Forth Estuary Transport Authority
Forth Road Bridge

Approval In Principle
For Design of Replacement Deck Roller Shutter Joints

Date: August 2014

Notice

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Revision	Purpose Description	Originated	Checked	Reviewed	Authorised	Date

Plan Design Enable

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Location Plan and Photograph

REPRODUCED FROM THE 1993 ORDNANCE SURVEY LANDLINE DATA WITH THE PERMISSION OF THE CONTROLLER OF HER MAJESTY'S STATIONERY OFFICE CROWN COPYRIGHT 01 LICENCE NO. GD 272663

Figure 1 – Forth Road Bridge

1. Highway details

1.1 Type of highway

Over: Dual 2 lane carriageway – A90 road (D2AP)

Under: Firth of Forth

1.2 Permitted traffic speed

Over Structure: 80 kph (50 mph)

Under Structure: N/A

1.3 Existing restrictions

None

2. Site details

2.1 Obstacles crossed

2 No. roller shutter movement joints exist at each main suspension tower in each carriageway; they span the gaps between the towers and both the main and side spans.

3. Existing and Proposed structure

3.1.1 Description of Existing Structure

The existing roller shutter movement joints were manufactured by Demag and were commissioned in 1964. The joints are located adjacent to the main suspension towers and are of two different lengths. The joints between the towers and the central span are approximately 5.0 metres long with a specified +810/-920 mm movement range, whilst the joints between the towers and the side spans are approximately 2.5 metres long with a specified +150/-260 mm movement range. Appendix B shows a general arrangement of the original joint.

In total there are 8 No. sets of joint units, 4 No. sets in each carriageway. Each set comprises 6 No. units of varying width, the 4 No. inner units are 1228 mm wide, the edge units adjacent to the central reserve are 1245 mm wide and the edge units adjacent to the verge are 1340 mm wide.

Each unit has a tongue plate and movement train. The latter comprises a shuttle (bridge) plate and a number of link (train) plates, 5 No. link plates in the longer units and 2 No in the shorter units. The trains are supported on curved beam slide tracks. With the exception of the outer slide track, each beam supports one side of adjacent pairs of trains.

The tongue plates and slide tracks of both the large and small joints are bolted to steelwork grillages that are connected to the main towers. Each tongue plate is attached to the support beam by a pair of spring loaded holding down bolts.

The shuttle and link plates of the trains are supported at four corners by bearing cams and/or steel bearing blocks. Further blocks are welded to the underside of the plates in the region of the slide tracks to restrain the trains from moving laterally.

The shuttle plates of the trains are connected to the main and side spans, and movement of these deck spans is accommodated by the trains moving along the slide tracks and under the tongue plates. Provision is made at the ends of the shuttle plates for the plan rotation of the deck ends when the spans are subject to lateral loading. The arrangement includes central locating blocks which maintain a clearance at the ends of the plates and a single, central spring loaded holding down bolt capable of accommodating rotation. Rotation of the deck ends therefore gives rise to joint movement whist the longitudinal alignment of the trains is maintained.

Records would indicate that the joints have generally performed well, given that they have now been in service for over 50 years and they last underwent a detailed inspection and overhaul in 1975. This inspection found evidence of wear in the hinges and the interface between the trains and slide tracks.

A recent sample inspection, which involved the removal of the tongue plates and trains of both main and side spans, revealed the following defects:

- Excessive play in the connection between the plates of the train due to wear within the hinges particularly elongation of the holes;
- General wear of the shuttle and link plate bearings (cams and blocks);
- Wear of the slide track with localised surface indentations;
- Excessive wear of the steel pads that interface with the bearing blocks at the end of the shuttle plates.

3.1.2 Description of Proposed Structure and Design Life

It is proposed that the existing joints should be replaced with those of a similar roller shutter type. Consideration has been given to a number of other options including the continued maintenance or refurbishment of the existing joints and the replacement with other types of joints. These considerations are detailed in *Forth Road Bridge - Options Report for Bridge Deck Joints* (Atkins doc. ref. 5088419/002 Rev A)

In addition to replacing the tongue, shuttle and link plates, the connection of the slide tracks to the support grillage by bolting allows the easy replacement of these beams. There is evidence that the contact surface of these beams is worn with indentations. The in-situ re-facing of these surfaces would be time-consuming, costly and the alignment tolerances difficult to achieve. It is therefore proposed to replace all slide tracks, by so doing it is possible to incorporate minor changes to the vertical alignment of the contact surface should it be necessary to alter the overall depth of the trains.

The form of the joints would be similar to the existing, except for:

- The width of the outermost joint units at either side of the carriageway would be made the same;
- The hinges would include an additional inboard non-load bearing cam to secure the alignment of the pin so reducing wear within the hole;
- The ends of the shuttle and link plates would be rebated to receive the cams, allowing an increase to the current length of the weld;
- The bearing detail at the end of the tongue plates will be amended in order that the contact surfaces are accessible for maintenance purposes;

In addition, the works should include:

- Replacing all spring loaded holding down bolts;
- Repairing/replacing worn edging strips that abut the surfacing;
- Replacing the steel pads that support the shuttle plate bearing blocks;
- Maintenance painting of steelwork, as necessary.

The proposed design life of the replacement joint is 50 years (Design Working Life Category 2), however maintenance will be required within the lifetime of the joint.

3.2 Structural type

The proposed replacement joint will be of the roller shutter type.

3.3 Foundation type

It is proposed to re-use the existing supporting structure of the current joint.

3.4 Span arrangements

The replacement joint will be designed to accommodate the same movement range as the existing joint. A theoretical required movement range for the joint has not been calculated, but inspection of the joints have indicated that the existing available movement range is adequate for the movement range experienced to date.

3.5 Articulation arrangements

The joint articulation will be as described in sections 3.1.1. and 3.1.2.

3.6 Classes and levels

3.6.1 Consequence class

CC2

3.6.2 Reliability class

RC2

3.6.3 Inspection level

IL2

3.7 Road restraint systems requirements

The existing system is non-standard, however no changes or improvements to the existing road restraint system are proposed other than to take down and re-erect as part of these works.

3.8 Proposed arrangements for future maintenance and inspection

3.8.1 Traffic management

The proposals will not affect the existing arrangements for traffic management.

3.8.2 Arrangements for future maintenance and inspection. Access arrangements to structure

The proposals will not affect the current access arrangements to the joint. However, It is proposed to provide holes/fixings in the tongue, shuttle and end link plates, for the attachment of lifting equipment.

3.9 Environment and sustainability.

The bridge is a listed structure therefore consultation will be undertaken with the planning authorities to confirm the proposals for the joint. The existing joint is virtually all steel and can be recycled. Replacing the joint extends the working life of the structure.

3.10 Durability. Materials and finishes

Materials	Type / Description
Steelwork: slide tracks (except top flange), plates, cams and blocks.	Grade S355NL/ML to BS EN 10025 – 3 & 4
Stainless steel - hinge pins. - bushes.	Grade 1.4404 (316L).700 to BS EN 10088-3 Grade 1.4306 (304L).500 to BS EN 10088-3
Steelwork: slide track top flanges and shuttle plate bearing pads	Wear resistant plate with a typical hardness of HBW400. (Hardox 400 or similar)
Steelwork painting.	SHW Series 1900
Maintenance Painting of Steelwork.	SHW Series 5000
Bridge Deck Waterproofing.	SHW Series 2000
Anti-slip surfacing.	Epoxy resin based slurry dressing with hard wearing aggregate (6-8mm aggregate size)

Note: All steelwork to EXC3 with additional tolerances to be specified for Hardox top flanges.

3.11 Risks and hazards considered for design, execution, maintenance and demolition. Consultation with and/or agreement from CDM co-ordinator

- Steelwork fabrication (cutting; welding, blasting, painting, lifting, and manual handling);
- Traffic Management including access for non-motorised users;
- Working at height in an aggressive environment;
- Working adjacent to live carriageways;
- Large gaps in structure once trains are removed, protective barriers/screens required;
- Restricted working space and headroom due to the presence of the temporary bridges;
- Lifting operations;
- Working adjacent to existing services.

For full details of the Design Risk Assessment refer to Appendix C

3.12 Estimated cost of proposed structure together with other structural forms considered (including where appropriate proprietary manufactured structure), and the reasons for their rejection (including comparative whole life costs with dates of estimates)

Five options for repair or replacement of the joints were considered and these have been discussed in detail in Atkins report '*Forth Road Bridge - Options Report for Bridge Deck Joints* (Atkins doc. ref. 5088419/001 Rev A)'. In summary the options were:

Option 1 Continue with current maintenance regime. This was rejected as it did not address long term durability issues and the joints are increasing in liability in terms of maintenance and potential failure.

Option 2 Completely refurbish the existing joint. This was rejected because of the difficulties in achieving the required tolerances on site and potential prolonged temporary carriageway closures. In addition this option doesn't take advantage of improved materials.

Option 3 Completely replace the existing joint with a new roller shutter type joint. This option is proposed.

Option 4 Completely replace the existing joint with a supported finger comb type joint. This was rejected because a suitable design that accommodates the movement range required is not available.

Option 5 Completely replace the existing joint with an elastomeric type with steel girders. This was rejected because of the large number of moving parts and long term durability issues have occurred on other bridges.

Of the options discussed in the report, Option 3 was considered the most preferred and therefore only the cost of this option was estimated. This was approximately £7.3million, excluding traffic management costs.

3.13 Proposed arrangements for construction

3.13.1 Construction of structure

It is proposed to replace both sets of joints to one carriageway at the same time to minimise the period of time for traffic management. However, consideration needs to be given for access to construction plant.

3.13.2 Traffic management

For replacing the joints it will be necessary to close a carriageway for the duration of the works. Traffic will use the opposing carriageway on a single lane, two way basis. Arrangements for setting up traffic management will follow established FETA procedures.

3.13.3 Service diversions

None

3.13.4 Interface with existing structures

Protection of the access ways below the joints may be necessary during the removal and installation works.

