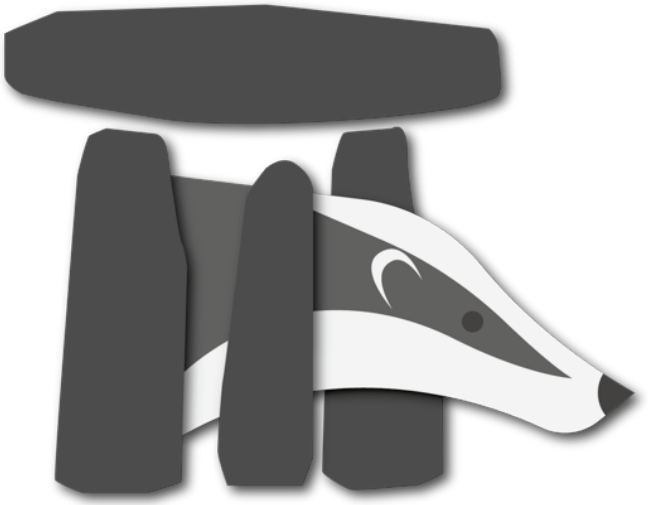

highways england

QS 7C
Outline Approval in Principle (AIP) for:
River Till Viaduct

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APPENDICES

Project Details

Name of project: A303 – Amesbury to Berwick Down in Wiltshire.

Name of bridge or structure: River Till Viaduct

Structure reference No.: TBA

Summary

This Outline AIP covers the River Till Viaduct Structure. This document records the agreed basis and outline criteria to be carried forwards for the detailed design of a highway structure in accordance with Highways England's Technical Approval (TA) procedures as outlined in CG 300. These procedures are required to give increased assurance for the required execution of highway structures.

Expected construction dates of scheme from 2023 to 2028.

1 HIGHWAY DETAILS

1.1 Type of highway

This is a proposed Dual 2-lane all-purpose carriageway (D2AP) with traffic lane widths outside the tunnels in accordance with CD 127.

1.2 Permitted traffic speed

The current proposal is for a 70-mph speed limit on this section of the highway network. During contraflow for planned maintenance, a reduced 40mph speed limit will be adopted or as deemed necessary to maintain safety.

1.3 Existing restrictions

The River Till Viaduct shall be designed and constructed as a five continuous span, twin decks, carrying the A303 over the River Till.

2 SITE DETAILS

2.1 Obstacles crossed

Proposed River Till viaduct structure spans over fields, and the River Till and the existing WST04 byway near Winterbourne Stoke, adjacent to the current A303.

3 PROPOSED STRUCTURE

3.1 Description of structure and design working life

The River Till viaduct is a twin composite deck with structural steel works and a reinforced concrete slab on top of them. Structural steel works in weathering steel, composed of two main girders braced with cross beams spaced 6 to 8 m.

The substructure is composed of reinforced concrete supports with deep foundation. Each abutment is a concrete bankseat with two cast in situ piles, and intermediate supports are smooth shaped concrete piers with deep foundations composed of a pile cap and four cast in situ piles underneath.

The River Till viaduct structure will be designed for a design working life category 5 in accordance with Table 7.1 of DMRB CD 350 and Table NA.2.1 of British National Annex to BS EN 1990:2002.

Bearings and nonstructural elements like expansion joints, vehicle parapets and visual panels will be design for a working life category 2 (typically 50 years design working life) according to table 7.1 of DMRB CD 350.

3.2 Structural type

Bridge structure with weathering steel girders and cast in situ concrete top slab with permanent bottom formwork.

3.3 Foundation type

Deep foundations with cast in situ piles, pile caps at intermediate supports and piled bank seats at abutments.

3.4 Span arrangements

Both decks have the same 5 span arrangement 36.0m + 46.0m + 47.5m + 47.0m + 35.5m for a total length of 212 m each.

3.5 Articulation arrangements

Each deck is a five continuous span structure supported on bearings at abutments and intermediate supports. The bridge articulation arrangement for each deck is as follows:

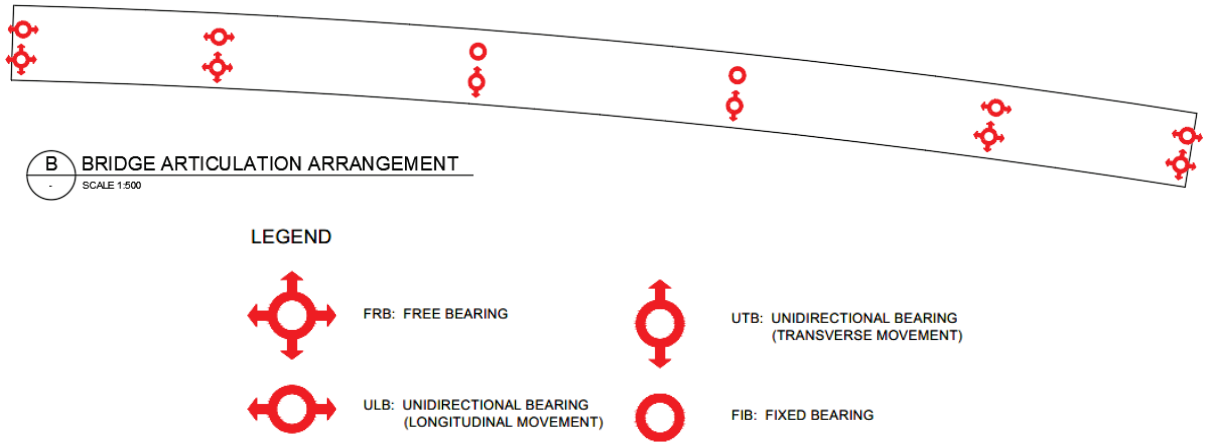

Figure 3-1: Bridge articulation arrangement

3.6 Classes and levels

A) Consequence class

For the main structure CC3 in accordance with CD 350 Table 7.2, and BS EN 1990 Table B1

B) Reliability class

RC3 for whole structure and K_{FI} taken as 1.1, in accordance with BS EN 1990 Table B3.

C) Inspection level

Design Supervision Level DSL3. Inspection Level IL2 or IL3 as required by CD 350, Table 7.2. for whole or parts of structure, in accordance with CD 350, Table 7.2.

3.7 Road restraint systems requirements

The structure has VRS systems at both edges of each deck. The edges of the decks will be provided with steel vehicle parapets. The containment level shall be H2 and a Class B Impact Severity Level (ISL), according to section 5.1 of ITPD Vol 2 part 2 and DMRB CD 377.

Proposed heights for Vehicle Parapets: 1000mm.

According to section 13.2 of ITPD Vol 2 part 2, a visual screen shall be provided at the southern edge of the westbound deck, being attached to dedicated posts independent of the VRS system. VRS system and visual screen will be separated a distance equal to the working width of the VRS.

Required height for visual panels: 1500mm.

3.8 Proposals for water management.

Water management for decks shall be designed in accordance with DMRB CD 358.

Drainage strategy: according to the OEMP and Technical requirements, water will be collected in the lower side of the deck by means of bridge kerb drainage units and driven to the A-01N and A-01S abutments where will be discharged to the General drainage system.

Bridge deck waterproofing shall be continuous, covering the entire deck between parapets upstands including the central reserve and verges. It will be composed of waterproofing membranes.

For the pile caps and bankseats surfaces buried or in contact with backfilling, it will be applied a waterproofing membrane system a bottom horizontal perforated tubes, as detailed in drawing HE551506-BGR-SBR-Z1BRT00Z-DR-S-0004.

3.9 Proposed arrangements for future maintenance and inspection

A) Arrangements for future maintenance and inspection of structure. Access arrangements to structure.

Access for maintenance and inspection of the structure will be via the carriageway lane or full carriageway during closures for the elements on the deck.

Those elements located underneath the concrete slab like steel works, bearings and columns, will be reached by the use of mobile working platforms operating from the ground level under the deck and drones provided with high resolution cameras.

Permanent safe access and galleries for maintenance and inspection at the abutments will be provided.

The inspection and survey programme and methodology for the structures Assets shall include the baseline survey and inspection requirements in accordance with bellow baseline survey and inspection requirements:

- **Bridge structures:**
    - **General inspection frequency:** Year three (3) of Maintenance Period and two (2) yearly thereafter.
    - **Principal Inspection frequency:** Year one (1) and year five (5) of Maintenance Period and six (6) yearly thereafter.

3.10 Environment and sustainability

The use of steel structure partially assembled from plants and precast concrete solutions for the slab, reduces site works, which benefits the environment and also reduces embedded CO_2.

3.11 Durability – materials and finishes

The durability of materials utilized will be such that the design life of 120 years is met with concrete specification in accordance with BS8500-1:2015.

The concrete elements shall be grade C32/40 minimum.

Reinforcement shall be High Yield Grade B500B or B500C 'Ribbed' bars conforming to BS 4449:2005+A2:2009 and BS EN 10080:2005 with a characteristic yield strength fy = 500MPa.

The final finish to all in situ concrete pours will be determined during detailed design to suit the agreed design vision requirements. Buried concrete elements, other than piles, in permanent contact with the soil shall be painted with two coats of cut back bitumen or equivalent.

Finishes of the structures aligned with Design Vision and to be confirmed during detailed design:

- Visual Screen: Abstraction of woven pattern in lightweight precast concrete / GRC. Woven pattern to both faces.
- Twin Girders: Weathering steel, bespoke colour.
- Edge treatment: Precast concrete, smooth finish, warm colour.
- Concrete Piers: Cast in situ concrete, smooth finish, warm colour.

3.12 Risks and hazards considered for design, execution, maintenance and demolition. Consultation with and/or agreement from Overseeing Organisation

Early identification of risks in accordance with CDM regs, as referred to in **Appendix D**.

3.13 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)

Provided in Financial Submission.

