Forth Estuary Transport Authority
Forth Road Bridge

Approval In Principle
For Design of Replacement Comb Joints from Bridge Deck

Date: August 2014

Notice

This document was produced by Atkins Limited for the Forth Estuary Transport Authority (FETA) for the specific purpose of the Design Approval in Principle for the Replacement of Comb Joints from Bridge Deck on the Forth Road Bridge.

This report may not be used by any person other than FETA without FETA*'s* express permission. In any event, Atkins accepts no liability for any costs, liabilities or losses arising as a result of the use of or reliance upon the contents of this report by any person other than FETA.

Document History

JOB NUMBER: 5127603			DOCUMENT REF: 5127603/005			
B	Second Draft-Issued for FETA Review					28/08/2014
A	First Draft-Issued for FETA Review					20/02/2014
Revision	Purpose Description	Originated	Checked	Reviewed	Authorised	Date

Plan Design Enable

Contents

Section Page

Appendices

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

NAME OF PROJECT: **DESIGN FOR REPLACEMENT OF COMB JOINTS**

NAME OF STRUCTURE: **FORTH ROAD BRIDGE**

STRUCTURE REF NUMBER: **N/A**

The existing comb joints on Forth Road Bridge have worn down from general traffic usage and are showing signs of distress in the joint elements. The top edge of the support bar and the underside of the sliding fingers have locally worn resulting in a loss of support to the fingers. Some of the fingers appear to have bent downwards as a result of traffic loading. It is recommended to replace the existing comb joints with similar joint type. This AIP covers the analysis and design for the replacement comb joint, including the modifications in the supporting steelwork.

1. HIGHWAYS DETAILS

1.1. **Type of Highway**

Over structure: A90, 2 lane Dual Carriageway.

Under Structure: 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

1.4. Obstacles Crossed

This AIP is for the replacement of the existing comb joints on the main carriageways. The comb joints span the movement gaps in the approach viaducts - one at the north side tower and other at pier S3 on the south approach viaduct.

3. EXISTING AND PROPOSED STRUCTURE

3.1 Description of the Existing and Proposed Structure

3.1.1 Description of the Existing Structure (Comb Joints)

The 2No existing cantilever comb joints were manufactured by Head, Wrightson Teesdale Ltd. of Thornaby-on-Tees and were commissioned in 1964.

The joints accommodate the thermal movement in the approach viaducts. On the north side the joint is located between the approach viaduct and the side suspension span; and on the south side the joint is located within the approach viaduct, at Pier S3.

The 'as-built' drawings do not indicate the original design range of movement required for each joint. From the drawings the joint in the south approach viaduct is larger than the joint at the end of the north side suspension span, the length of the comb fingers being 305mm and 203mm respectively. The extreme physical movement range of the south viaduct joint is 280mm, whilst that of the north side joint is 178mm. These movement ranges are much smaller than the theoretical values calculated for the two joints. Even, based on their service, there is no reason to assume that the range allowed for in any of the joints is not adequate

At both locations the comb joints are confined to the width of the carriageways, in the central reserve and foot/cycle ways the gaps are bridged by pairs of sliding plates.

At carriageway level the joints have two comb plates with fingers that interlock with the opposite plate. On one side of the gap the comb plates are continuous over the full width of each carriageway, they are welded directly to the support structure which is connected to the main steelwork and concreted into the deck slab. At the ends to these plates a steel support bar has been welded to the underside of the fingers. The fingers from the other comb plate rest on this bar. On the opposite side of the gap the support structure is again built into the deck construction but the combs, which comprise a series of plates typically 915mm wide, are held down onto the support structure using spring loaded bolts. Only the bolted comb plates can be lifted for inspection and maintenance purposes.

As-built drawings indicate that the holding down bolts to the comb plates were replaced in 1970. The original "Dowpac" liquid spring units were replaced with conventional spring loaded bolts. The modifications also included replacement of the fixing brackets although this appears never to have been completed.