4. Design criteria

4.1 Actions:

4.1.1 Permanent actions

The following permanent actions will be considered in accordance with BS EN 1991-1-1 and the associated UK National Annex:

Steel self weight (to be taken as 78.5kN/m^3)

Superimposed dead load – Surfacing (to be taken as 23kN/m^3 +/- 40%)

4.1.2 Snow, Wind and Thermal actions

Movements ranges will be based on the existing recorded site data for the bridge. No further assessment of the movement range under thermal and wind loading will be carried out as part of this assessment. The effects of snow loads will be ignored.

4.1.3 Actions relating to normal traffic under AW regulations and C&U regulations

Load models 1 and 2 will be considered in accordance with BS EN 1991-2:2003 and corrigenda December 2004 and February 2010 and the associated UK National Annex with corrigendum no 1.

4.1.4 Actions relating to General Order Traffic under STGO regulations

SV models SV80, SV100 and SV196 from load model 3 will be considered in accordance with BS EN 1991-2:2003 and corrigenda December 2004 and February 2010 and the associated UK National Annex with corrigendum no 1. These load models have been determined to give the most onerous wheel loading for the roller shutter joint.

4.1.5 Footway or footbridge variable actions

Not applicable

4.1.6 Actions relating to Special Order Traffic, provision for exceptional abnormal indivisible loads including location of vehicle track on deck cross-section

None

4.1.7 Accidental actions

None

4.1.8 Action during construction

None

4.1.9 Any special action not covered above

No

4.2 Heavy or high load route requirements and arrangements being made to preserve the route, including any provision for future heavier loads or future widening

The bridge is not on a designated heavy or high load route.

4.3 Minimum headroom provided

Not applicable.

4.4 Authorities consulted and any special conditions required

None

4.5 Standards and documents listed in the Technical Approval Schedule

See Appendix A.

4.6 Proposed Departures relating to departures from standards given in 4.5

A Departure from Standards will be raised for the use of replacement clauses of MCHW Volume 1 Series 1800 to align with Eurocodes execution standards.

4.7 Proposed Departures relating to methods of dealing with aspects not covered by standards in 4.5

None

5. Structural analysis

5.1 Methods of analysis proposed for superstructure, substructure and foundations

The roller shutter joint elements which will be designed are the shuttle plates, the tongue plates, the slide track beams, the joint pins, and the pedestal bearing areas as shown in Figure 1.

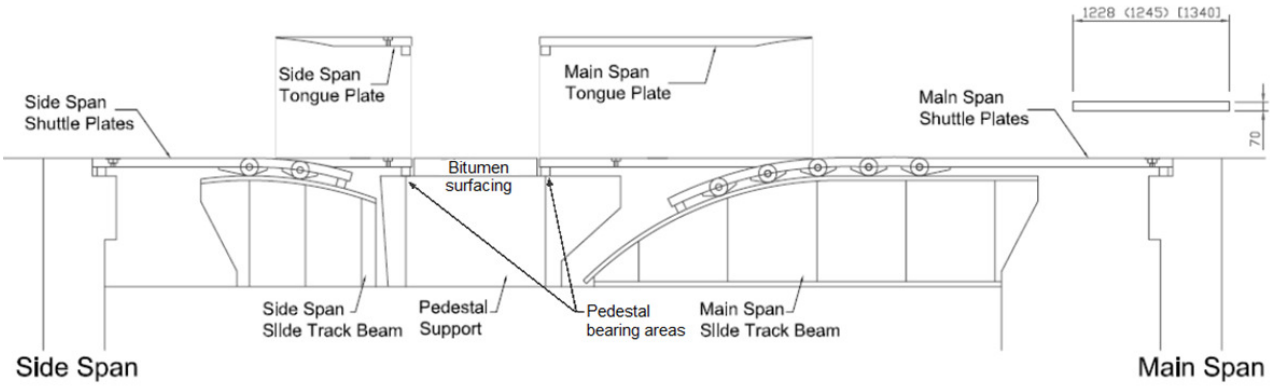


Figure 2: General Arrangement of the Roller Shutter Joint

It is proposed to model the different elements of the structure separately to simplify the analysis.

Refer to Appendix D for further details.

5.2 Description and diagram of idealised structure to be used for analysis

Refer to Appendix D for further details.

5.3 Assumptions intended for calculation of structural element stiffness

Gross cross section areas of the steel will be used to calculate section properties with reference to 'Steel Designers Manual" by Buick Davidson & Graham Owens (Fifth edition).

5.4 Proposed range of soil parameters to be used in the design of earth retaining elements

Not applicable.

6. Geotechnical conditions

6.1 Acceptance of recommendations of the Geotechnical Design Report to be used in the design and reasons for any proposed changes

Not applicable

6.2 Summary of design for highway structure in the Geotechnical Design Report

Not applicable

6.3 Differential settlement to be allowed for in the design of the structure

The shuttle plates, feet, pins and bearing areas shall all be designed with allowances for wear and out-of-plane tolerances. This is accounted for with load cases that model traffic loading as transferred into the substructure via two of the four bearing feet. These load combinations are described further in Appendix D.

6.4 If the Geotechnical Design Report is not yet available, state when the results are expected and list the sources of information used to justify the preliminary choice of foundations

Not applicable.

7. Checking

7.1 Proposed Category and Design Supervision level

Category 2.

7.2 If Category 3, name of proposed Independent Checker

Not applicable.

7.3 Erection proposals or temporary works for which Types S and P Proposals will be required, listing structural parts of the permanent structure affected with reasons

Trial assemblies of each whole joint set (i.e. the whole joint at one pier in one carriageway) will be undertaken off site to ensure the whole joint functions correctly.

Temporary works may be necessary for access around the joints (in addition to the existing access arrangements) and also to prevent any material or components falling. Temporary works will be considered as Type S as during the replacement of a joint the carriageway will be closed to the public.

8. Drawings and documents

8.1 List of drawings (including numbers) and documents accompanying the submission

Roller Shutter Joint New Layout – 5088419/301/006 Rev B

9. The above is submitted for acceptance

Signed: _____

Name: Stephen Jones _____

Design Team Leader

Engineering Qualifications BSc (Hons) CEng MICE _____

for and on behalf of

Atkins Consultants Ltd

Date: _____

10. The above is rejected / agreed subject to the amendments and conditions shown below

Signed: _____

Name: _____

Position held: _____

Engineering Qualifications: _____

TAA

Date: _____

A.1 Appendix A Technical Approval Schedule (TAS)

Technical Approval Schedule (TAS)

Schedule of Documents Relating to Design of Highway Bridges and Structures

Eurocodes and associated UK National Annexes

	Eurocode part	Title	Amendment / Corrigenda
	Eurocode 0		
✓	BS EN 1990 +A1:2005	Eurocode 0: Basis of structural design	+A1:2005 Corrigenda December 2008 and April 2010
✓	NA to BS EN 1990:2002 + A1:2005	UK National Annex to Eurocode 0 Basis of structural design	National Amendment No.1
	Eurocode 1		
✓	BS EN 1991-1-1:2002	Eurocode 1: Actions on structures. General Actions. Densities, self-weight, imposed load for buildings	Corrigenda December 2004 and March 2009
✓	NA to BS EN 1991-1-1:2002	UK National Annex to Eurocode 1: Actions on structures. General Actions. Densities, self-weight, imposed load for buildings	-
✓	BS EN 1991-1-3:2003	Eurocode 1: Actions on structures. General Actions. Snow loads	Corrigenda December 2004 and March 2009
✓	NA to BS EN 1991-1-3:2003	UK National Annex to Eurocode 1: Actions on structures. General Actions. Snow loads	Corrigendum No.1
✓	BS EN 1991-1-4:2005	Eurocode 1: Actions on structures. General Actions. Wind actions	+A1:2010 Corrigenda July 2009 and January 2010
✓	NA to BS EN 1991-1-4:2005 + A1:2010	UK National Annex to Eurocode 1: Actions on structures. General Actions. Wind actions	National Amendment No.1
✓	BS EN 1991-1-5:2003	Eurocode 1: Actions on structures. General Actions. Thermal actions	Corrigenda December 2004 and March 2009
✓	NA to BS EN 1991-1-5:2003	UK National Annex to Eurocode 1: Actions on structures. General Actions. Thermal actions	-
✓	BS EN 1991-1-6:2005	Eurocode 1: Actions on structures. General Actions. Actions during execution	Corrigendum July 2008, November 2012 and February 2013.
✓	NA to BS EN 1991-1-6:2005	UK National Annex to Eurocode 1: Actions on structures. General Actions. Actions during execution	-
✓	BS EN 1991-1-7:2006	Eurocode 1: Actions on structures. General Actions. Accidental actions	Corrigendum February 2010
✓	NA to BS EN 1991-1-7:2006	UK National Annex to Eurocode 1: Actions on structures. Part 1-7 : Accidental actions	-
✓	BS EN 1991-2:2003	Eurocode 1: Actions on structures. Traffic loads on bridges	Corrigenda December 2004 and February 2010

