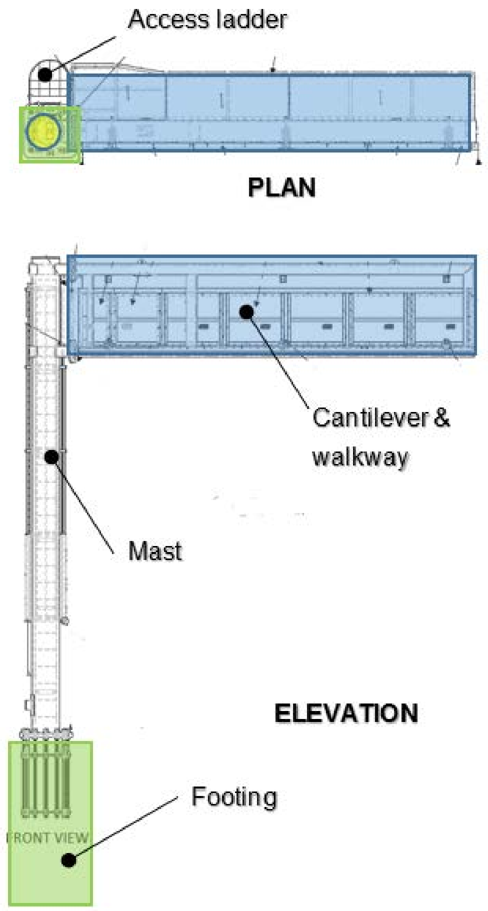
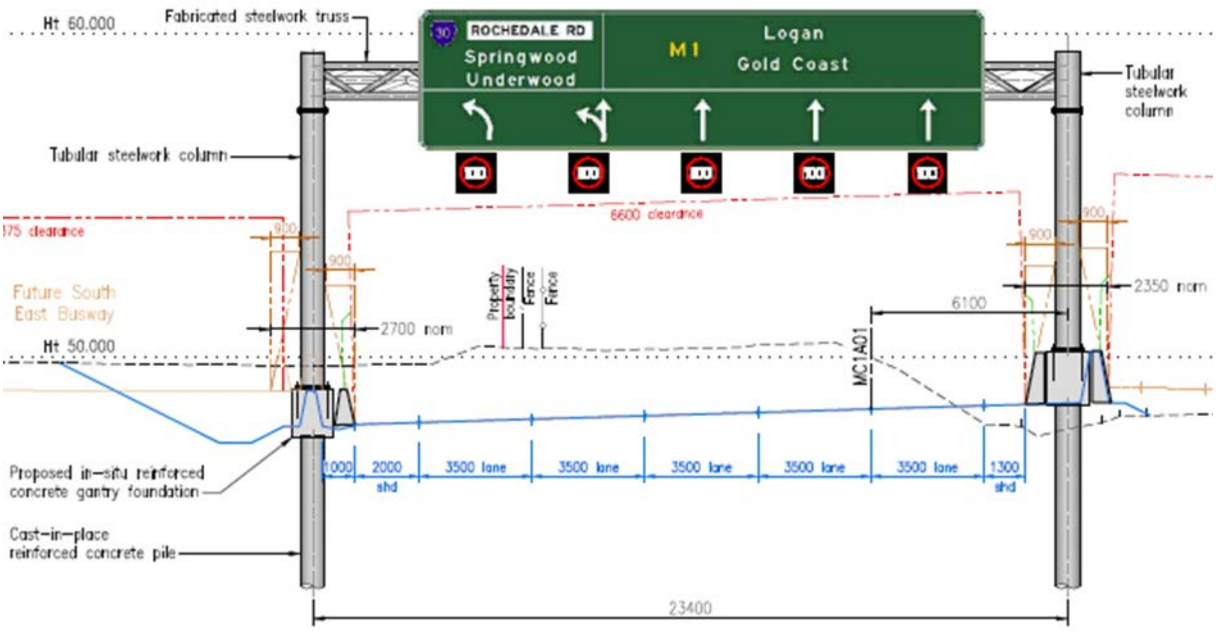


Figure 21.6(b) - Multi Post Gantry (lightweight gantry shown)



21.7 Reference documents

The following documents are relevant for reference when tendering or designing a VMS cantilever gantry. All referenced documents are to be the latest available version at the time of tender award.