The joints are still functional, but owning to their general traffic usage and movement are now showing signs of increased wear in the supporting bar and comb fingers. The fingers of the bolted comb plate appear to have both bent downwards and tapered at the ends. In addition, the comb joints over the north side tower are also showing signs of misaligned in a vertical direction with the south side (side span) of the joint being higher than the north approach span side.

3.1.2 Description of Proposed Structure (Comb Joints) and Design Working Life

It is proposed that the replacement works of the existing joints should be undertaken for both bolted and fixed comb plates including their fixing detail. The existing joint type that utilises support bar will be replaced with a similar system but with modification in the fixing detail to allow future replacement. A schematic sketch of the replacement comb joint is included in Appendix B. The replacement comb plates will include high grade structural steel S355 with anti-slip grip enhancing pattern for riding surface. Both comb plates on either side of the joints will be made modular to allow easy installation and replacement without using heavy lifting plant.

In addition to replacing the comb plates, the work would also include replacing all spring loaded bolts, original fixing brackets and drainage system. Refurbishment of the worn running rails that abut the surfacing may also be required along with maintenance painting of the steelwork.

The proposed design life of the replacement joint shall be for 30 years with limited maintenance for the first 20 years of its service life.

3.2 Structural type

The proposed replacement joint will be a bespoke product, but cutting of comb plates, welding of brackets and milling of grip enhancing pattern will be undertaken in factory environment. Some on-site welding may be required to modify the existing steelwork for fixing of new joint assembly.

3.3 Foundation type

The support to comb joints will be retained. However steelwork comprising steel brackets and supporting bars at the fixed comb plate will be removed to incorporate new support arrangement for the replacement joint. This may require in-situ welding to modify bolting of new joints to the supporting steelwork.

3.4 Span arrangements

The replacement joints will be designed to accommodate the same movement range as the existing joints. These were determined to be conservative and much less than the theoretical movements calculated for north and south approach spans.

3.5 Articulation arrangements

The replacement comb joints will incorporate a sliding bar, fixed to the steel bracket underside the cantilever comb plate that will allow the bolted (spring loaded) comb plate to slide over it and thereby allow the movement. The new support bars will be replaceable and will be bolted into the supporting bracket. The proposed modification will allow easy replacement for future maintenance.

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 road restraint systems are retained as it is. No changes are envisaged due to joints replacement.

3.8 Proposed arrangements for future maintenance and inspection

3.8.1 Traffic management

The replacement joints will not affect the requirements for Traffic management for future maintenance and inspections. However with improved material and sliding system, the frequency of maintenance interventions is likely to decrease.

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, with improvement in drainage system, inspection and maintenance of comb joints will be much more convenient than existing.

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 replacement joints. Limited used of hydrodemolition of the concrete deck slab is expected for removal of the existing joints. The proposal for treatment of water prior to its disposal will be developed and discussed with the environmental agency.

3.10 Durability, Materials and Finishes

4 Material properties for joints replacement shall be as follows:

Concrete:	Repair concrete for deck slab shall be Grade C50/60 to BS EN 206. The cover to reinforcement shall conform to BS 8500 and IAN 95/07. The exposure class for deck slab protected with waterproofing shall be taken as XC3 and XC4.
Reinforcement:	Steel reinforcement shall be Grade B500B or B500C to BS 4449: 2005.
Concrete Surfaces:	Exposed surfaces requiring waterproofing shall have U4 finish. All other unformed surfaces shall have U1 finish.
Steelwork:	Steelwork used as part of permanent works shall be Grade S355J2 to BS EN 10025-2. All exposed steelwork shall be painted with an approved protective system as per specification on the exposed surfaces. All bolts to be High Strength Friction Grip Bolts (HSFG) spun galvanised, with property class 8.8 or 10.9. The bolt assembly, nuts and washers shall comply with BS EN 14399-1.
Waterproofing:	Waterproofing on the top surface of the deck slab shall be reinstated with a spray applied waterproofing system in accordance with Cl. 2003 of the Specification for Highway Works and to the requirement of BD47/99.
Expansion Joints:	The steel for the replacement comb joints shall be Grade S355J2 to BS EN 10025-2.
Drainage:	The replacement comb joints will incorporate a drainage channel running below the comb joints and drain into the existing outfall. The material for the drainage channel shall be transparent PVC.