✓	NA to BS EN 1991-2:2003	UK National Annex to Eurocode 1: Actions on structures. Traffic loads on bridges	Corrigendum No.1 (May 2008)
	Eurocode 2		
	BS EN 1992-1-1:2004	Eurocode 2: Design of concrete structures– Part 1-1: General rules and rules for buildings	Corrigendum January 2008 and November 2010
	NA to BS EN 1992-1-1:2004	UK National Annex to Eurocode 2: Design of concrete structures – Part 1-1: General rules and rules for buildings	National Amendment No.1
	BS EN 1992-2:2005	Eurocode 2: Design of concrete structures – Part 2: Concrete bridges – Design and detailing rules	Corrigendum July 2008
	NA to BS EN 1992-2:2005	UK National Annex to Eurocode 2: Design of concrete structure – Part 2: Concrete bridges – Design and detailing rules	-
	BS EN 1992-3:2006	Eurocode 2: Design of concrete structures – Part 3: Liquid retaining and containment structures	-
	NA to BS EN 1992-3:2006	UK National Annex to Eurocode 2: Design of concrete structure – Part 3: Liquid retaining and containment structures	-
	Eurocode 3		
✓	BS EN 1993-1-1:2005	Eurocode 3: Design of steel structures – Part 1-1 General rules and rules for buildings	Corrigenda February 2006 and April 2009
✓	NA to BS EN 1993-1-1:2005	UK National Annex to Eurocode 3: Design of steel structures – Part 1-1 General rules and rules for buildings	-
	BS EN 1993-1-3:2006	Eurocode 3: Design of steel structures – Part 1-3 General rules – Supplementary rules for cold-formed members and sheeting	Corrigendum November 2009
	NA to BS EN 1993-1-3:2006	UK National Annex to Eurocode 3: Design of steel structures – Part 1-3 Supplementary rules for cold-formed members and sheeting	-
✓	BS EN 1993-1-4:2006	Eurocode 3: Design of steel structures – Part 1-4 General rules – Supplementary rules for stainless steels	-
✓	NA to BS EN 1993-1-4:2006	UK National Annex to Eurocode 3: Design of steel structures – Part 1-4 Supplementary rules for stainless steels	-
✓	BS EN 1993-1-5:2006	Eurocode 3: Design of steel structures – Part 1-5 Plated structural elements	Corrigendum April 2009
✓	NA to BS EN 1993-1-5:2006	UK National Annex to Eurocode 3: Design of steel structures – Part 1-5 Plated structural elements	-
✓	BS EN 1993-1-6:2007	Eurocode 3: Design of steel structures – Part 1-6 Strength and stability of shell structures	Corrigendum April 2009
✓	BS EN 1993-1-7:2007	Eurocode 3: Design of steel structures – Part 1-7 Plated structures subject to out of plane loading	Corrigendum April 2009
✓	BS EN 1993-1-8:2005	Eurocode 3: Design of steel structures – Part 1-8 Design of joints	Corrigenda December 2005, September 2006, July 2009 and August 2010
✓	NA to BS EN 1993-1-8:2005	UK National Annex to Eurocode 3: Design of steel structures – Part 1-8 Design of joints	-

✓	BS EN 1993-1-9:2005	Eurocode 3: Design of steel structures – Part 1-9 Fatigue	Corrigenda December 2005, September 2006 and April 2009
✓	NA to BS EN 1993-1-9:2005	UK National Annex to Eurocode 3: Design of steel structures – Part 1-9 Fatigue	-
✓	BS EN 1993-1-10:2005	Eurocode 3: Design of steel structures – Part 1-10 Material toughness and through-thickness properties	Corrigenda December 2005, September 2006 and March 2009
✓	NA to BS EN 1993-1-10:2005	UK National Annex to Eurocode 3: Design of steel structures – Part 1-10 Material toughness and through thickness properties	-
✓	BS EN 1993-1-11:2006	Eurocode 3: Design of steel structures – Part 1-11 Design of structures with tension components	Corrigendum April 2009
✓	NA to BS EN 1993-1-11:2006	UK National Annex to Eurocode 3: Design of steel structures – Part 1-11 Design of structures with tension components	-
✓	BS EN 1993-1-12:2007	Eurocode 3: Design of steel structures – Part 1-12 Additional rules for the extension of EN 1993 up to steel grades S 700	Corrigendum April 2009
✓	NA to BS EN 1993-1-12:2007	UK National Annex to Eurocode 3: Design of steel structures – Part 1-12 Additional rules for the extension of EN 1993 up to steel grades S 700	-
✓	BS EN 1993-2:2006	Eurocode 3: Design of steel structures – Part 2 Steel bridges	Corrigendum July 2009
✓	NA + A1:2012 to BS EN 1993-2:2006	UK National Annex to Eurocode 3: Design of steel structures – Part 2 Steel bridges	+ A1:2012
	BS EN 1993-5:2007	Eurocode 3: Design of steel structures – Part 5 Piling	Corrigendum May 2009
	NA + A1:2012 to BS EN 1993-5:2007	UK National Annex to Eurocode 3: Design of steel structures – Part 5 Piling	+ A1:2012
	Eurocode 4		
	BS EN 1994-1-1:2004	Eurocode 4: Design of composite steel and concrete structures – Part 1-1 General rules and rules for buildings	Corrigendum April 2009
	NA to BS EN 1994-1-1:2004	UK National Annex to Eurocode 4: Design of composite steel and concrete structures – Part 1-1 General rules and rules for buildings	-
	BS EN 1994-2:2005	Eurocode 4: Design of composite steel and concrete structures – Part 2 General rules and rules for bridges	Corrigendum July 2008
	NA to BS EN 1994-2:2005	UK National Annex to Eurocode 4: Design of composite steel and concrete structures – Part 2 General rules and rules for bridges	-
	Eurocode 5		
	BS EN 1995-1-1:2004 + A1:2008	Eurocode 5: Design of timber structures – Part 1-1 General – common rules and rules for buildings	+ A1:2008 Corrigendum June 2006
	NA to BS EN 1995-1-1:2004 + A1:2008	UK National Annex to Eurocode 5: Design of timber structures – Part 1-1 General – common rules and rules for buildings	+ A1:2008 National Amendment No. 2
	BS EN 1995-2:2004	Eurocode 5: Design of timber structures – Part 2 Bridges	-

	NA to BS EN 1995-2:2004	UK National Annex to Eurocode 5: Design of timber structures – Part 2 Bridges	-
	Eurocode 6		
	BS EN 1996-1-1:2005 + A1:2012	Eurocode 6: Design of masonry structures – Part 1-1 General rules for reinforced and unreinforced masonry structures	Corrigenda February 2006 and July 2009
	NA to BS EN 1996-1-1:2005 + A1:2012	UK National Annex to Eurocode 6: Design of masonry structures – Part 1-1 General rules for reinforced and unreinforced masonry structures	-
	BS EN 1996-2:2006	Eurocode 6: Design of masonry structures – Part 2 Design considerations, selection of materials and execution of masonry	Corrigendum September 2009
	NA to BS EN 1996-2:2006	UK National Annex to Eurocode 6: Design of masonry structures – Part 2 Design considerations, selection of materials and execution of masonry	Corrigendum No.1
	BS EN 1996-3:2006	Eurocode 6: Design of masonry structures – Part 3 Simplified calculation methods for unreinforced masonry structures	Corrigendum October 2009
	NA to BS EN 1996-3:2006	UK National Annex to Eurocode 6: Design of masonry structures – Part 3 Simplified calculation methods for unreinforced masonry structures	-
	Eurocode 7		
	BS EN 1997-1:2004	Eurocode 7: Geotechnical design – Part 1 General rules	Corrigendum February 2009
	NA to BS EN 1997-1:2004	UK National Annex to Eurocode 7: Geotechnical design – Part 1 General rules	Corrigendum No.1
	BS EN 1997-2:2007	Eurocode 7: Geotechnical design – Part 2 Ground investigation and testing	Corrigendum June 2010
	NA to BS EN 1997-2:2007	UK National Annex to Eurocode 7: Geotechnical design – Part 2 Ground investigation and testing	-
	Eurocode 8		
	BS EN 1998-1:2004 + A1:2013	Eurocode 8: Design of structures for earthquake resistance – Part 1 General rules, seismic actions and rules for buildings	Corrigendum June 2009, January 2011 and March 2013
	NA to BS EN 1998-1:2004	UK National Annex to Eurocode 8: Design of structures for earthquake resistance – Part 1 General rules, seismic actions and rules for buildings	-
	BS EN 1998-2:2005+A2:2011	Eurocode 8: Design of structures for earthquake resistance – Part 2 Bridges	Corrigenda February 2010 and February 2012
	NA to BS EN 1998-2:2005	UK National Annex to Eurocode 8: Design of structures for earthquake resistance – Part 2 Bridges	-
	BS EN 1998-5:2004	Eurocode 8: Design of structures for earthquake resistance – Part 5 Foundations, retaining structures and geotechnical aspects	-
	NA to BS EN 1998-5:2004	UK National Annex to Eurocode 8: Design of structures for earthquake resistance – Part 5 Foundations, retaining structures and geotechnical aspects.	-

	Eurocode 9		
	BS EN 1999-1-1:2007 + A1:2009	Eurocode 9: Design of aluminium structures– Part 1-1 General structural rules	+ A1:2009
	NA to BS EN 1999-1-1:2007 + A1:2009	UK National Annex to Eurocode 9: Design of aluminium structures – Part 1-1 General structural rules	National Amendment No.1 Corrigendum No.1
	BS EN 1999-1-3:2007 + A1:2011	Eurocode 9: Design of aluminium structures – Part 1-3 Structures susceptible to fatigue	+ A1:2011
	NA to BS EN 1999-1-3:2007 + A1:2011	UK National Annex to Eurocode 9: Design of aluminium structures – Part 1-3 Structures susceptible to fatigue	+ A1:2011
	BS EN 1999-1-4:2007 +A1:2011	Eurocode 9: Design of aluminium structures – Part 1-4 Cold formed structural sheeting	+ A1:2011 Corrigendum November 2009
	NA to BS EN 1999-1-4:2007	UK National Annex to Eurocode 9: Design of aluminium structures – Part 1-4 Cold formed structural sheeting	-

Bsi Published Documents
For guidance only unless clauses are otherwise specified in IAN 124/11 Annex B.