Table 21.7 – Reference documents

Reference	Title
-	*Design Criteria for Bridges and Other Structures*
MRTS61	*Mounting Structures for ITS Devices*
SD1573	*ITS gantries - Lane control/Variable speed limit signs - Without maintenance platform*
SD1577	*ITS gantries - Lane control/Variable speed limit signs - Walk on gantry*
SD1581	*ITS - Cantilever - Cantilever structure*

21.8 Site Specific Design

1. Footings
2. Section showing minimum vertical clearance / roadway carriageways including future carriageways, the section is to reflect actual site sectional profile including surveyed heights (Australian Height Datum), proposed footing heights, existing or proposed barriers and types (to protect sign structure from vehicle impact and associated failure risks), services including numbers, sizes and locations, minimum clearance of services to footings or noted approximate locations with a note the actual locations are to be determined on site prior to commencement of work.
3. Wind speed
4. Earthquake region
5. Existing services locations and proposed relocation / protection

21.9 Typical Drawing Set

1. **Drawings** may be submitted for approval in two sets simultaneously containing:
   a) Engineering Drawings
   b) Shop Drawings
2. **Engineering Drawings** are to contain as a minimum:
   a) **Site plan and drawing index** including all drawings and current revision numbers for type approved drawings.
   b) **General arrangement** – Section, plan and end view, locating the structure, calling up general parts and showing clearances and services locations. Footing assembly details including anchor bolts, sizes, grades, nuts and washer details, grout thickness and other details relevant to the assembly of the complete gantry for example - construction sequence.

c) **Footing details** – Plan, section, dimensions, reinforcement details, location of footing centre point if not shown elsewhere, bolt layout, projection and orientation in plan, concrete grade, depth of footing, heights and geotechnical requirements, for example, 2500 deep into slightly weathered greywacke or 4000 into sand.

3. **Shop drawings or fabrication drawings** are to contain all other relevant information not covered by the engineering drawings for the fabrication of structural steelwork including dimensions, material grades, sizes, lengths and surface treatments.

21.10 Design and Construction Contract for VMS Gantry

The design and construction of a singular Cantilever VMS Gantry may be summarised as follows:

Step 1

Design Tender

Design to be undertaken only by BD#3 prequalified design consultant

Relevant documents for tender and design include but are not limited to

- TMR Design Criteria for Bridges and Other Structures
- TMR Structural Drafting Standards
- MRTS 61, 63, 63A, 70 , 71 & 78
- TMR Standard Drawings

Step 2

Fabrication

Fabrication shall not commence until final review / acceptance of the design details by TMR Structures (refer *"Design Criteria for Bridges and Other Structures"*)

Fabrication to be undertaken by a TMR prequalified fabricator to MRTS78

Inspections and material test certificates apply

Step 3

Erection

Erection to be undertaken only after ....

1 Peer Review of engineering drawings as per the process described in the Design Criteria for Bridges and Other Structures (As above)

2 Geotechnical and services investigations undertaken

3 Certified design of footing for the site specific geotechnical conditions

4 Design and installation of appropriate barriers

Technical Note TN68 VMS Gantry Installation Procedure applies to the gantry installation

21.11 Detailed Design Drawings Checklist

The following table is supplied for designers and Regional Managers to address minimum design requirements are detailed prior to submission for peer review by structures