4.1 Risks and Hazards Considered for the 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;
- Gaps in structure once plates are removed, protective barriers/screens required;
- Lifting operations;
- Site works (welding; grinding, blasting painting and manual handling);
- Working adjacent to existing services.

For full details of the Design Risk Assessment at AIP stage, refer to Appendix C.

4.2 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 Date of Estimates)

Following options for the repair/refurbishment of the comb joints were considered at the optioneering stage.

Option 1: Continue with current maintenance regime.

Option 2: Completely refurbish the existing joint.

Option 3: Completely replace the existing joint with bespoke supported finger comb type joint similar to existing.

Option 4: Completely replace the existing joint with an Elastomeric in Metal Runners (EMR) type joint.

Of the four options, Option 3 was recommended. The cost this options was estimated to be around £1.2 million, excluding traffic management costs.

Details on the options could be found in Atkins report - *FRB Options Report for Comb Joints Replacement from Bridge Deck* (Atkins doc. ref. 5127603/003 Rev A).

4.3 Proposed Arrangements for Construction

4.3.1 Construction of structure

It is proposed to replace both sets of joints to one carriageway at the same time to minimise the period for carriageway closure.

4.3.2 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.

4.3.3 Service Diversions

None

4.3.4 Interface with Existing Structures

Some modification in the supporting steelwork will be required for fixing of new replacement joints. Limited concrete breakout in deck slab to cut or unbolt the embedded bracket in slab will be required.

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:

Normal weight of reinforcement concrete, density γ_c =25 kN/m^3

Asphaltic surfacing, density γ_a=23 kN/m^3

Structural Steel, density γ_s =78.5 kN/m^3

4.1.2 Snow, Wind and Thermal actions

For calculating theoretical movement ranges, thermal actions in accordance with Section 6 of BS EN 1991-1-5 and NA to BS EN 1991-1-5 will be considered. However existing movement ranges if found conservative will be retained.

Wind and Thermal actions will not be considered simultaneously in any combination. This is conforming to the clause A2.2.2 (6) of BS EN 1990:2002

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

Load Models, LM1 and LM2 shall be considered in accordance with BS EN 1991-2:2003 and associated UK National Annex, NA to BS EN 1991-2:2003.

Adjustments factor α taken from NA to BS EN 1991-2:2003 table NA.1.

Traffic loading groups as defined in NA to BS EN 1991-2:2003 table NA.3.

4.1.4 Actions relating to General Order Traffic under STGO regulations

Load Model, LM3 (SV80, SV100 and SV196) shall be adopted in accordance with UK National Annex NA to BS EN 1991-2:2003.

4.1.5 Footway or footbridge variable actions

Not Applicable

4.1.6 Actions relating to 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 Actions during construction

None

4.1.9 Any special action not covered above

Braking and Skidding loading shall be considered in accordance with BS EN 1991-2:2003 and NA to BS EN 1991-2:2003.

Fatigue Load Model 3, as defined in BS EN 1991-2:2003 Clause 4.6.4 shall be considered for design as per recommendations in BS EN 1993-2:2006 Clause 9.2.2.

4.2 Heavy of high load route requirement and arrangements being made to preserve the route, including and provisions for future heavier loads or future widening

None

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

The TAS is included in Appendix A

4.6 Proposed Departures relating to departures from standards given in 4.5

Departure to Standards will be raised for use of replacement clauses of MCHW Vol-1 Series 1700 and 1800 to align with Eurocodes execution standards.

4.7 Proposed Departures relating to methods for 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

It is proposed that replacement comb joint will comprise of two finger plates, one bolted as fixed cantilever and other as simply supported with one end sliding over the supporting bar incorporated in the cantilever comb plate. Both comb plates and supporting steelwork as shown in Figure 2 in Appendix B will be analysed in LUSAS using Finite Element Methods.

Connections for the comb plates (to the bridge deck) will be analysed using hand calculations.