	Document Number	**Title**
✓	PD 6688-1-1:2011	Recommendations for the design of structures to BS EN 1991-1-1
✓	PD 6688-1-2:2007	Background paper to the UK National Annex to BS EN 1991-1-2
✓	PD 6688-1-4:2009	Background paper to the UK National Annex to BS EN 1991-1-4
✓	PD 6688-1-7:2009	Recommendations for the design of structures to BS EN 1991-1-7
✓	PD 6688-2:2011	Recommendations for the design of structures to BS EN 1991-2
✓	PD 6687-1:2010	Background paper to the UK National Annexes to BS EN 1992-1 and BS EN 1992-3
✓	PD 6687-2:2008	Recommendations for the design of structures to BS EN 1992-2:2005
✓	PD 6695-1-9:2008	Recommendations for the design of structures to BS EN 1993-1-9
✓	PD 6695-1-10:2009	Recommendations for the design of structures to BS EN 1993-1-10
✓	PD 6695-2:2008 + A1:2012 and corrigendum no 1 February 2013.	Recommendation for the design of bridges to BS EN: 1993
✓	PD 6696-2:2007 + A1:2012	Background paper to BS EN 1994-2 and the UK National Annex to BS EN 1994-2
✓	PD 6694-1:2011	Recommendations for the design of structures subject to traffic loading to BS EN 1997-1
	PD 6698:2009	Recommendations for the design of structures for earthquake resistance to BS EN 1998
	PD 6703:2009	Structural bearings – Guidance on the use of structural bearings
✓	PD 6705-2:2010 + A1:2013	Recommendations for the execution of steel bridges to BS EN 1090-2
	PD 6705-3:2009	Recommendations on the execution of aluminium structures to BS EN 1090-3
	PD 6702-1:2009	Structural use of aluminium. Recommendations for the design of aluminium structures to BS EN 1999

Execution Standards referenced in British Standards or Eurocodes

	Execution Standard	Title
✓	BS EN 1090-1:2009+A1:2011	Execution of steel structures and aluminium structures - Part 1: Requirements for conformity assessment of structural components
✓	BS EN 1090-2:2008+A1:2011	Execution of steel structures and aluminium structures – Part 2: Technical requirements for the execution of steel structures
	BS EN 1090-3:2008	Execution of steel structures and aluminium structures – Part 3: Technical requirements for aluminium structures
	BS EN 13670:2009	Execution of concrete structures

Product Standards referenced in British Standards or Eurocodes

	Product Standard	Title
	BS EN 206:2013	Concrete – Specification, performance, production and conformity
	BS EN 1317-1:2010	Road Restraint Systems – Part 1 – Terminology and general criteria for test methods
	BS EN 1317-2:2010	Road Restraint Systems – Part 2 – Performance classes, impact test acceptance criteria and test methods for safety barriers.
	BS EN 1317-3:2010	Road Restraint Systems – Part 3 – Performance classes, impact test acceptance criteria and test methods for crash cushions.
	DD ENV 1317-4:2002	Road Restraint Systems – Part 4 – Performance classes, impact test acceptance criteria and test methods for terminals and transitions of safety barriers.
	BS EN 1317-5:2007+A1:2008 and corrigendum August 2012	Road Restraint Systems – Part 5 - Product requirements and evaluation of conformity for vehicle restraint systems
✓	BS EN 1337-1:2000	Structural bearings – Part 1: General Design Rules
	BS EN 1337-2:2004	Structural bearings – Part 2: Sliding elements
	BS EN 1337-3:2005	Structural bearings – Part 3: Elastomeric bearings
✓	BS EN 1337-4:2004 and corrigendum no 1 March 2007	Structural bearings – Part 4: Roller bearings
	BS EN 1337-5:2005	Structural bearings – Part 5: Pot bearings
	BS EN 1337-6:2004	Structural bearings – Part 6: Rocker bearings
	BS EN 1337-7:2004	Structural bearings – Part 7: Spherical and cylindrical PTFE bearings
	BS EN 1337-8:2007	Structural bearings – Part 8: Guide bearings and restraint bearings
	BS EN 1337-9:1998	Structural bearings – Part 9: Protection
	BS EN 1337-10:2003	Structural bearings – Part 10: Inspection and maintenance
	BS EN 1337-11:1998	Structural bearings – Part 11: Transport, Storage and Installation.
✓	BS EN 10025-1:2004	Hot rolled products of structural steels Part 1: General technical delivery conditions.
✓	BS EN 10025-2:2004	Hot rolled products of structural steels Part 2: Technical delivery conditions for non-alloy structural steels.
✓	BS EN 10025-3:2004	Hot rolled products of structural steels Part 3: Technical delivery conditions for normalized/normalized rolled weldable

		fine grain structural steels.
✓	BS EN 10025-4:2004	Hot rolled products of structural steels Part 4: Technical delivery conditions for thermomechanical rolled weldable fine grain structural steels.
✓	BS EN 10025-5:2004	Hot rolled products of structural steels – Part 5: Technical delivery conditions for structural steels with improved atmospheric corrosion resistance
	BS EN 10025-6:2004+A1:2009	Hot rolled products of structural steels – Part 6: Technical delivery conditions for flat products of high yield strength structural steels in the quenched and tempered condition.
	BS EN 10080:2005	Steel for the reinforcement of concrete – Weldable reinforcing steel - General
	BS EN 10248-1:1996	Hot rolled sheet piling of non alloy steels. Technical delivery conditions
	BS EN 10248-2:1996	Hot rolled sheet piling of non alloy steels. Tolerances on shape and dimensions
	BS EN 12063:1999	Execution of special geotechnical work. Sheet pile walls.
	BS EN 15050:2007 + A1:2012	Precast concrete products – Bridge elements

British Standards

	British Standard	Title
	BS 4449:2005+A2:2009	Steel for the reinforcement of concrete
	BS 5896:2012	Specification for high tensile steel wire and strand for the pre-stressing of concrete
	BS 8006-1:2010	Code of practice for strengthened/reinforced soils and other fills
	BS 8500-1:2006 +A1:2012 Incorporating Corrigendum No.1	Concrete – Complementary British Standard to BS EN 206-1 – Part 1: Method of specifying and guidance for the specifier.
	BS 8500-2:2006 +A1:2012 Incorporating Corrigendum No.1	Concrete – Complementary British Standard to BS EN 206-1 – Part 2: Specification for constituent materials and concrete.

The Manual Contract Document for Highway Works (MCHW)

	Volume Number	Title
✓	MCHW Volume 1: November 2009	Specification for Highway Works
✓	MCHW Volume 2: November 2009	Notes for guidance on the Specification for Highway Works
✓	MCHW Volume 3: November 2008	Highway Construction Details

The Design Manual for Roads and Bridges (DMRB)

	Volume Number	Title
✓	BD 2/12	Technical Approval of Highway Structures
	BD 7/01	Weathering steel for highway structures
	BD 10/97	Design of highway structures in areas of mining subsidence
	BD 12/01	Design of corrugated steel buried structures with spans greater than 0.9 metres and up to 8.0 metres
	BD 29/04	Design criteria for footbridges
✓	BD 33/94	Expansion joints for use in highway bridge decks

✓	BD 35/06	Quality assurance scheme for paints and similar protective coatings
✓	BD 36/92	Evaluation of maintenance costs in comparing alternative designs for highway structures
	BD 43/03	The impregnation of reinforced and prestressed concrete highway structures using hydrophobic pore-lining impregnants
	BD 45/93	Identification markings of highway structures
	BD 47/99	Waterproofing and surfacing of concrete bridge decks
	BD 51/98	Portal and cantilever signs/signal gantries
✓	BD 57/01	Design for durability
✓	BD 62/07	As built, operational and maintenance records for highway structures
	BD 65/97	Design criteria for collision protection beams
	BD 67/96	Enclosure of bridges
	BD 68/97	Crib retaining walls
	BD 78/99	Design of road tunnels
	BD 82/00	Design of buried rigid pipes
	BD 90/05	Design of FRP bridges and highway structures
	BD 94/07	Design of minor structures
✓	BA 26/94	Expansion joints for use in highway bridge decks
	BA 28/92	Evaluation of maintenance costs in comparing alternative designs for highway structures
	BA 36/90	The use of permanent formwork
	BA 41/98	The design and appearance of bridges
	BA 42/96	The design of integral bridges
	BA 47/99	Waterproofing and surfacing of concrete bridge decks
✓	BA 57/01	Design for durability
	BA 59/94	Design of highway bridges for hydraulic action.
	BA 67/96	Enclosure of bridges
	BA 68/97	Crib retaining walls
	BA 82/00	Formation of continuity joints in bridge decks
	BA 84/02	Use of stainless steel reinforcement in highway structures
✓	BA 85/04	Coatings for concrete highway structures & ancillary structures
	BA 92/07	Use of recycled concrete aggregates in structural concrete
	TD 19/06	Requirement for road restraint systems
	TD 27/05	Cross-sections and headrooms
	HD 22/08	Managing geotechnical risk
	HA 66/95	Environmental barriers

Transport Scotland Interim Amendments (TS IA Series)

	TS IA Number	**Title**
✓	TS IA 11	Model Contract Documents for Highway Works
✓	TS IA 12	Specification for Highway Works Mar 98
✓	TS IA 13	Model Contract Documents for Highway Works (For use in Scotland) Aug 94
✓	TS IA 14	Model Contract Documents for Highway Works (For use in Scotland) Aug 94
	TS IA 15	
	TS IA 16	Methods of Measurement for Highway Works Aug 94

	TS IA 17	
✓	TS IA 18	Notes for Guidance on the Specification for Highway Works May 05
	TS IA 19	
	TS IA 20	Concrete Half Joint Deck Structures Apr 06
	TS IA 21	Principal and General Inspection of Sign / Signal Gantries, and Gantries with low Handrails or Open Mesh Flooring – Oct 06
	TS IA 22	Implementation of New Reinforcement Standards (BS 4449:2005, BS 4483:2005, BS 8666:2005) Oct 06
	TS IA 23	Implementation of BS8500-1:2006 Concrete – Complementary British Standard to BS EN 206-1 – Jun 07
✓	TS IA 24	Guidance on implementing results of research on bridge deck waterproofing – July 07
	TS IA 25	Assessment and Upgrading of Existing Vehicle Parapets Aug 07
	TS IA 26	The Anchorage of Reinforcement & Fixings in Hardened Concrete – Feb 08
	TS IA 27	Implementation of the Construction (Design and Management) regulations 2007 and the withdrawal of SD 10/05 and SD 11/05 - May 08
	TS IA 28	Certification of Combined Kerb and Drainage Products - Dec 08
	TS IA 29	Identification of 'Particularly at Risk' Supports - June 09
	TS IA 30	The Use of Foamed Concrete - Oct 09
	TS IA 31	The use of Eurocodes for the design of bridges and road related structures – April 10
	TS IA 32	Clarification on the deflection of permanent formwork during the construction of trunk road bridges – Oct 10
	TS IA 33	Guidance on the use of various documents relating to General & Principal Inspections for Trunk Road Structures – Oct 10
	TS IA 34	Guidance on the use of High Friction Surfacing at Signalised Pedestrian Crossings on single carriageway Trunk Roads – Nov 10
✓	TS IA 35	Guidance on the Introduction of Transport Scotland TS 2010 surface course specification – Dec 10