3.14 Proposed arrangements for construction

A) Construction of structure

Typical construction sequence for this type of composite structures:

- Excavation of foundations and piling. Partial filling of approach ramps.
- Execution of foundations: pile caps for columns and piles for bank seats in abutments.
- Bank seats of abutments.
- Column shafts.

- Completion of approach embankments.
- Placing of steel girders on the substructure by segments in 5 stages per deck.
- Placing of the pieces' permanent formwork for the concrete slab.
- Placement of slab reinforcement and pour of concrete slab.
- Execution of road pavement, barriers and finishes

B) Traffic management

River Till viaduct will be constructed as a part of a new alignment of the A303 at that point. Therefore, no diversions of the A303 needed.

Existing alignment of WST04 shall be maintained. It also shall remain open during construction, with a diversion if it were necessary due to the construction sequence.

C) Service diversions

No service diversions expected.

D) Interface with existing structures

There are no structures in the immediate vicinity of the proposed River Till viaduct.

4 DESIGN CRITERIA

4.1 Actions

A) Permanent actions

Permanent actions will be applied in accordance with BS EN 1991-1-1 including the National Annex.

B) Snow, wind and thermal actions

Snow actions will be considered in the structure as per BS EN 1991-1-3:2003 +A1:2015 and NA + A2:18 to BS EN 1991-1-3:2003+A1:2015.

Wind actions will be considered in the structure as per BS EN 1991-1-4:2005 +A1:2010 and NA to BS EN 1991-1-4:2005 + A1:2010.

Thermal actions will be considered in the structure as per BS EN 1991-1-5:2003 and NA to BS EN 1991-1-5:2003.

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

Load models LM1, LM2 and LM4 as per BS EN 1991-2 and NA to BS EN 1991-2:2003

D) Actions relating to General Order traffic under STGO regulations

SV80, SV100 and SV196 loading as per CD 350 Table 7.6.2 & the National Annex to BS EN 1991-2:2003 and PD6688-2:2011.

E) Footway or footbridge variable actions

Variable actions considered in the footpath around the edge in accordance with BS EN 1991-2.

F) Actions relating to Special Order traffic, provision for exceptional abnormal indivisible; loads including location of vehicle track on deck cross-section

The structure will not be designed for Special Order Traffic i.e., abnormal indivisible loads.

G) Accidental actions

Actions during construction will be considered in accordance with BS EN 1991-1-6:2005 and its UK National Annex. Vehicle impact loads on columns will be applied in accordance with BS EN 1991-1-7 including the National Annex and PD6688-2:2011, where applicable.

Actions due to explosion are not considered.

H) Actions during construction

It will be considered actions during construction for any machinery above the bridge in accordance with BS EN 1991-1-6:2005 and its UK National Annex.

I) Any special action not covered above

Not applicable.

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

Not considered.

4.3 Proposed minimum headroom to be provided

Minimum headroom = 5300mm plus sag curve compensation in the span over the WST04 BOAT.

The carriageway level shall be a minimum ten metres above the River Till where it crosses the river channel.

4.4 Authorities consulted and any special conditions required

Additionally, continuous collaboration within BADGER as well as with Highways England representatives allows for seamless incorporation of any change into the design, once agreed between all parties.

This project is the subject of a Development Consent Order (DCO). In preparation of the DCO application, consultation with interested third parties has been undertaken. The approved DCO will specify conditions for the design, construction and operation of the tunnel. It will also specify requirements for ongoing consultation with relevant third parties and set out various planning conditions to be discharged and approvals gained.

4.5 Standards and documents listed in the technical approval schedule (TAS)

Technical Approval Schedule (TAS) is in Appendix A to this OAIP.

4.6 Proposed departures from standards given in 4.5

None

4.7 Proposed departures relating to methods for dealing with aspects not covered by standards in 4.5

None

4.8 Proposed safety critical fixings

None

5 STRUCTURAL ANALYSIS

5.1 Methods of analysis proposed for superstructure, substructure and foundations

Closed form solutions used for the initial assessment to size the elements for this stage of design. Upon award of the detailed design, a structural analysis model will be created using software such as SAP2000 Structural Analysis.

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

The structure shall be modelled with a plane grid for the decks composed by main girders braced with cross elements to support the loads from transversal elements modelling the concrete slab where are applied all the loads coming from deck and live loads. This grid will be elastically linked to the substructure modelled as vertical frames. The model will have evolutive sections and a schedule of the installation of the different structural elements to take into account the respective sections and loads to apply in every construction stage. It will be also included in the corresponding construction stage the temporary stiffeners considered to reach the necessary stability and stiffness in each stage. An image of the final model arrangement in SAP2000 is shown below:

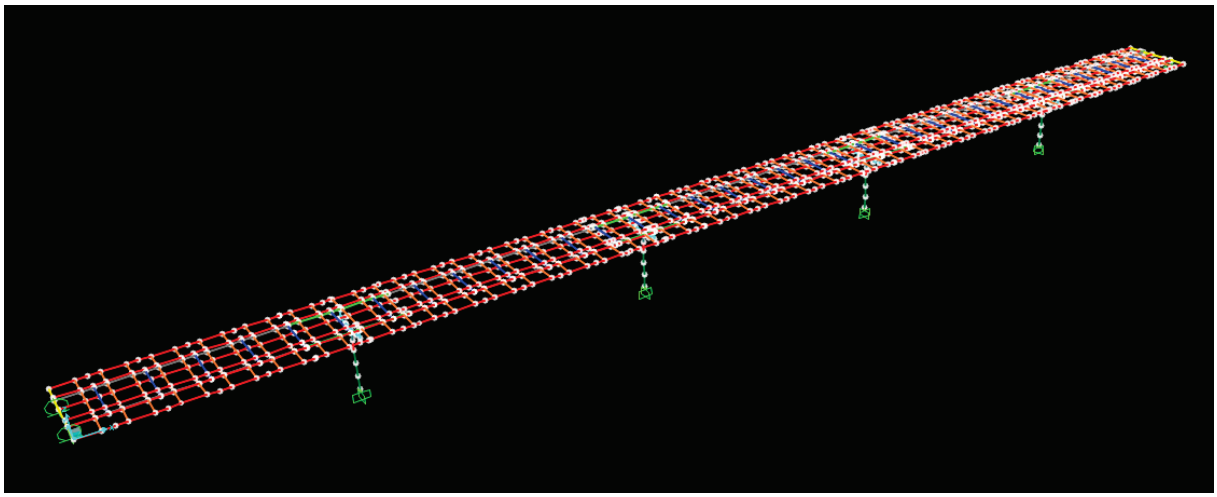

Figure 5-2: Idealised SAP2000 Structural Analysis Model

5.3 Assumptions intended for calculation of structural element stiffness

Precast concrete section properties will be based on the gross, uncracked concrete cross-section.

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

This applies for the abutments and lateral walls of the bridge. Earth pressures are obtained as per assumption values below.

Table 5-1: Ground parameters

Ground	Weight Density	Shear resistance
Backfilling around the structure	γ' = 20 kN/m3	Φ' = 30° C’ = 0 MPa

6 GEOTECHNICAL CONDITIONS

6.1 Acceptance of recommendations of the ground investigation report (reference/dates) to be used in the design and reasons for any proposed changes

A summary of the Geotechnical Report reviewed is included in **Appendix B**. Assessed preliminary design soil parameters are also included in **Appendix B**.

6.2 Summary of design for highway structure in the ground investigation report

Refer to Appendix B for preliminary soil design parameters.

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

It will be allowed a differential settlement of 20mm between supports, according to BS EN 1997-1:2004+A1:2013 and the National Annex to BS EN 1997-1:2004+A1:2013.

6.4 If the ground investigation 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

N/A

7 CHECK

7.1 Proposed category and design supervision level

Category 3 as per clause 3.9 of CG300

7.2 If category 3, name of proposed independent checker

TBD

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

TBD

8 DRAWINGS AND DOCUMENTS

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

Table 8-1: Drawings and Documents

Document	Number
General Plan and profile views	HE551506-BGR-SBR-Z1BRT00Z-DR-S-0001
Deck sections	HE551506-BGR-SBR-Z1BRT00Z-DR-S-0002
Typical section at pier	HE551506-BGR-SBR-Z1BRT00Z-DR-S-0003
Details	HE551506-BGR-SBR-Z1BRT00Z-DR-S-0004

9 THE ABOVE IS SUBMITTED FOR ACCEPTANCE

We confirm that details of the temporary works design will be/have been passed to the permanent works designer for review[16].

Signed	_____	
Name	_____	Design Team Leader
Engineering Qualifications	_____	
Name of Organisation	_____	
Date	_____	

Signed	_____	
Name	_____	Check 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	_____

Appendix A – 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	**Basis of structural design**		
BS EN 1990:2002 +A1:2005	Eurocode 0: Basis of structural design	+A1:2005 Incorporating corrigenda December 2008 and April 2010	See CD 350 section 7 for additional guidance.
NA to BS EN 1990:2002 + A1:2005	UK National Annex to Eurocode 0 Basis of structural design	National Amendment No.1	See CD 350 section 7 for additional guidance.
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	Corrigenda July 2019	
BS EN 1991-1-3:2003 +A1:2015	Eurocode 1: Actions on structures. General Actions. Snow loads	+A1:2015 Incorporating corrigenda December 2004 and March 2009	
NA + A2:18 to BS EN 1991-1-3:2003+A1:2015	UK National Annex to Eurocode 1: Actions on structures. General Actions. Snow loads	+A2:2018 Incorporating corrigenda June 2007, December 2015 and October 2018	
BS EN 1991-1-4:2005 +A1:2010	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	