As there is no apparent change in the load path to the supporting steelwork from the joints replacement works, assessment of the existing supporting cross beams or box girders is not considered essential for the purpose of this AIP. The loading on the supporting steelwork to joints will be dependent on rated load capacity of the bridge, which is not likely to increase as it is dependent on the other critical elements in the bridge.

5.2 Description and Diagram of Idealised Structure to be used for Analysis

The cantilever finger plate of the comb joint will be analysed as plate elements with fixed support at one end. The supporting steel bracket and flats will be modelled as plate elements and will be analysed for traffic loading applied as patch loads on the finger plates. The reaction from the other comb plate on the supporting bar will be applied statically as a line load.

The other comb plate with comb fingers supported on steel bar will be analysed as plate elements with line support at both ends. Wheel loading on the fingers plate will be applied as patch load considering the effective contact area.

5.3 Assumptions intended for Calculation of Structural Element Stiffness

Full gross steel sections will be used for element stiffness.

5.4 Proposed Earth Pressure Coefficients (Ka, Ko or Kp) to be used in Design of Earth Retaining Elements

Not applicable.

6. GEOTECHNICAL CONDITIONS

6.1 Acceptance of Recommendations of Section 8 of the Geotechnical Report to be used in the design and reasons for any proposed changes

Not applicable.

6.2 Geotechnical Report Structure Design Summary Sheet (Form C)

Not applicable.

6.3 Differential Settlement to be Allowed for in Design of the Structure

Not considered significant for comb joint as both ends of the deck will be supported on common substructure and foundation.

6.4 If the Geotechnical 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

Category 2

7.2 If Category 3, Name of Proposed Independent Checker

Not applicable

7.3 Erection Proposals or Temporary Works for which an independent check will be required, listing parts of the structure affected with reasons for recommending an independent check

Trial assembly of comb plates shall be undertaken in the factory environment to ensure that fingers from the opposite comb plates align together in perfect fit when bolted at site.

8. DRAWINGS AND DOCUMENTS

8.1 List of Drawings (Including Numbers) and Documents accompanying the Submission

Appendix A Technical Approval Schedule (TAS)
Appendix B General Arrangement Drawing
Appendix C Hazard Identification and Risk Assessments

9. THE ABOVE PROPOSALS ARE SUBMITTED FOR ACCEPTANCE

Signed: .....

Name:.....
Design Team Leader

Engineering Qualifications:.....

Name of Organisation: .....

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 invoked by TS Interim Amendment No. 39
(Highlight standards that are required)

	Eurocode part	Title	Amendment / Corrigenda
Eurocodes 0: Basic of Structural Design			
✓	BS EN 1990 +A1:2005	Eurocode 0: Basis of structural design	+A1:2005Corrigenda 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: Actions on Structures			
✓	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: Design of Concrete Structures			
✓	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 Design of Steel Structures			
✓	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 Design of Composite and Concrete Structures			
	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 Design of Timber Structures			
	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 Design of Masonry Structures			
	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 Geotechnical design			
	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	Corrigendum No.1

		rules	
	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 Design of Structures for Earthquake Resistance			
	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 Design of Aluminium Structures			
	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