	TS IA 36	Guidance on structural safety reporting relating to the Scottish Trunk Road Network – Dec 10
	TS IA 37	Design of Single 2+1 single roads – Dec 10
	TS IA 38	Temporary Barrier Decision Tool (TBDT) – May 11
✓	TS IA 39	Use of Eurocodes for the design of bridges and road related structures – Aug 11
	TS IA 40	Road Safety Auditor Certification – Compliance with EC Directive 2008/96/EC – Dec 2011
	TS IA 42	Temporary Cover Plates Over Bridge Expansion Joints – Aug 2013
	TS IA 43	Strategy for the Repair/Replacement of Joints

Miscellaneous

	Document	**Title**
	BRE Special Digest 1: 2005: Third Edition	Concrete in aggressive ground.
	CHE Memorandum 227/08	The Impregnation of Reinforced and Pre-stressed Concrete Highway Structures using Hydrophobic Pore Lining Impregnants
	CIRIA C543	Bridge Detailing Guide
	CIRIA C660	Early-age Thermal Crack Control in Concrete
	CIRIA C686	Safe Access for Maintenance and Repair

A.2 Appendix B General Arrangement Details of Structure

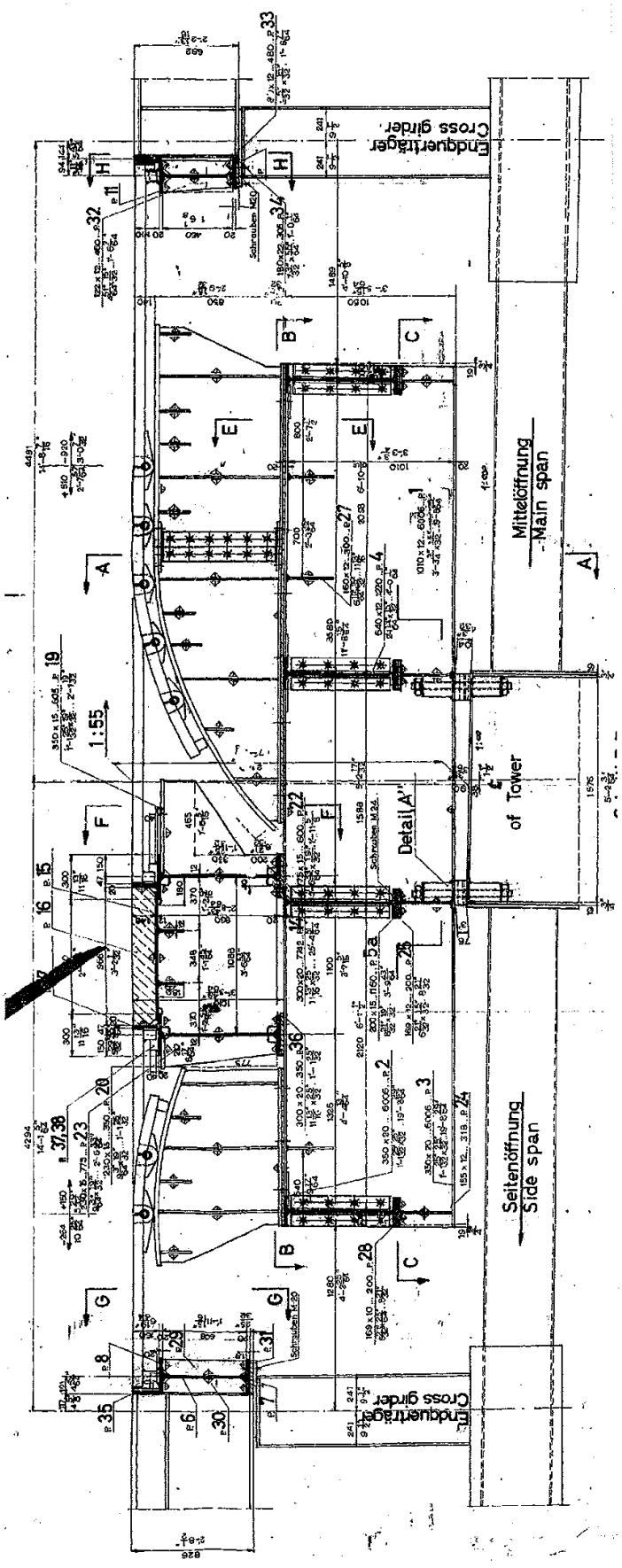
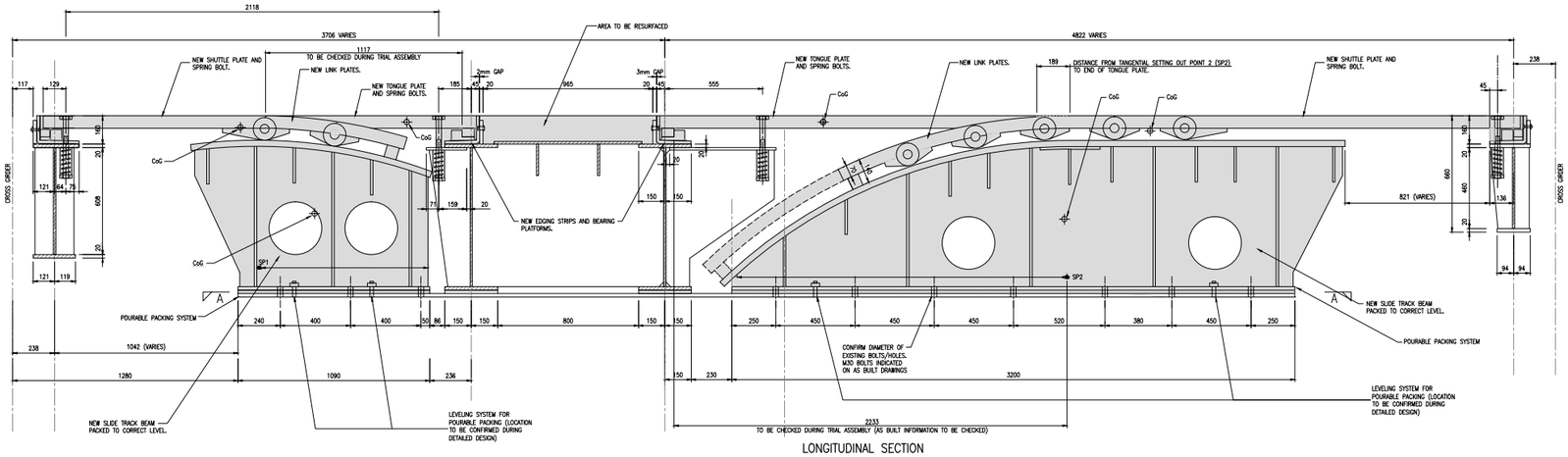
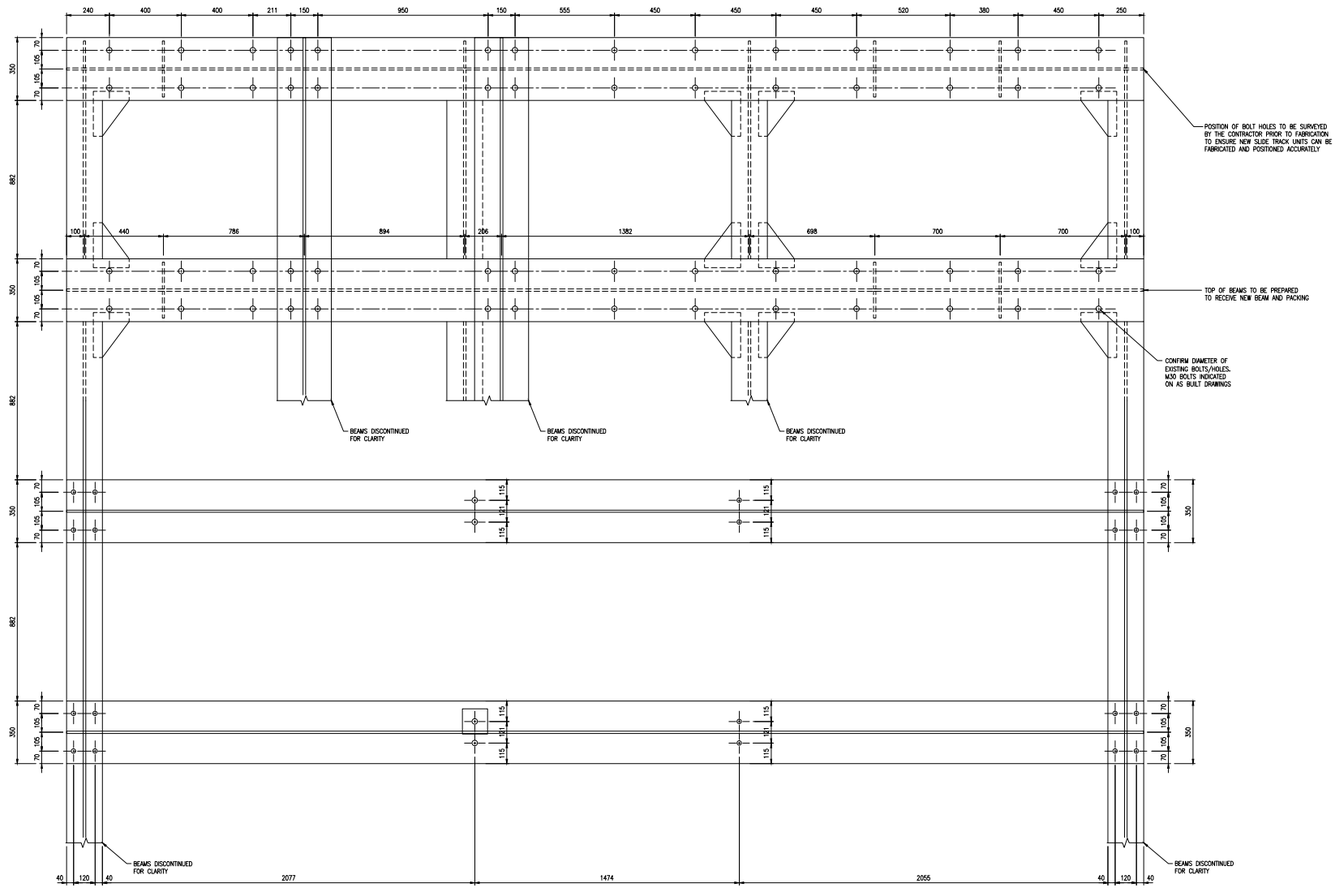