Eurocode part	Title	Amendment / Corrigenda	
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	Corrigenda 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 +A1:2014	Eurocode 1: Actions on structures. General Actions. Accidental actions	+A1: 2014 Corrigendum February 2010	
NA+A1 to BS EN 1991-1-7:2006+A1:2014	UK National Annex to Eurocode 1: Actions on structures. Part 1-7: Accidental actions	+A1:2014 Incorporating corrigenda August 2014 and November 2015	See CD 350 for additional guidance.
BS EN 1991-2:2003	Eurocode 1: Actions on structures. Traffic loads on bridges	Corrigenda December 2004 and February 2010	See CD 350 section 7 for additional guidance.
NA to BS EN 1991-2:2003	UK National Annex to Eurocode 1: Actions on structures. Traffic loads on bridges	Corrigendum No.1	See CD 350 section 7 for additional guidance.
Eurocode 2	**Design of concrete structures**		
BS EN 1992-1-1:2004 + A1:2014	Eurocode 2: Design of concrete structures– Part 1-1: General rules and rules for buildings	Incorporating corrigendum January 2008, November 2010 and January 2014	
NA + A2:2014 to BS EN 1992-1-1:2004 + A1:2014	UK National Annex to Eurocode 2: Design of concrete structures – Part 1-		

Eurocode part	Title	Amendment / Corrigenda	
	1: General rules and rules for buildings		
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	-	
Eurocode 3	**Design of steel structures**		
BS EN 1993-1-1:2005 + A1:2014	Eurocode 3: Design of steel structures – Part 1-1 General rules and rules for buildings	Corrigenda February 2006 and April 2009	
NA + A1:2014 to BS EN 1993-1-1:2005 + A1:2014	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 + A1:2015	Eurocode 3: Design of steel structures – Part 1-4 General rules – Supplementary rules for stainless steels	+ A1:2015 Amendment No. 1	
NA+A1:15 to BS EN 1993-1-4:2006+A1:2015	UK National Annex to Eurocode 3: Design of steel structures – Part 1-4 Supplementary rules for stainless steels	+ A1:2015 Amendment No. 1	
BS EN 1993-1-5:2006+A2:2019	Eurocode 3: Design of steel structures – Part 1-5 Plated structural elements	Corrigendum April 2009, +A1:2017 Amendment No. 2, +A2:2019	
NA+A1:2016 to BS EN 1993-1-5:2006	UK National Annex to Eurocode 3: Design of steel structures –	+ A1:2016	

Eurocode part	Title	Amendment / Corrigenda	
	Part 1-5 Plated structural elements	Amendment No. 1	
BS EN 1993-1-6:2007+ A1:2017	Eurocode 3: Design of steel structures – Part 1-6 Strength and stability of shell structures	+ A1:2017 Amendment No. 1	
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 1993-1-10:2005	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 1993-5:2007	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 steel 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	-	

Eurocode part	Title	Amendment / Corrigenda	
	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 7	**Geotechnical design**		
BS EN 1997-1:2004+A1:2013	Eurocode 7: Geotechnical design – Part 1 General rules	+A1:2013 Corrigendum February 2009	
NA+A1 to BS EN 1997-1:2004+A1:2013	UK National Annex to Eurocode 7: Geotechnical design – Part 1 General rules	+A1:2013 Incorporating 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	-	

BSi Published Documents

For guidance only unless clauses are otherwise specified in BD 100/16 Annex B.

Doc No.	Title	
PD 6687-1:2020	Background paper to the UK National Annexes to BS EN 1992-1 and BS EN 1992-3	Supersedes PD 6687-1:2010 See CD 350 clauses 3.6, 4.1, 4.2 and Appendix A for additional guidance. Clause 3.6 in CD 350 refers to clause 2.5 in PD 6687-1, this is now clause 4.5 in PD 6687-1 Clause 4.2 in CD 350 refers to clause 2.22

Doc No.	Title	
		in PD 6687-1, this is now clause 4.21.4 in PD 6687-1
PD 6687-2:2008	Recommendations for the design of structures to BS EN 1992-2:2005	See CD 350 clauses 4.1, 4.2 and Appendix A for additional guidance.
PD 6688-1-1:2011	Recommendations for the design of structures to BS EN 1991-1-1	See CD 350 Appendix A for additional guidance.
PD 6688-2:2011	Recommendations for the design of structures to BS EN 1991-2	See CD 350 Appendix A for additional guidance.
PD 6695-1-10:2009	Recommendations for the design of structures to BS EN 1993-1-10	See CD 350 Appendix A for additional guidance.
PD 6694-1:2011	Recommendations for the design of structures subject to traffic loading to BS EN 1997-1	See BD100 Annex B for additional guidance.