[To be used with Eurocodes, as instructed by BD 02/12

	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

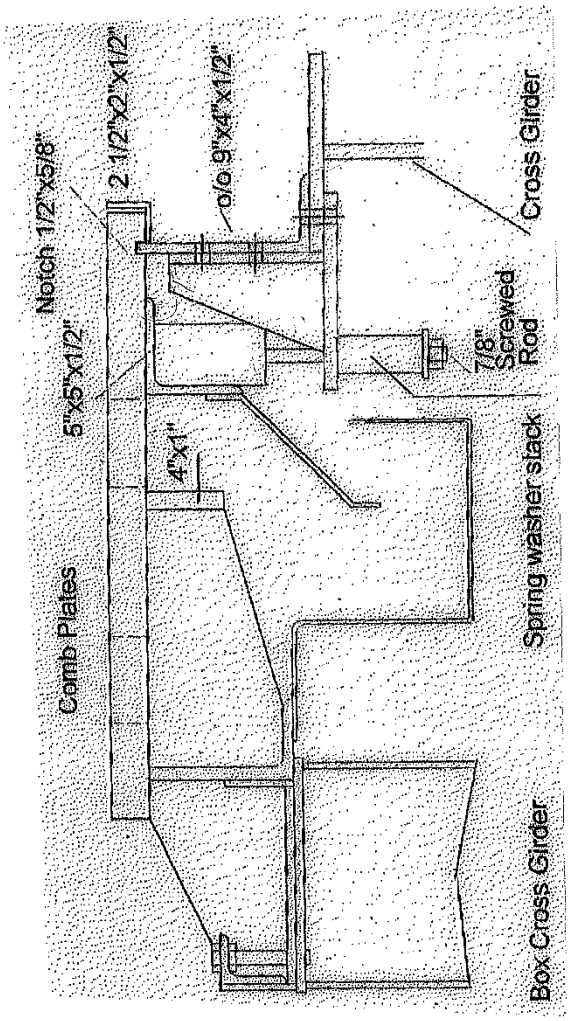

Fig 1: Typical Section through Comb Joint (Existing)

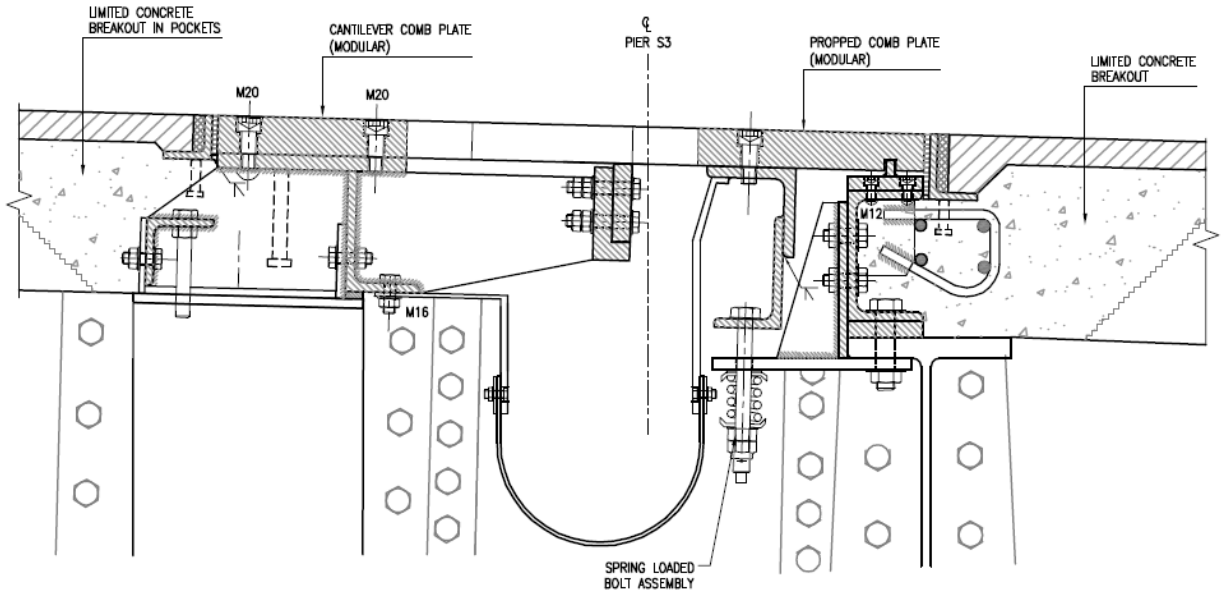

Fig 2: Typical Section through Comb Joint (Proposed)

A.3 Appendix C Hazard Identification and Risk Assessments

Atkins H&T - Scheme Health & Safety Risk Register - for use by Designers on Schemes where Atkins is the Lead Designer