Fig 1 – Typical Section through Roller Shutter Joint



LONGITUDINAL SECTION
SCALE 1:10



SECTION A–A ON SUPPORTING GRILLAGE
SCALE 1:10

NOTES

1. REFER TO INDIVIDUAL COMPONENT DRAWINGS FOR DETAILS OF MATERIALS AND DIMENSIONS.

2. DIMENSIONS TO BE CHECKED ON SITE BY CONTRACTOR PRIOR TO FABRICATION.

3. FOR FABRICATION TOLERANCES REFER TO INDIVIDUAL COMPONENT DRAWINGS AND APPENDICES.

4. INSTALLATION OF NEW BEARING PLATFORMS TO BE POSITIONED AND LEVELLED TO ENSURE THE NEW TONGUE PLATES ARE IN FULL CONTACT WITH THE LINK PLATES.

KEY

ELEMENT TO BE REPLACED

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION
IN ADDITION TO THE HAZARDS/RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, NOTE THE FOLLOWING SIGNIFICANT RESIDUAL RISKS
CONSTRUCTION
WORK AT HEIGHT, HIGH WINDS AND LIMITED WORKING SPACE
MAINTENANCE/CLEANING
WORK AT HEIGHT, HIGH WINDS AND LIMITED WORKING SPACE
USE
NONE
DECOMMISSIONING/DEMOLITION
WORK AT HEIGHT, HIGH WINDS AND LIMITED WORKING SPACE

Stat	Purpose of Issue	Date	Auth
P	AIP	02/14	SHJ

Rev	Description	By	Date	Chk'd	Auth

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Client
FORTH ESTUARY TRANSPORT AUTHORITY

Project
FORTH ROAD BRIDGE
JOINT REPLACEMENT

Title
ROLLER SHUTTER JOINT
NEW LAYOUT
GENERAL ARRANGEMENT FOR AIP

Sheet Size	Original Scale	Designed/Drawn	Checked	Authorised
A0	As Shown	SH 02/14	CM 02/14	SHJ 02/14

Status	Drawing Number	Rev
P	5088419/202/AIP	A

Rev A
Drawing Number 5088419/202/AIP
Status P

DO NOT SCALE

A0 0 10 100

File: 5057541_301_006-009_A2__AIP_V2.dwg
Date: Feb 14, 2014 - 3:31pm Plotted by: hugh5416

P:\GBBSB\Hand1\Tsol\CN\5088419 Forth Road Bridge Joints 2013 timb1702\70 – Drawings\Previous design drawings\AIP\Auto CAD\5057541_301_006-009_A2__AIP_V2.dwg

A.3 Appendix C Hazard Identification and Risk Assessments

Appendix D Design and Assessment loading and assumptions

Scheme Title: Forth Road Bridge - Replacement of Roller Shutter Joints CDM Hazard Log

Notes:
1. This CDM Hazard Log does not use conventional risk scoring. In its place is a requirement to determine whether the residual risk is "Significant" as ACOP 131-134
2. The CDM Hazard Log should be used in conjunction with the RAG List dated November 2008 (See "RAG List" sheet)
3. The provision of items on the Red and Amber Lists does not remove from the designer any obligation to identify and assess hazards and risks specific to the project
4. Refer also to Guidance Worksheet
5. Risks not on the RAG list should be compared with Red and Amber items on the list to help judge their risk rating

PART A - RISK IDENTIFICATION

Ref	Date	Designer (Name)	Element or Location	Hazard (For examples, hover over this cell. Also use "Activity List" sheet to prompt hazards from work situations)	RAG Item No. and abbreviated description (Click here to see list and full description)	Risk Rating Red - Extreme, Amber - Significant or Not Significant	Project Stage
001	13 Jan '14	D Timby	General	Activity Time Constraints - in terms of contract period and carriageway closures Hazard Potential for accidents to rush job within time limits	None applicable	**Amber - Significant**	C/D
002	13 Jan '14	D Timby	General	Activity High noise levels from work activities and passing traffic. Hazard Potential hearing damage. Could affect both work force and residential properties	A14 - Specify work which exceed Noise at Work Regulations.	**Amber - Significant**	C/D
003	13 Jan '14	D Timby	General	Activity Access for future maintenance - can the joints be designed to allow easier access Hazard Poor access could lead to lack of inspection and maintenance. Risk of injury to personnel in reaching inaccessible areas.	None applicable	**Not Significant**	M
004	13 Jan '14	D Timby	General	Activity Dismantling existing joints Hazard Risk of injury to operatives	A13 - Require manual work with Musculoskeletal Disorder potential (eg. Drilling)	**Amber - Significant**	D
005	13 Jan '14	D Timby	Traffic Management	Activity Carriageway closures Hazard Risk of vehicle accidents caused by delays and diversions	None applicable	**Not Significant**	C/D
006	13 Jan '14	D Timby	General	Activity Difficult access around joints Hazard Risk of falling (people or materials)	R3 - Design prevents fall prevention systems	**Red - Extreme**	C
007	13 Jan '14	D Timby	General	Activity Lifting in / out components / joints Hazard Damage to other parts of bridge lifting in / out joints	None applicable	**Not Significant**	C
008	13 Jan '14	D Timby	Steelwork	Activity Maintenance painting of existing components - removal of unsound paint. Hazard Potential lead in paint which is hazardous to health	None applicable	**Amber - Significant**	C
009	13 Jan '14	D Timby	General	Activity Working at height Hazard Falls from height	R9 - Design at height without provision for suitable working platform	**Red - Extreme**	C
010	13 Jan '14	D Timby	General	Activity Working over water Hazard Pollution of water course from work activities (e.g. Painting, grit blasting)	None applicable	**Not Significant**	C
011	13 Jan '14	D Timby	General	Activity Working on highway Hazard Working close to traffic - risk of conflict with vehicles	R7 - TM design not using all information available	**Red - Extreme**	C
012	13 Jan '14	D Timby	General	Activity General Hazard Limited working space. Potential of injury from adjacent activities, plant movements.	A10 - Site layout without space for delivery / storage of materials	**Amber - Significant**	C
013	13 Jan '14	D Timby	General	Activity All Hazard Bridge contains services (water, communications) for maintenance. Risk of damage and loss of service.	R8 - Relevant services information not obtained	**Red - Extreme**	C
014	13 Jan '14	D Timby	General	Activity General access between various joint locations Hazard Conflict between passing plant moving from one area to another	A9 - Safe site traffic routes prevented (one way / segregation systems)	**Amber - Significant**	C
015	13 Jan '14	D Timby	General	Activity Plant movement, particularly reversing vehicles. Hazard Conflict between plant and operatives.	A9 - Safe site traffic routes prevented (one way / segregation systems)	**Amber - Significant**	C
016	13 Jan '14	D Timby	General	Activity Unauthorised access by operatives or members of the public Hazard Risk of personal injury to those unfamilair with site.	R6 - Design prevents segregation of public from site.	**Red - Extreme**	C
017	13 Jan '14	D Timby	Steelwork	Activity Site Welding. Hazard Fire resulting from falling hot welding slag or sparks on the passing ships or oil tankers below the bridge deck.	A17 - New structures requiring on-site welding.	**Amber - Significant**	C
018	13 Jan '14	D Timby	General	Activity Manual handling Hazard Musculoskeletal Disorders (MSD)	A4 - Materials weighing > 20kgs requiring manual handling	**Amber - Significant**	C
019	13 Jan '14	D Timby	Foot / cycleway	Activity General working on footway joints, inc access plant Hazard Potential conflict between site operations and users of foot / cycleway. Risk of personal injury.	R6 - Design prevents segregation of public from site.	**Red - Extreme**	C
020	13 Jan '14	D Timby	General	Activity Weather conditions - site exposed to wind, rain and temperature. Hazard Potential sickness, increased risk of falling in high winds.	None applicable	**Amber - Significant**	C/O/M

PART B - RISK ELIMINATION / REDUCTION

Date design measure suggested	Can the risk be eliminated	If a Green RAG list item employed to significantly reduce risk, list it here (Click here to see green list of preferred materials, elements and processes)	Designer measures taken and considered to eliminate or reduce risk
	No	G16 - Ensure use of right people for the right job at the right time to reduce risk, paperwork and encourage teamwork.	Programme work. Discuss with Contractor to ensure sufficient time available at start of work
	No	None applicable	Avoid anti-social hours. Residential properties sufficiently far enough away. Ear protection on site if necessary.
	No	None applicable	Improvements have been made for access to joints. Limited scope for further changes
	No	G12 - Encourage use of mechanical means instead of manual handling	Use of experienced contractor with suitable equipment.
	Yes	None applicable	Undertake works after new crossing in place. Liaise with neighbouring highway authorities to avoid road space clash.
	Yes	G2 - Provision for maintenance / replacement access	Use of experienced contractor. Available means to fix safety harnesses. Design joints so that they can be assembled on site in easily managed sized components.
	Yes	G19 - Designer to consider lifting operation feasibility of and risks	Joints can be dismantled or cut into parts to limit lifting weight and size
	Yes	None applicable	Test for lead prior to start of works. Consult existing records.
	Yes	G2 - Provision for maintenance / replacement access	Also use harnesses for work force. Avoid working in high winds / bad weather
	Yes	None applicable	Painting off site. Existing components, if fell, would not significantly pollute
	Yes	G13 - Consult with all interested parties for TM scheme	Use FETA standard procedures for carriageway closure
	Yes	G14 - Provision for safe Plant / Materials storage areas away from c'way	Consider use of FETA depot
	Yes	None applicable	No service diversions will be necessary, but consult FETA records.
	Yes	G13 - Consult with all interested parties for TM scheme	Use FETA standard procedures for carriageway closure
	Yes	G1 - Minimise vehicle reversing requirements	Carriageway will be closed. Use of banksmen.
	Yes	None applicable	Existing CCTV cameras available to monitor
	Yes	G10 - Construction sequence considered to minimize the workforce exposure to live traffic.	Trial erection off site to minimise any fabrication on site. May have some repairs / modification to supporting structure.
	Yes	G12 - Encourage use of mechanical means instead of manual handling	Crane can be positioned on carriageway for lifting. FETA have standard procedures. Consider new components to have lifting points.
	Yes	None applicable	Avoid use of foot / cycleway for construction uses. Consider screens (avoid wind loads)
	Yes	G21 - Consider minimum welfare facilities needed for contract.	Also avoid poor weather, consult forecasts.