Execution Standards referenced in British Standards or Eurocodes

Doc No.	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 13670:2009 Incorporating corrigenda October 2015 and November 2015	Execution of concrete structures	

Product Standards referenced in British Standards or Eurocodes

Doc No.	Title	
BS EN 206:2013+A1:2016	Concrete – Specification, performance, production and conformity	+A1:2016
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.	*Draft BS EN 1317-4 for public comment published in June 2012*
BS EN 1317-5:2007+A2:2012	Road Restraint Systems – Part 5 - Product requirements and evaluation of conformity for vehicle restraint systems	Incorporating corrigendum August 2012 *Draft prEN 1317-5 for public comment published in December 2013*
BS EN 206:2013	Concrete – Specification, performance, production and conformity	Corrigendum May 2014
BS EN 10080:2005	Steel for the reinforcement of concrete – Weldable reinforcing steel - General	
BS EN 15050:2007 + A1:2012	Precast concrete products – Bridge elements	See BD100 clause 2.18 for additional guidance.
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	Structural bearings – Part 4: Roller bearings	Corrigendum No.1 March 2007
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	Corrigendum No.1 November 2003
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 10025-2:2019	Hot rolled products of structural steels Part 2: Technical delivery conditions for non-alloy structural steels.	Supersedes BS EN 10025-1:2004
BS EN 10025-3:2019	Hot rolled products of structural steels Part 3: Technical delivery conditions for normalized/normalized rolled weldable fine grain structural steels.	Supersedes BS EN 10025-3:2004
BS EN 10025-4:2019	Hot rolled products of structural steels Part 4: Technical delivery conditions for thermomechanical rolled weldable fine grain structural steels.	Supersedes BS EN 10025-4:2004
BS EN 10025-5:2019	Hot rolled products of structural steels – Part 5: Technical delivery conditions for structural steels with improved atmospheric corrosion resistance	Supersedes BS EN 10025-5:2004

BS EN 10025-6:2019	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.	Supersedes BS EN 10025-6:2004+A1:2009

British Standards

Doc No.	Title	
BS 4449:2005+A2:2009	Steel for the reinforcement of concrete	
BS 8004:2015 +A1 2020	Code of practice for foundations	Amendment +A1:2020
BS 8500-1:2015+A1:2016	Concrete – Complementary British Standard to BS EN 206: Method of specifying and guidance for the specifier.	Incorporating Corrigendum No.1
BS 8500-2:2015+A1:2016	Concrete – Complementary British Standard to BS EN 206: Specification for constituent materials and concrete.	Incorporating Corrigendum No.1 and Corrigendum No.2 June 2020 Amendment +A2:2019
BS 8666:2020	Scheduling, dimensioning, bending and cutting of steel reinforcement for concrete	Supersedes BS 8666:2005

The Manual Contract Document for Highway Works (MCHW)

Doc No.	Title	
MCHW Volume 1: March 2020	Specification for Highway Works	*Specification compliant with the execution standards must be used. A Departure is necessary for the parts where a compliant revision has not been published. Amendments March 2020*
MCHW Volume 2: March 2020	Notes for guidance on the Specification for Highway Works	*Notes for guidance compliant with the execution standards must be used. A Departure is necessary for the parts where a compliant revision has not been published. Amendments March 2020*

The Design Manual for Roads and Bridges (DMRB)

DMRB reference	Title	Notes
GG 101 Revision 0	Introduction to the Design Manual for Roads and Bridges	Replaces GD 01/16
GG 102 Revision 0	Quality Management Systems for Highway Design	Replaces GD 02/16
GG 103 Revision 0	Introduction and general requirements for sustainable development and design	
GG 104 Revision 0	Requirements for Safety Risk Assessment	Replaces GD04/12 and IAN 191/16
GG 184	Specification for the use of Computer Aided Design	Replaces IAN 184/16
CG 300	Technical approval of highway structures	Supersedes BD 2/12

DMRB reference	Title	Notes
Revision 0		
CG 302 Revision 0	As-built, operational and maintenance records for highway structures	Supersedes BD 62/07
CG 303 Revision 0	Quality assurance scheme for paints and similar protective coatings	Supersedes BD 35/14
CG 305 Revision 0	Identification marking of highway structures	Supersedes BD 45/93
CG 501 Revision 2	Design of highway drainage systems	Supersedes HD 33/16, TA 80/99
CD 127 Revision 1	Cross-sections and headrooms	Replaces TD 27/05 and TD 70/08
CD 350 Revision 0	The design of highway structures	Supersedes BD 100/16, BA 57/01, BD 57/01 and IAN 124/11
CD 351 Revision 0	The design and appearance of highway structures	Supersedes BA 41/98
CD 352 Revision 0	Design of road tunnels	Supersedes BD 78/99
CD 353 Revision 0	Design criteria for footbridges	Supersedes BD 29/17
CD 354 Revision 1	Design of minor structures	Supersedes BD 94/17
CD 355 Revision 0	Application of whole-life costs for design and maintenance of highway structures	Replaces BD 36/92 and BA 28/92
CD 356 Revision 1	Design of highway structures for hydraulic action	Supersedes BA 59/94
CD 357 Revision 1	Bridge expansion joints	Replaces BD 33/94, BA 26/94, IAN 168/12 and IAN 169/12
CD 358 Revision 1	Waterproofing and surfacing of concrete bridge decks	Replaces BD 47/99, BA 47/99 and IAN 96/07
CD 359 Revision 0	Design requirements for permanent soffit formwork	Supersedes BA 36/90 and IAN 131/11
CD 361 Revision 0	Weathering steel for highway structures	Supersedes BD 7/01
CD 362 Revision 1	Enclosure of bridges	Replaces BD 67/96 and BA 67/96
CD 364 Revision 0	Formation of continuity joints in bridge decks	Replaces BA 82/00
CD 366 Revision 0	Design criteria for collision protection beams	Replaces BD 65/14
CD 369 Revision 0	Surface protection for concrete highway structures	Replaces BA 85/04
CD 372 Revision 0	Design of post-installed anchors and reinforcing bar connections in concrete	Supersedes IAN 104/15
CD 373 Revision 0	Impregnation of reinforced and prestressed concrete highway structures using hydrophobic pore-lining impregnants	Supersedes BD 43/03
CD 374 Revision 0	The use of recycled aggregates in structural concrete	Supersedes BA 92/07
CD 377 Revision 3	Requirements for road restraint systems	Supersedes TD 19/06