	Project:	**Forth Road Bridge- Replacement of Comb Joints**	**Author(s):**	**JV**	
	Design Stage:		◄ e.g. Strategy/ Concept or Scheme or Detailed PLUS Prelim. or Final	**Date of this Revision of Risk Register:**	11/02/2014
	Spec Series or Element:	Comb Joints Replacement from Carriageways	◄ or say "whole project"	**Revision No.**	R0
	Option Ref. (if relevant)		◄ when undertaking option appraisal of alternative solutions		

designoutrisk! RED AMBER& GREEN

ATKINS

	Hazard Identification			**Hazard Elimination or Risk Reduction by Control - CDM 2007 Regulation 11(4) - Duties of designers**				**Communication of Residual Risk**				**Notes**
A	**B**	**C**	**D**	**E**	**F**		**G**	**H**	**I**		**J**	**K**	**L**
Ref.	**Structure Element and/ or Location**	**Record Hazardous Activity and separately the Hazard**	**Stage Affected (from dropdown) (End Use ONLY if designed as a workplace)**	**Risk Reduction to be tackled as a Hierarchy - either 1. Record that Hazard has been/ will be eliminated (designed out) and how this has been/ will be achieved, Or if not then: 2. Record Design Assumptions and/ or Control measures to reduce risk**	**Green RAG list item employed to significantly reduce risk (if any)**		**Record Means of Assuring that either: 1. Elimination has been/ will be achieved. Or if not then: 2. Design Assumptions are valid/ Control measures will be in place**	**Designer Initials here to verify commitments in Column G**	**Significance of Residual Risk (Select from RAG List or classify as equivalent)**		**Means of Communicating Significant Residual Risk (RED/ AMBER Construction will go in PCI)**	**Designer Initials here to verify commitments in Column J**	**Commentary if required/ Project Director sign off of any Red Items**
1	Deck slab	Activity Concrete breakout for removal of existing comb joints. Hazard Musculoskeletal Disorders (MSD), Flying fragments	Demolition	1. The hazard will be controlled but can't be eliminated. 2. Control measures: Use of vehicle mounted plants or hydrodemolition will be preferred over handheld equipments for concrete breakout. Further, the extent of concrete breakout will be limited to removal of the fixed comb plate and exposure of the supporting steelwork for fixing of new joint units.			Use of hydrodemolition or vehicle mounted plant for concrete breakout will be specified in the specification		Amber - Significant	**A13**	Specification and PCI		
2	Deck slab	Activity Hydrodemolition of structural concrete Hazard Musculoskeletal Disorders (MSD), Flying fragments, Noise	Construction	1. The hazard will be controlled but can't be eliminated. 2. Control measures: Only trained and skilled operatives shall be allowed to undertake this work. Contractor shall also provide safe access for hydrodemolition works.			Control measures will be included in the specification		Amber - Significant	**A18**	Specification and PCI		
3	Deck slab	Activity Noise at work arising from concrete breakout Hazard Effect of noise and vibration etc. Health risk to operatives and local residents	Demolition	1. The hazard will be controlled but can't be eliminated. 2. Control measures: The contractor to set up instruments to monitor the noise level in the vicinity of the residential properties below the Bridge. If the noise level exceeds the threshold level, as specified in specification then suitable sound barriers shall be installed to reduce the impact of noise in the residential areas. The operatives to wear suitable PPE during works.			Contractor to monitor and prepare Control measures to reduce impact of noise to the local residents. Nearby residents should be consulted regarding nature and timing of works.		Amber - Significant	**A14**	Specification and PCI		