PART C - RESIDUAL RISK INFORMATION

Risk Rating Red - Extreme, Amber - Significant or Not Significant	Residual risk information to pass onto Contractor	Means of communicating significant residual risk (RED and Amber items will go into PCI and drawings)	Further Comments / Record of communication to Project Director for sign off if a **Red List** item	Is the residual risk significant and not obvious to those who will use the design?	Contractor accepts issues	**Status** Active/ Closed
Not Significant	None, but review contractors programme.	N/A	N/A	No		
Not Significant	None, but permitted noise levels and times to be included in contract specification.	N/A	N/A	No		
Not Significant	None.	N/A	N/A	No		
Not Significant	None specific, but advise on drawings.	N/A	N/A	No		
Not Significant	Use of FETA standard procedures for carriageway closures as these tried and tested.	N/A	N/A	No		
Not Significant	Advise that will be working at height.	N/A	N/A	No		
Not Significant	None.	N/A	N/A	No		
Amber - Significant	Advise Contractor if records or tests show that lead may be present	Indicate risk on drawings and contract specification	N/A	No		
Not Significant	Advise that will be working at height.	N/A	N/A	No		
Not Significant	None	N/A	N/A	No		
Not Significant	Use of FETA standard procedures for carriageway closures as these tried and tested. Details in contract documentation.	N/A	N/A	No		
Not Significant	Advise contractor of suitable storage areas in contract documentation	N/A	N/A	No		
Not Significant	Advise contractor of any nearby services in contract documentation.	N/A	N/A	No		
Not Significant	Use of FETA standard procedures for carriageway closures as these tried and tested. Details in contract documentation.	N/A	N/A	No		
Not Significant	Use of FETA standard procedures for carriageway closures as these tried and tested. Details in contract documentation.	N/A	N/A	No		
Not Significant	Contractor to take security measures such as fencing, locking away equipment, etc	N/A	N/A	No		
Amber - Significant	Some site welding may be unavoidable but design site connections to be bolted where possible.	N/A	N/A	No		
Not Significant	None	N/A	N/A	No		
Not Significant	Contractor to be advised that foot / cycleway not available to him in contract documents	N/A	N/A	No		
Not Significant	None	N/A	N/A	No		

Issue: 2
Printed: 18/02/2014

Checks to be completed

Design

Shuttle and Tongue Plates

- Shuttle Plates
  - Main span
  - Side span
- Tongue Plate
  - Main span
  - Side span
- Uplift bolts and springs in the shuttle and tongue plates
- Pins between shuttle plates

Slide Tracks

- Beam as a unit
  - Moment and shear capacity at various locations along beam
- Splice between:
  - Webs
  - Top flanges
  - Bottom flanges
- Stiffeners
- Connection between bottom flange of slide track beam and seating beam

Assessment

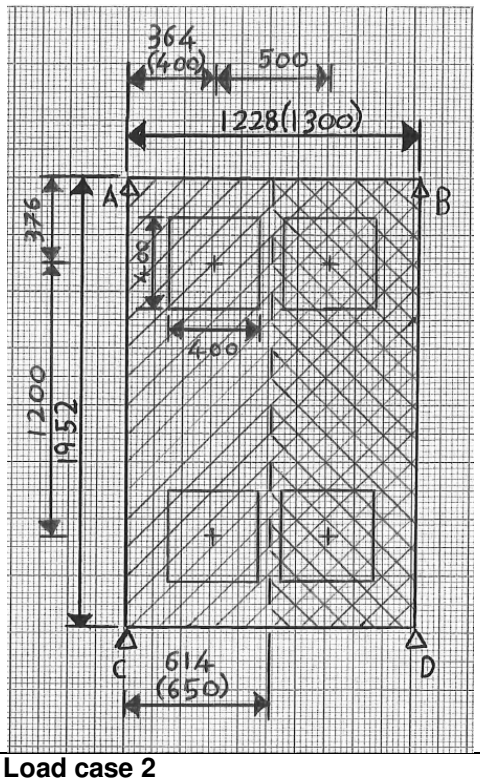
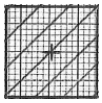
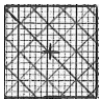
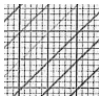
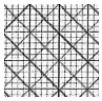
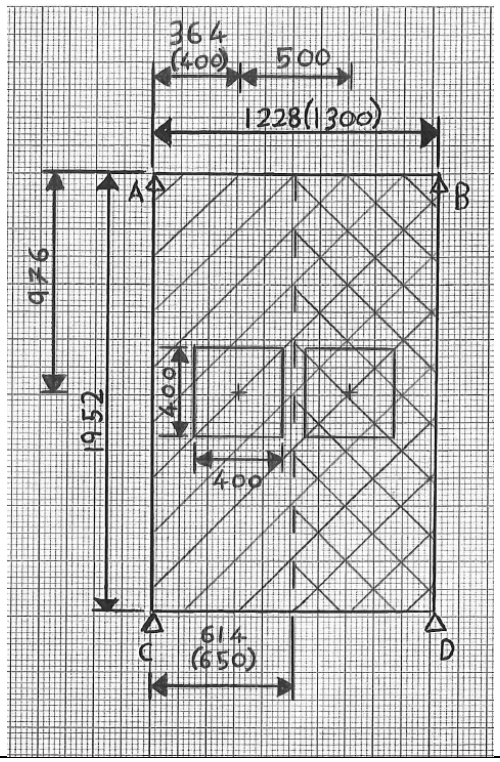
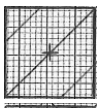
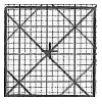
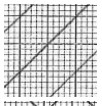
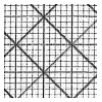
- Slide track beams supporting plate girder
- Roller shutter plates supporting cross beams
  - Main span
  - Side span
- Bearing Pins
- Pedestal support (crosshead)

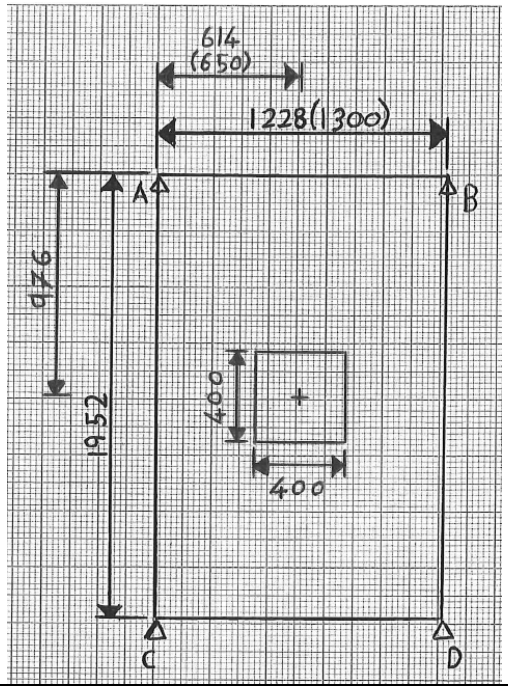
Design

Shuttle and Tongue Plates

Main Span Large Shuttle Plates

The shuttle plates will be modelled as basic finite element plates in LUSAS Finite Element Structural Analysis they will be modelled with the following load cases.