Item	Category	Detailed description
1.0	Design	The structure shall be designed and detailed in accordance with current versions of the following: • MRTS61 *Gantries and Support Structures* • *Design Criteria for Bridges and Other Structures* • Transport and Main Roads Structural Drafting References
1.1	Layout and general info	Site layout, Drawing index, Road Name and Section with offsets and clearances, barriers, wind loads - including region.
1.2	Certification and WHS	• Designer to RPEQ certify on the drawings that the design complies with AS 1657 • Fabrication carried out using only RPEQ certified drawings • All details of the fall arrest system are shown
1.3	Notes	Standard notes from *Structural Drafting Standards,* Chapter 5 - *Notes* utilised: • General • Foundation and Footings • Reinforcement & cover • Concrete • Welding Consumables & Welding • Steel • Material grades
1.4	Clearance	Minimum vertical clearance of structure as per *Design Criteria for Bridges and other Structures* (most cases 6500 +100 tolerance)
1.5	Vertical deflection	• The design vertical deflections of the horizontal member / arm under self-weight of the complete structure is shown on drawings. • The structure shall be designed and pre-cambered so that the horizontal member / arm is in an upwards orientation under permanent load, and not in a sagging position.
1.6	Presentation & Archival	Transport and Main Roads Title Blocks & drawing No's
1.7	Materials	Materials grades, thicknesses, sectional properties and dimensions including plate thicknesses
1.8	General	General presentation standards as per the DDPSM – for example, 3.5 mm text at A1 size, dimensioning and arrowheads sizes, scales…etc

Item	Category	Detailed description
1.9	Design Loads	• The design Region and wind speed shall be selected by the designer for the specific site. • The ultimate and serviceability limit state wind speed shall be noted on the drawings. • Design Live Load for walkways and service platforms is in accordance with *Design Criteria for Bridges and Other Structures*. The platform is designed with minimum Design Loads: i. Design Live Load of 2.5 kPa ii. 1 kN concentrated load over 300 mm² patch located anywhere on the platform floor iii. with simultaneous local Moving Live Load of 5 kPa applied over 1 m² • Design Loads are shown on the RPEQ certified drawings
2.0	Design Loads	Fatigue Design: Whole structure design for fatigue in accordance with LRFD Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals.
2.1	Foundations & Footings	• Footings to be certified by an RPEQ geotechnical engineer for the site specific conditions • Sufficient information to locate footings is supplied - for example, Easting, Northing for set out point in centre of footing • Orientation of base plate shown for correct orientation of hold down bolts
2.2	Foundations & Footings	All bored piles / cast-in-place piles are to have steel liners
2.3	Foundations & Footings	Cast-in-piles shall comply with MRTS63 *Cast-in-Place Piles*
2.4	Foundations & Footings	• Holding down anchors / bolts are positioned within the confines of the pile reinforcing cage - not outside • Holding down bolts are defined in length, grade, setting out and penetration
2.5	Foundations & Footings	Concrete strength, exposure classification and cover appropriate for footing site
2.6	Reinforcement	• Drawing states: "All reinforcing shall be ACRS Certified" • All reinforcement bars labelled as per *Structural Drafting Standards*
5.0	Steel Fabrication	All weld symbols are detailed on drawings and welding notes - current version
5.1	Steel Fabrication	Full penetration butt welds shall be used instead of fillet welds for all tubular CHS, SHS and RHS connections.
5.2	Steel Fabrication	• All steelwork is hot dip galvanised to the requirements of AS/NZS 4680 • Engineering drawings show all galvanising vent holes • Painted gantry structures require approval from the Director of Bridge Design

Item	Category	Detailed description
5.3	Steel Fabrication	• Short lengths of steel joined together are not permitted by Transport and Main Roads • Full length members without any joints are to be used
5.4	Steel Fabrication	12 mm thick plate is placed over all slotted holes in the base plate when the holding down bolts are installed
6.0	Erection Procedure	A detailed erection and installation procedure including all requirements for tightening of hold down bolts prior to grouting and prior to attachment of the outreach arm is needed for review by the department.
6.1	Erection Procedure	• The structure is supported by mortar and not by levelling nuts during service. If levelling nuts are used initially, they shall be backed off to transfer the dead load onto temporary packers prior to casting of grout. The temporary packers shall be removed after the grout has been cured and remaining voids grouted. • TN68 *VMS Gantry Installation Procedure* applies.
7.0	Protection of Structure from traffic impact	Form of protection provided for gantry is detailed in accordance with the *Design criteria for bridges and other Structures.*
7.1	Protection of Structure from traffic impact	Risk assessment to determine barrier requirements has been conducted
7.2	Minimum Views required	• Elevation of gantry showing road profile, minimum vertical clearance, services, footing and labelling major components. • Plan and end elevation of gantry showing major components including overall dimensions such as walkway widths. • Details of all connections, end plates, vent hole sizes numbers and locations. • Details of all major components not sufficiently detailed on the other views.