4	Concrete works	Activity Manual handling including lifting, carrying, pushing, pulling or moving materials at site. Hazard Risk of injury to operatives from heavy lifting, back pain etc.	Construction	Contractor to encourage use of mechanical means for all manual handling operations.	Green	**G12**	To be controlled through Contractor's method statement						
5	Concrete works	Activity Drilling and fixing of reinforcement/dowels or similar and surface preparation Hazard Musculoskeletal Disorders (MSD), Noise	Construction	1. The hazard will be controlled but can't be eliminated. 2. Control measures: Vibration limits will be included in the specification together with reference to appropriate literature.			To be controlled by specifying limit to vibration in the specification		Amber - Significant	**A13**	Specification and PCI		
6	Joint works	Activity Saw cutting of existing joint Hazard Musculoskeletal Disorders (MSD), Flying fragments, Sparks, Noise, Dust	Construction	1. The hazard will be controlled but can't be eliminated. 2. Control measures: Minimise area of manual methods through use of vehicle mounted plant. All blade guards to be in place during cutting operations. Appropriate PPE to be worn to protect operatives including from sparks.					Not Significant				
7	Lifting and removal of existing comb joints	Activity Lifting of existing comb plates Hazard Falling/swinging objects striking operatives.	Demolition	1. Can be eliminated by cutting the existing comb plates (fixed) into manageable segments and then lifted them off from one side of the deck using wheel mounted cranes.	Green	**G19**	The proposed sequence of joints removal will be shown on the drawings with crane capacity for lifting of heaviest unit.		Not Significant		Drawings and PCI		
8	Lifting operations	Activity Working at height, installation of new joints in position Hazard Falling from height causing personal injury.	Construction	1. The hazard can be eliminated by using access platform built for inspection and maintenance of the existing joints for accessing the joints during works.			Details of access platform will be included in the PCI		Not Significant		PCI		
9	Lifting operations	Activity Placement of fixed unit of the comb plate. Hazard Falling/swinging objects striking operatives, trapping of fingers, tipping of crane	Construction	1. The hazard will be controlled but can't be eliminated. 2. Control measures: As the fixed comb plate is installed in one segment covering the full width of the carriageway, the Contractor/Supplier's proposal shall define the method of working.			To be controlled through Contractor/Supplier's method statement		Amber - Significant	**A**			
10	Site access	Activity Working in and around the general public Hazard Injuries to general public	Construction and Maintenance	1. Will be eliminated, by adopting suitable TM during works.			TM requirement will be included in the Contract Documentation.		Not Significant				
11	Site access	Activity Proximity to live traffic Hazard Injury to operatives due to collision with vehicles	Construction	1. The hazard can not be eliminated. 2. Control measures: Existing carriageway will be closed during the period of installation of new joints. Two way traffic from north and southbound will be carried over the other carriageway with suitable TM in place.			TM requirement will be included in the Contract Documentation.		Not Significant				

	Hazard Identification			Hazard Elimination or Risk Reduction by Control - CDM 2007 Regulation 11(4) - Duties of designers				Communication of Residual Risk				Notes
A	B	C	D	E	F		G	H	I		J	K	L
Ref.	Structure Element and/ or Location	Record Hazardous Activity and separately the Hazard	Stage Affected (from dropdown) (End Use ONLY if designed as a workplace)	Risk Reduction to be tackled as a Hierarchy - either 1. Record that Hazard has been/ will be eliminated (designed out) and how this has been/ will be achieved, Or if not then: 2. Record Design Assumptions and/ or Control measures to reduce risk	Green RAG list item employed to significantly reduce risk (if any)		Record Means of Assuring that either: 1. Elimination has been/ will be achieved. Or if not then: 2. Design Assumptions are valid/ Control measures will be in place	Designer Initials here to verify commitments in Column G	Significance of Residual Risk (Select from RAG List or classify as equivalent)		Means of Communicating Significant Residual Risk (RED/ AMBER Construction will go in PCI)	Designer Initials here to verify commitments in Column J	Commentary if required/ Project Director sign off of any Red Items
12	Site access	Activity Moving of vehicular traffic at site. Hazard Danger resulting from site traffic route which does not allow provision for 'one way' system for vehicular traffic.	Construction and Maintenance	1. Due to closure of existing carriageway, 'one way' system of site traffic route can not be followed as site. 2. Control measures: Traffic cones or suitable traffic delineators shall be used to segregate two way site traffic.			Contractor's method statement will cover movement of site vehicles.		Amber - Significant	A9			
13	Site access	Activity Implementation of traffic management Hazard Danger resulting from inappropriate traffic management leading to drivers becoming confused.	Construction and Maintenance	1. Traffic management to be in accordance with Chapter 8 requirements. TM guidelines and layouts/diversion routes will be provided in Works Information.	Green	G24	Will be included as Employer's requirement		Not Significant				
14	Pavement surfacing	Activity Installation of hot materials for resurfacing of affected section of the deck. Hazard Risk of burns to personnel arising from contact with hot pavement materials.	Construction	1. The hazard can not be eliminated. 2. Control measures: Installation of hot materials to be undertaken by appropriately qualified personnel as per the specification. Appropriate PPE to be worn. Hot materials to be storage in covered vessels.			The requirement will be included in the specification.		Amber - Significant	A	Specification and PCI		
15	Site Weld	Activity Site Welding Hazard Fire resulting from falling hot welding slag or sparks on the passing ships or oil tankers below the bridge deck.	Construction	1. The hazard can not be eliminated. 2. Control measures: (i) temporary falsework shall be erected below the working area to prevent any slag or hot material falling on the passing ships or tankers (ii) to prevent injury to the operatives, only trained and competent operatives shall be allowed to carry out on site welding (iii) All welding that can be carried out off site shall be maximised			The requirement to install temporary falsework below the joints during site welding shall be included in the specification.		Amber - Significant	A17	Specification and PCI		
16	Services	Activity Working in and around live services. Hazard Disruption to services operations. Risk of injury to operatives: explosion, electrocution, overcome by fumes	Construction	1. The hazard can not be eliminated. 2. Control measures: Service locations shall be confirmed by the Contractor. The Contractor will liaise with FRB to either protect the utilities in place or divert it for safe working.			Contractor to liaise with FRB for protection or diversion of services in the vicinity of the working area. Requirement will be included in PCI.		Amber - Significant	A	Drawings, PCI		
17	Confined space working	Activity Confined space working due to restricted working area Hazard Suffocation, asphyxiation	Construction and Maintenance	1. The hazard can not be eliminated. 2. Control measures: Where required to work in confined spaces, all operatives must be confined spaces trained and competent to carry out hot working			All operatives working in confined spaces must be confined space trained		Amber - Significant	A15			
18	Drainage system	Activity Contact with contaminated water from existing drainage system Hazard Waterborne diseases e.g. Leptospirosis	Construction	1. The hazard can not be eliminated. 2. Control measures: Competent contractor shall be aware about the risk of contaminated water. Appropriate PPE in line with HSE requirements shall be worn.					Not Significant				
19	Site	Activity Working in and around moving plant Hazard Personal injury: danger from collision with moving plant	Construction	1. The hazard can not be eliminated. 2. Control measures: Moving plant to be minimised. When moving plant is required a qualified banksman must be present.			To be controlled through Contractor's method statement.		Not Significant				
20	Use of paints and chemicals at site	Activity Working with chemicals and paints harmful to health Hazard Danger to personnel resulting from exposure to substances hazardous to health.	Construction	1. The hazard can not be eliminated. 2. Control measures: Materials to be supplied with H&S information and COSHH requirements. Paints to be tested for lead. Contractor's method statement to define Control measures. Appropriate PPE to be worn and Site Waste Management to be followed.			All chemical substances used at site shall follow manufacture's instruction for use. The requirement will be included in the specification.		Amber - Significant	A	Specification and PCI		
21	Working at night	Activity Working at night Hazard Injuries and damage resulting from lack of suitable task lighting	Construction	1. The hazard can not be eliminated. 2. Control measures: Contractor's Method Statement to define method of working. Appropriate task lighting to be provided at the site prior to start of work.			To be controlled through Contractor's method statement. Possession of site and permissible working hours will be included in the specification.		Not Significant	A	Specification and PCI		

To insert a row - select any row with a right click, then click "Insert". Same to delete a row.

Notes:
1. This Design Risk Register does not use conventional risk scoring. In its place is a requirement to determine whether any residual risk is "Significant" as ACOP 131-134.
2. This Risk Register should be used in conjunction with the RAG List dated November 2008, adopted by Atkins, Arup, Halcrow and Mott MacDonald.
3. The provision of the items on the Red and Amber Lists does not remove from the Designer, an obligation to identify and asses hazards and risks specific to the project
4. Refer also to Guidance Worksheet

Owner	B.Swan+M.Reynolds	Issue Date	18/02/2011	Reference: HS
Revision	13	Review Date	05/04/2012	