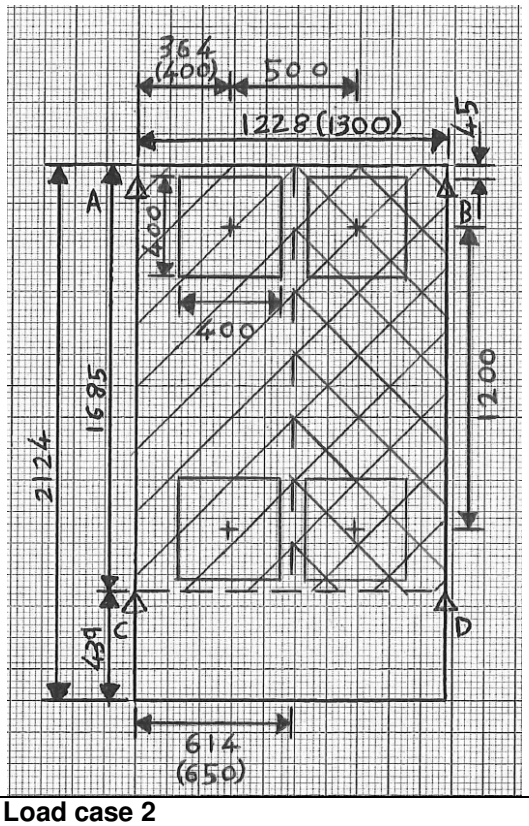
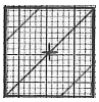
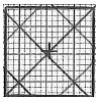
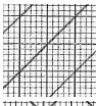
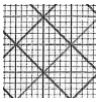
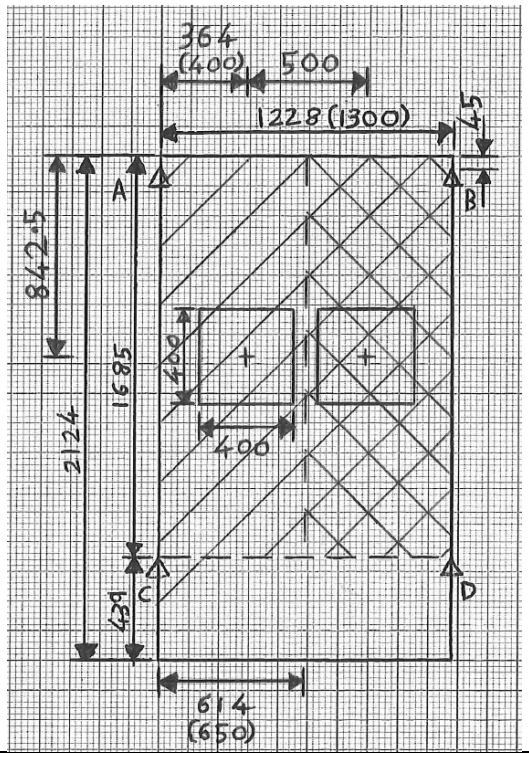
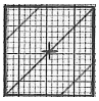
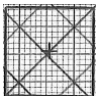
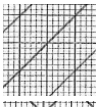
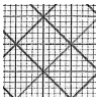
Load case 1  	**Loading from Load Model 1 (LM1):** • Four patch loads corresponding to two wheels from each of two tandem systems (TS) in notional lanes 1 & 2. ○  $(\alpha_{Q1}Q_{1k})/2 = (1.0*300)/2 = 150kN$ ○  $(\alpha_{Q2}Q_{2k})/2 = (1.0*200)/2 = 100kN$ • 2 different UDL loads, which correspond to the UDLs for notional lane 1 and notional lane 2. ○  $\alpha_{q1}q_{1k} = 0.61*9 = 5.49kN/m^2$ ○  $\alpha_{q2}q_{2k} = 2.2*2.5 = 5.5kN/m^2$
Load case 2	The same loading as Load case 1 but only supported at A + D or B + C due to either wear or uplift at other supports.
Load case 3  	**Loading from Load Model 1 (LM1):** • Two patch loads corresponding to one wheel from each of two tandem systems (TS) in notional lanes 1 & 2. ○  $(\alpha_{Q1}Q_{1k})/2 = (1.0*300)/2 = 150kN$ ○  $(\alpha_{Q2}Q_{2k})/2 = (1.0*200)/2 = 100kN$ • 2 different UDL loads, which correspond to the UDLs for notional lane 1 and notional lane 2. ○  $\alpha_{q1}q_{1k} = 0.61*9 = 5.49kN/m^2$ ○  $\alpha_{q2}q_{2k} = 2.2*2.5 = 5.5kN/m^2$

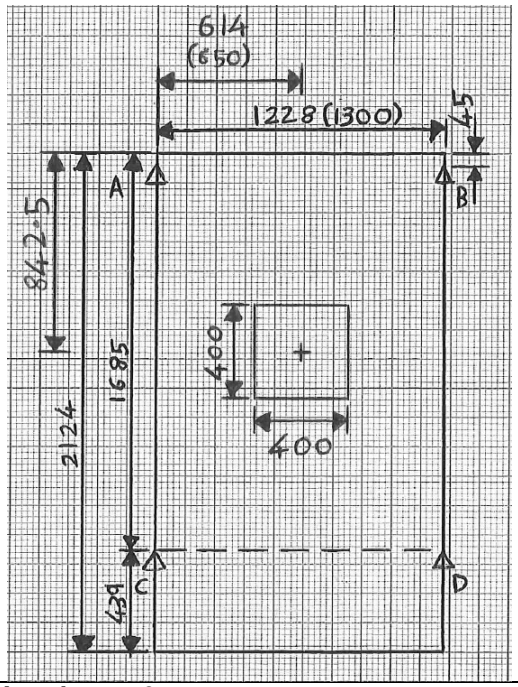
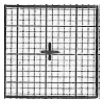
Load case 4	The same loading as Load case 3 but only supported at A + D or B + C due to either wear or uplift at other supports.
Load case 5  	**Loading from Load Model 2 (LM2):** • Single patch load from one wheel of the single axle LM2 load. ○  $(\beta_Q Q_{ak} \Delta\varphi_{fat})/2 = (\alpha_{Q1} Q_{ak} \Delta\varphi_{fat})/2 =$ (1.0*400*1.30)/2 = 260kN
Load case 6	The same loading as Load case 5 but only supported at A + D or B + C due to either wear or uplift at other supports.

Side Span Shuttle plates
If the previous main span shuttle plates pass capacity checks, these plates will pass by inspection therefore no further analysis will be needed.

Load Cases for Main Span Tongue Plate

The tongue plates will be modelled as basic finite element plates in LUSAS Finite Element Structural Analysis they will be modelled with the following load cases.

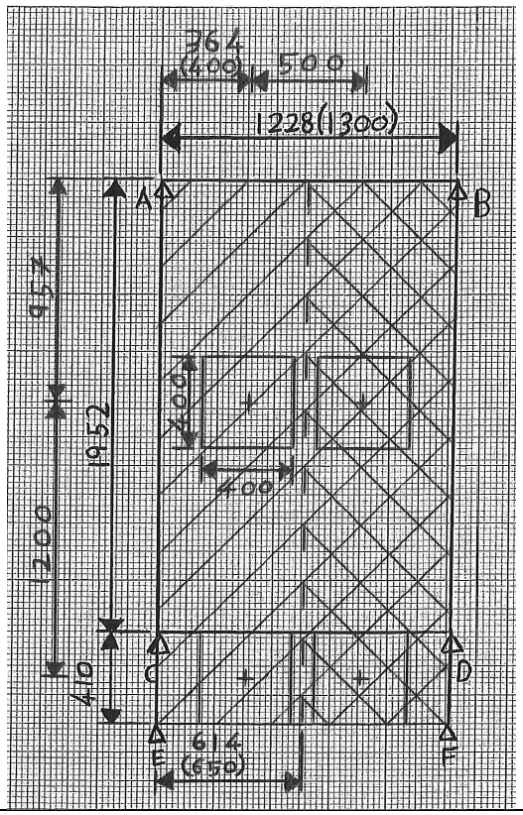
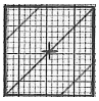
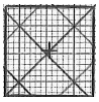
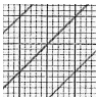
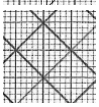
Load case 1  	**Loading from Load Model 1 (LM1):** • Four patch loads corresponding to two wheels from each of two tandem systems (TS) in notional lanes 1 & 2. ○  $(\alpha_{Q1}Q_{1k})/2 = (1.0*300)/2 = 150kN$ ○  $(\alpha_{Q2}Q_{2k})/2 = (1.0*200)/2 = 100kN$ • 2 different UDL loads, which correspond to the UDLs for notional lane 1 and notional lane 2. ○  $\alpha_{q1}q_{1k} = 0.61*9 = 5.49kN/m^2$ ○  $\alpha_{q2}q_{2k} = 2.2*2.5 = 5.5kN/m^2$
Load case 2	The same loading as Load case 1 but only supported at A + D or B + C due to either wear or uplift at other supports.
Load case 3  	**Loading from Load Model 1 (LM1):** • Two patch loads corresponding to one wheel from each of two tandem systems (TS) in notional lanes 1 & 2. ○  $(\alpha_{Q1}Q_{1k})/2 = (1.0*300)/2 = 150kN$ ○  $(\alpha_{Q2}Q_{2k})/2 = (1.0*200)/2 = 100kN$ • 2 different UDL loads, which correspond to the UDLs for notional lane 1 and notional lane 2. ○  $\alpha_{q1}q_{1k} = 0.61*9 = 5.49kN/m^2$ ○  $\alpha_{q2}q_{2k} = 2.2*2.5 = 5.5kN/m^2$
Load case 4	The same loading as Load case 3 but only supported

	at A + D or B + C due to either wear or uplift at other supports.
Load case 5  	**Loading from Load Model 2 (LM2):** • Single patch load from one wheel of the single axle LM2 load.  $(\beta_Q Q_{ak} \Delta\varphi_{fat})/2 = (\alpha_{Q1} Q_{ak} \Delta\varphi_{fat})/2 =$ (1.0*400*1.30)/2 = 260kN
Load case 6	The same loading as Load case 5 but only supported at A + D or B + C due to either wear or uplift at other supports.

Side Span Tongue plates
If the previous main span tongue plate passes capacity checks, this plate will pass by inspection therefore no further analysis will be needed.

Pins between Shuttle Plates

The pins that hold the shuttle plates together will be assessed by using the loads taken from the following load case applied to a finite element model of two plates created in LUSAS Finite Element Structural Analysis representing the two shuttle plates and hand calculations will be used to design the pins.

Load case 1	**Loading from Load Model 1 (LM1):**
	• Four patch loads corresponding to two wheels from each of two tandem systems (TS) in notional lanes 1 & 2. ○  $(\alpha_{Q1}Q_{1k})/2 = (1.0*300)/2 = 150kN$ ○  $(\alpha_{Q2}Q_{2k})/2 = (1.0*200)/2 = 100kN$ • 2 different UDL loads, which correspond to the UDLs for notional lane 1 and notional lane 2. ○  $\alpha_{q1}q_{1k} = 0.61*9 = 5.49kN/m^2$ ○  $\alpha_{q2}q_{2k} = 2.2*2.5 = 5.5kN/m^2$

Slide Track Beams

3D solid shell models of both the main span and side span slide track beams will be created. These will be loaded by the load effects taken from the assessment of the tongue plates, shuttle plates and the pin load cases.

Assessment

All of the members and components to be assessed will be assessed using capacities determined from Eurocodes compared to the new loadings obtained from the Eurocode design of the new members.