Interim Advice Notes

Doc No.	Title
IAN 105/08	Implementation of construction (design and management) 2007 and the withdrawal of SD 10 and SD 11

Miscellaneous

Standard reference	Title	Notes
CIRIA C543	Bridge Detailing Guide	
CIRIA C766	Control of cracking caused by restrained deformation in concrete	Supersedes C660
CIRIA C686	Safe Access for Maintenance and Repair	
CIRIA C760	Guidance on embedded retaining wall design	

Project Specific Documents

A303 Amesbury to Berwick Down (Stonehenge). Volume 2 – Scope. Part 2 – Design and Technical Requirements. April 2020. Doc Ref: A303-Proc-PD-009-V2-P2-Design and Technical

Appendix B – Geotechnical Design Report Summary

GEOTECHNICAL ASSESSMENT SHEET			
Project:	A303 Amesbury to Berwick Down	Rev: 0	Calc No: XXXXXX
Structure name:	Foundation of River Till viaduct		Date: 2021-02-04
Prepared: CRB	Checked: MP	Reviewed: JC	Job No: XXXXXXXX

Relevant exploratory boreholes:

RIVER TILL VIADUCT

Piers/abutments location and closest borehole

Eastbound structure		Westbound structure		BOREHOLES		
Pier/Abtmt	Chainage	Pier/Abtmt	Chainage	Closest borehole	Ground elevation (m)	Borehole depth (m)
A-01N	3+958.56	A-01S	3+948.14	21762-R122	72.93	20.50
C-01N	3+993.85	C-01S	3+983.85	PC197510-R70901	72.18	39.90
				21762-R123	71.71	20.00
C-02N	4+040.56	C-02S	4+031.14	16174-CP4	71.40	20.00
C-03N	4+087.28	C-03S	4+078.41	21762-R124	71.72	20.10
C-04N	4+133.99	C-04S	4+125.71	PC197510-R70903	71.98	40.20
A-02N	4+169.28	A-02S	4+161.40	16174-CP5	73.38	20.00

References:

[1] Jacobs UK Ltd. (2020) A303 Amesbury to Berwick Down – Exploratory Hole Location Plan and Geological Long Section. Drawing HE551506-BGR-GEN-SWMLM00Z-DR-GE-0004
[2] A303 Tunnel Ground Model Technical Note HE551506-BGR-HGT-SWGN000Z-RP-Z-0001

[3] PC197510 A303 Amesbury to Berwick Down - Phase 7a (i) Factual Report AMENDED FINAL 05 Nov 19_Optimized. HE551506-HE-VSS-ZZ_GN_ZZ_Z-RP-KK-0167
[4] 16174_A303 Stonehenge GI Ph. 2 Factual_MM 2001 (merged).
[5] 21762_A303 Stonehenge Imp_Ph. 1A Supplementary GI_HG 2003 (merged)

[6] CIRIA C574 Engineering in chalk
[7] Eurocode 7: Geotechnical Design – Part 1: General rules
[8] NA+A1:2014 to BS EN 1997-1:2004+A1:2013_UK National Annex to Eurocode 7: Geotechnical de-sign – Part 1: General rules

Proposed structure/foundation:

- The River Till viaduct is an isostatic structure of twin independent structures (Eastbound and Westbound)
- Located approx. between Ch 3+900 and Ch 4+200
- The viaduct length is 212m, in spans pf 35.5-47-47-47-35.5 m
- The location of abutments and piers are different in terms of chainage for each deck.
- The viaduct will cross over the river Till with a minimum clearance of 10m to road level

The proposed foundation consists of:

- Pile type: Bored
- 2x2 pile group at pier locations
- Pile diameter D=1500 mm
- Pile spacing 5.0m between axes (>3D)

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Prepared: CRB	Checked: MP	Reviewed: JC	Job No: XXXXXXXX
For bored piles of D=1500mm, in 2x2 groups, and with the A1 and A2 load combinations, the GEO ULS was verifies. The results indicate that the pile tip should be located at elevation 40-41m. Combination A2 was found to govern the Geotechnical design			

Encountered Ground conditions:

RIVER TILL VIADUCT

Piers/abutments location and closest borehole

Eastbound structure		Westbound structure		BOREHOLES			GROUND PROFILE			
Pier/Abtmt	Chainage	Pier/Abtmt	Chainage	Closest borehole	Ground elevation (m)	Borehole depth (m)	Soil and structureless chalk (=location of weathering depth)	Weathered chalk (CRS4-CSR5-CSR6)	Competent chalk (CR1-CR2-CR3)	Design GW level above ground surface (m)
A-01N	3+958.56	A-01S	3+948.14	R122	72.93	20.50	0-5m	_	5.0-20m CR1 (H, A2-A3)	+0.4
C-01N	3+993.85	C-01S	3+983.85	R70901	72.18	39.90	0-10.6m	_	10.6-39.5m CR2/CR1 (MH, B3/B2)	+1.0
				R123	71.71	20.00	0-6.8m	_	6.8-20.0m CR1 (C3)	
C-02N	4+040.56	C-02S	4+031.14	CP4	71.40	20.00				
C-03N	4+087.28	C-03S	4+078.41	R124	71.72	20.10	0-6m	_	6.0-20.0m CR1 (H, A1)	+1.88
C-04N	4+133.99	C-04S	4+125.71	R70903	71.98	40.20	0-5m and 11-15.5m (no recovery)	_	5.0-11.0m CR2/CR1 (MH, C3) 15.5-26.7m CR2/CR1 (B3) 26.7-40.0m CR1 (A2)	+1.94
A-02N	4+169.28	A-02S	4+161.40	CP5	73.38	20.00	0-2.6m	2.6-20.0m CRS6 (M, C3, C4)	_	+1.03
Interpreted fault at Ch. 4+150 approx. This marks zones of localised deeper weathering and disturbed ground										
A-02N	4+169.28	A-02S	4+161.40	CP5	73.38	20.00	0-2.6m	2.6-20.0m CRS6 (M, C3, C4)	_	+1.03

Note 1: Groundwater (GW) level for design is 20% Climate change GW level, as measured from the ground profile
Note 2: Chalk classification according to EGU codes in Table 2-1 of ref [2], and CIRIA field assessed (in brackets).

Ground model for foundation design:

- Reference borehole for ground model are the 40m long boreholes R70901 and R70903
- Only the two long (40m) long boreholes were used for design calculations of piles, the remaining short boreholes (20m) were used to verify the soil and weathered chalk profile.
- Design groundwater GW elevation (m) as per 20% Climate change level

- Shaft resistance in soils and structureless chalk disregarded
- Base resistance disregarded in this preliminary estimate, considering bored piles below groundwater, and no guarantee that the pile base will be clean
- Shaft resistance in weathered and competent chalk calculated as per Design Guide in CIRIA C574

Interpreted fault at Ch. 4+150 approx. This marks zones of localised deeper weathering and disturbed ground that may affect foundation design (i.e. longer piles) of Abutments A-02N and A-02S. Targeted ground investigation is required.
Ref Borehole is CP5 (20long) with 2.6m of soil and structureless chalk, over 17.4m of weathered chalk

Design approach and for pile foundations:

For bridges, the geotechnical design is carried out using Design Approach 1, as recommended by the UK national Annex to BS EN 1997. Where BS EN 1997 does not specify the value of certain factors to be used, the recommendations and guidance provided in the UK National Annex to BS EN 1997 are used.

Design Approach 1 provides reliability by applying different partial factors to two variables in two separate calculations; it incorporates two partial factors combinations (Combinations 1 and 2) that are verified for each design situation. In all cases, one of the two combinations, the most onerous one, governs the geotechnical design.

For the design of axially loaded piles:
Combination 1: A1+M1+R1
Combination 2: A2+ (M1 or M2) +R4
Note: A: for Actions or effects of actions; M: for soil parameters; R: for resistances

Ultimate limit states (ULS)
For preliminary design, it is verified that the ULS of Compressive resistance failure of a single pile is not exceeded

Serviceability Limit States (SLS)
For preliminary design, It is verified that a sufficiently low fraction of the ground strength is mobilized to keep deformations within the required serviceability limits

For the verification of geotechnical (GEO) limit states, set A1 or set A2 on actions, and set R1 or set R4 on soil resistances, as defined in the National Annex are used.

For bored piles, soil characteristic resistances may be derived from static load tests using EN 1997□1 7.6.2.2 (7.6.3.2 for tensile loading), or from ground test results using EN 1997□1 Equations 7.8 or 7.9 (7.17 or 7.18 for tensile loading). When the approach of Equations 7.9 or 7.18 is used to derive the characteristic resistances, a model factor should be applied to the shaft and base resistance calculated using characteristic values of soil properties by a method complying with EN 1997□1, **2.4.1**(6). The value of the model factor should be 1.4, except that it may be reduced to 1.2 if the resistance is verified by a maintained load test taken to the required, unfactored ultimate resistance.

The procedure and parameters for pile design are explained in CIRIA C574, and in particular in Figure 8.14. This procedure gives the values of shaft resistance and base resistance for pile design: