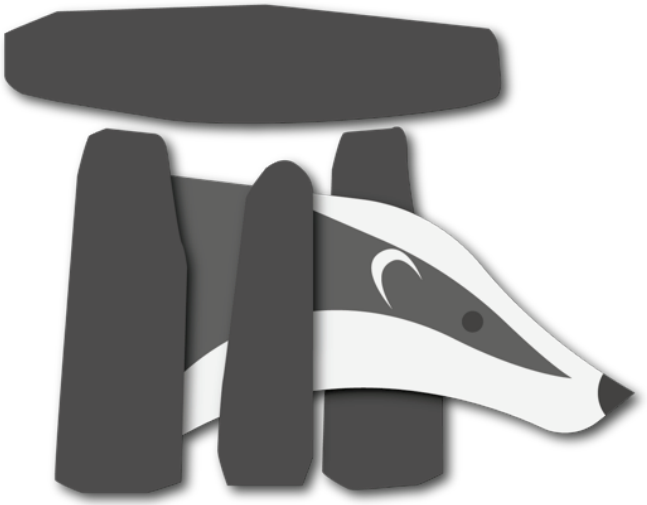

highways england

QS5C
Outline Approval in Principle (AIP) for:
The Eastern Portal Structures

5. Your outline approval in principle for the Eastern portal structures shall:
    5.1. be provided using Appendix A (Model form of Approval in Principle for the design of bridges and other highway structures where UK National Standards (Eurocodes) are used) of CG 300 (Technical approval of highway structures), inclusive of all sections;
    5.2. include a CDM designer's risk register for the eastern portal structures, which describes for each significant feature, element, process or works activity:
        5.2.1 the constraint and the identified hazard;
        5.2.2 the designer's intervention to reduce or eliminate the hazard;
        5.2.3 any significant residual hazard that remains following the designer intervention;
        5.2.4 the proposed information to be provided to allow the hazard to be managed on site or in the future.
6. You may include the CDM designer's risk register and the Technical Approval Schedule as appendices to the outline approval in principle.

Project Details

Name of Project

A303 Amesbury to Berwick Down (Stonehenge)

Name of Bridge or Structure

Eastern Portal Structures (Eastern Cut and Cover Tunnel Section, Eastern Tunnel Services Building)

Structure Reference Number

TBA

Summary

This Outline AIP covers the Eastern Portal Structures, including the Eastern Cut and Cover Tunnel Section and the Eastern Tunnel Services Building, it covers both the reinforced concrete structure and the soil nail works.
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 in the tunnels in accordance with CD 127.

1.2 Permitted traffic speed[1]

The route through the retained cut and cut and cover tunnel will be restricted to 70mph (110km/h).

1.3 Existing restrictions[2]

The retaining structure is to be constructed within the limits of deviation set by the Development Consent Order.

2. SITE DETAILS

2.1 Obstacles crossed

Proposed Eastern portal structures will span over the new A303. The site is within World Heritage Site, thus a DCO will be in place including mitigations in accordance with Detailed Archaeological Mitigation Strategy (DAMS).

3. PROPOSED STRUCTURE

3.1 Description of structure and design working life[3]

The eastern cut and cover tunnel will run from the end of the retained cut at CH 10475 to the start of the bored tunnel at CH 10425 and is composed of upper, intermediate and base

slabs with supporting walls. The intermediate slab supports the carriageway, beneath which is an under-deck access gallery support by the base slab. The base slab and walls will be constructed from in situ reinforced concrete, the intermediate slabs will be pre-cast elements and the roof will consist of precast beams connected to the walls. The roof to side wall joints will be detailed as moment connections to ensure the precast beams form an integral structure with the walls. Particular attention will be paid to waterproofing the joints between adjacent beams and between the beams and the walls, it is anticipated hydrophilic strips and re-injectable tubing will be used to waterproof those joints. It is noted that the future water level (climate change +20%) is still far below these joints, however it is understood that infiltration from rainwater, etc must still be prevented from entering the structure.

The eastern Tunnel Service Building (TSB) will be composed of upper, intermediate and lower reinforced concrete slabs with internal walls to separate rooms and external structural walls. The eastern TSB tapers in as it approaches the portal to reduce the overall footprint of the area whilst still providing efficient use of space. The structure will run from CH 10452 to CH 10616.

All the eastern portal structures will utilize permanent soil nails in order to withstand permanent ground loading. Behind the outer reinforced concrete walls, soil nails will be installed on a 1:10 angled slope with reinforced sprayed concrete facing covering the nail heads, drain holes will be provided through the sprayed concrete facing as the soil nail walls are not water retaining structures. The drain holes will only be required during the temporary case prior to the construction of the permanent structures, the final structure will be designed to work even if the holes have silted up. The space between the sprayed concrete and the outer walls will be filled with a light-weight non-structural void filling material, likely an expanded polystyrene material or similar.

The outer walls of the TSB and cut and cover tunnel will serve as the water retaining walls for those structures with the bottom 1.5m being reinforced to serve as the Vehicle Restraint System (VRS). A waterproofing layer will be installed around the TSB and Cut and Cover structures, including roof, walls, and base slabs, to maintain the required levels of watertightness inside those structures.

An integral sealing system will be provided with a water bar in order to prevent the ingress of water between in-situ pours on all structures.

The base of the upper slab of the Eastern structures is 6.78m above the road level and the top of the base slab is 2.6m below the base of the intermediate slab.

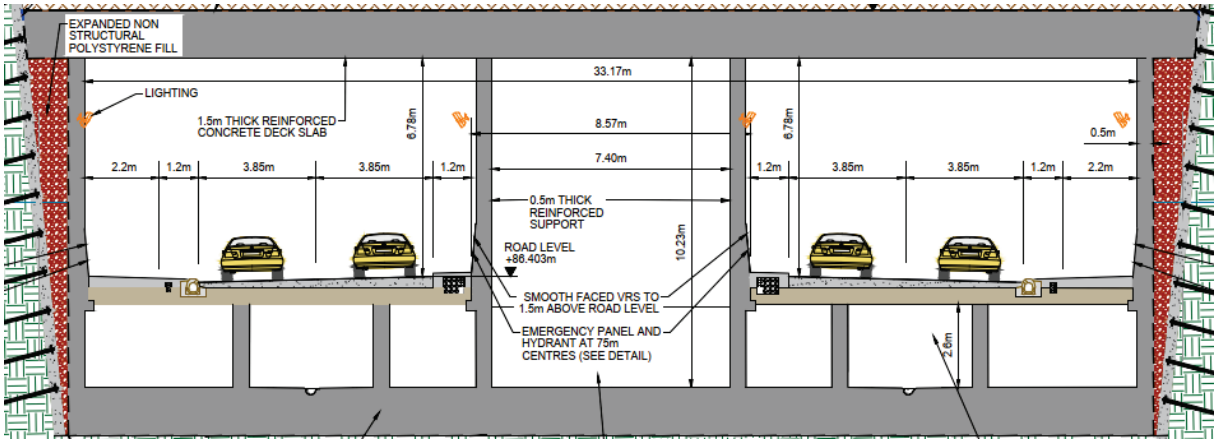

Figure 3-1-1: Typical Cross-section through cut and cover tunnel

The eastern portal structures will be designed for a design working life of 120 years in accordance with Table NA.2.1 of British National Annex to BS EN 1990:2002.

3.2 Structural type

Reinforced concrete slabs and walls. Precast beams for the roof and intermediate slab of the TSB and cut and cover tunnel. Soil nailed wall with in-situ concrete facing wall for the retained cut, connected to an in situ reinforced concrete base slab where provided. Soil nail walls to take the permanent ground loadings, roof beams to take surface surcharge and hydrostatic loads, side walls to take lateral water loads.

3.3 Foundation type

The base slab will act as a raft foundation for the portal, TSB and adjacent section of retained cut.

3.4 Span arrangements

The intermediate and roof slabs span between the external and internal structural walls. The roof slabs will be integrally connected to the walls, the intermediate slab will be pin connected. The effect of them acting as props will be checked at detailed design.

In the Eastern cut and cover tunnel the spans above the highway are 12.2m at the portal, widening to 13.1m at the start of the bored tunnel to allow space to launch the TBM. The central span is 8.1m at its widest point by the bored tunnel and reduces to 7.8m at its narrowest point by the portal.

In the TSB the largest span will be between the external structural wall and the traffic facing wall which is 18.7m at its widest and 13.6m at its narrowest point.

3.5 Articulation arrangements

There will be waterproof movement joints between the cut and cover tunnel and the portal structure and between the cut and cover tunnel and the TSB structure. Differential settlement is not anticipated to be significant (see section **6.3** of this AIP) so these movement joints provide provision for differential movement due to thermal effects and deflections under differential cyclic loading. The movement joints will be waterproof (Omega Seal type joints or similar, to be confirmed during detailed design) to stop ingress from rainwater and similar.

The interface between the bored tunnel and the cut and cover structure will be assumed to be fixed, due to the presence of the large grout block outside the structure into which the TBM will be launched and the nature of the construction sequence. The structure will be designed and modelled as such during detailed design.

3.6 Classes and levels[4]

A) Consequence class

For the main structure CC3 in accordance with CD 350, Table 7.2. Secondary elements may be designed to a lower consequence class.

B) Reliability class

RC3 for whole structure. K_{FI} taken as 1.0, in accordance with CD 350, Table 7.2 and Cl 7.3.

C) Inspection level

IL3 in accordance with Table B5, BS EN 1990:2002 + A1:2005 and CD 350, Table 7.2.

3.7 Road restraint systems requirements

The structural walls have been designed for impact in order to achieve architectural clean lines. Steel approach barriers are provided to guide into the tunnel in order to improve the

aesthetics of tunnel opening, minimise the visual impact of the restraint system and invite the end user naturally into the tunnel.

3.8 Proposals for water management.

The maximum anticipated groundwater level in this location, (using 20% allowance for Climate Change) is 73.1m, which is substantially below the level of the structures, so water management is primarily concerned with highway drainage and managing run off water.

An infiltration system positioned beneath the central reserve will be used to drain the carriageway in catchment 11. Water will fall to the drains at the road edge, down carrier drains and into a geo-cellular infiltration tank located under the central reserve. An overflow at the end of the retained cut will connect the tank to the main Highway drainage system outside of the eastern tunnel approaches.

Use of online attenuation systems such as oversized pipes along the carriageway including flow controls to maximize its capacity. Remotely operated pollution shut of valves in the tank will be provided.

Wastewater from the welfare facilities in the TSB will discharge to small, packaged treatment plants which separate out and treat the water element, so it can be discharged the road drainage system. The solid element will be tankered away periodically.

The waterproofing approach for the structures is described in section **3.1** of this AIP.

3.9 Proposed arrangements for future maintenance and inspection

A) Traffic management

It is expected that in order to safely carry out detailed inspection and certain specified maintenance activities, access to the portal and retained cut will be via the carriageway during tunnel closures. The tunnel systems will allow the closure of only a single bore for these inspections, giving the option that when a tunnel bore is closed the other tunnel bore will be capable of operating under contraflow.

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

Very little maintenance of the structure itself is anticipated and a risk-based strategy will be implemented regarding inspections. Maintenance activities may include:

- Carriageway re-surfacing
- Routine inspection of structural elements (walls, roof slabs, etc)
- Routine wash-down of the walls
- Routine inspection and maintenance of the drainage systems
- Routine inspection and maintenance of Parapets / barriers

Visual inspections are proposed to be carried out from a distance to minimise the time required for bore closures. Detailed inspections will require closer access and extended bore closures.

Use of remote working will be maximized where possible and monitoring periods are to be agreed with Highways England in line with the requirements and intervals of Volume 2, Part 4 of the ITPD. Access to the TSB will be via the maintenance hard standing area outside the TSB, this area and the muster point are behind steel VRS barriers to allow safe access and mustering. The underdeck gallery allows safe access from the TSB to the gallery, the portal pump room (located between the bores in the cut and cover tunnel) and the key cross passages where equipment is located.

The under-deck gallery will run the length of the bored tunnel beneath the carriageway and is accessed from the Tunnel Service Building (TSB). It will also provide access to the portal pump room located between the carriageways in the cut and cover tunnel. The under-deck gallery will contain cabling for a majority of the systems required to operate the tunnel, and all the "wet" systems such as the fire main, fixed firefighting suppression system, nadir sump pumps and drainage.

All equipment will be remotely monitored from the Highways England Regional Operations Centre and the TSB which will significantly reduce the necessity for maintenance personnel to be in the under-deck gallery. Nonetheless, some access will be required for maintenance personnel and their equipment. Further some equipment will need to be replaced via this gallery during the life of the tunnel.

The TSB will be a two-level structure and access to the under-deck gallery will be via the TSB basement. The stair core will form a fire compartment and will contain an access stair a minimum of 1m wide and two floor hatches. Measuring 3m x 3m and 1.5m x 1.5m the purpose of the hatches is for lowering / retrieving equipment and tools to / from the basement level. A lifting eye will be provided above each hatch and the larger one will be used for personnel evacuation should that be required. Upon reaching the ground floor level of the TSB, level access will be provided to the maintenance vehicles hardstanding adjacent to the carriageway.

Within the under-deck gallery access to the tunnel will be provided by electric vehicle.

The following sketches indicate the proposed configuration.

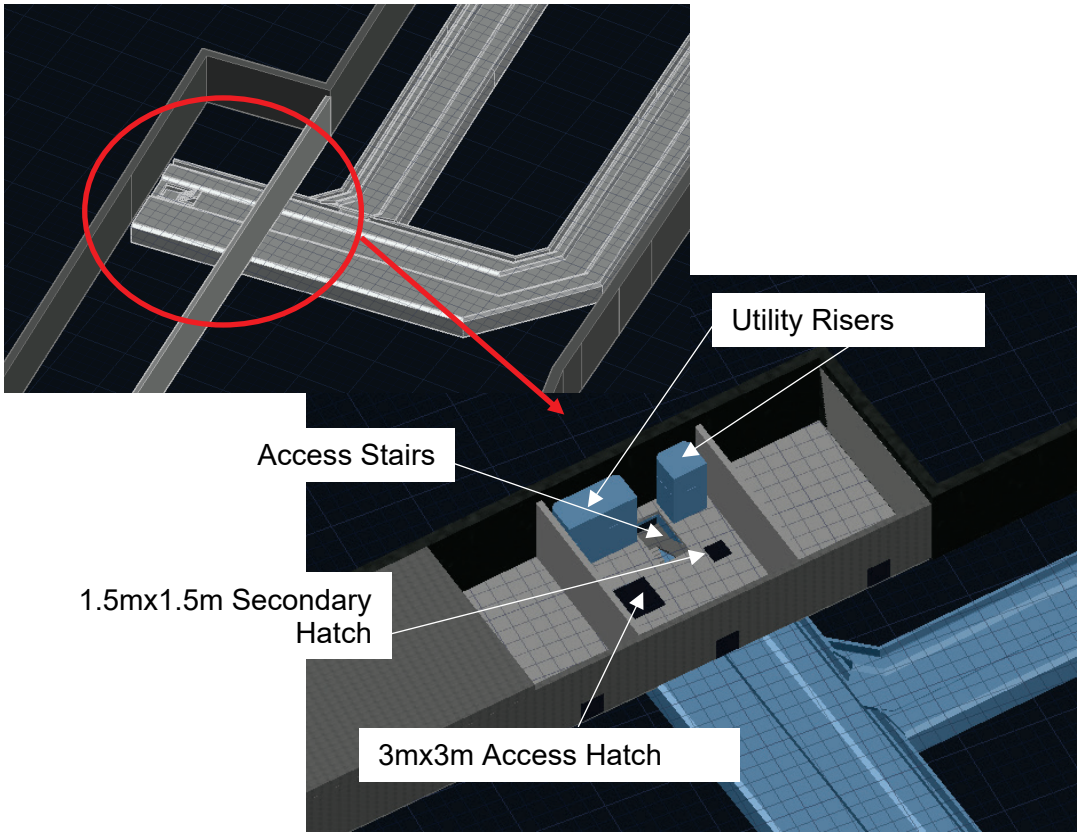

Figure 3.9.1: 3D Isometric sketch showing key features of under-deck gallery access

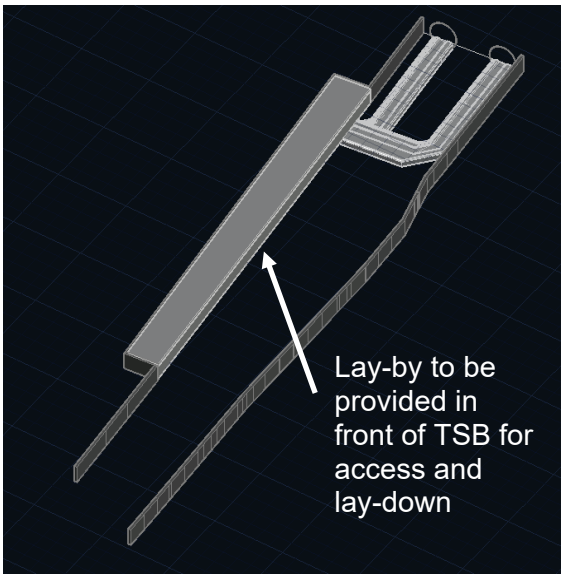

Figure 3.9.2: Indicative 3D sketch of TSB relative to tunnels, lay-by and under-deck galleries

3.10 Environment and sustainability

Utilizing the efficient engineering solution of soil nail walls, as opposed to diaphragm walls, reduces material usage which benefits the environment embedded carbon dioxide is also reduced. This methodology also eliminates the requirement for piling rigs to be visible on the horizon from the World Heritage Site.

The use of pre-cast beams fabricated off-site allows an accelerated programme, reducing time spent working in the World Heritage Site, and reduces wastage and materials usage as the beams can be manufactured to better tolerances and so made smaller.

3.11 Durability - materials and finishes[5]

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

The soil nail tendons will be galvanized high yield steel self-drilling hollow bars with spacers, as necessary, to maintain the bar central in the drilled hole. They will comply with the requirements of BS 8006-2 and will be tested in accordance with BS 8006-2, ISO 22477-5 & BS EN1997-1. The grout will have a minimum strength of 40N/mm^2, will comply with EN 197-1 type CEM I, EN 447:2007 and EN 446:2007 and will be tested in accordance with EN 445:2007. A 2mm corrosion allowance on the galvanised soil nails has been allowed for at this stage.

The in situ and pre-cast concrete elements shall be grade C32/40 minimum and will have an unformed face. The sprayed concrete facing will be reinforced with mesh, with a minimum concrete cover of 55mm.

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 and noise reduction requirements. The lower 1.5m of the road facing walls will serve as the Vehicle Restraint System (VRS) so will be smooth finished in warm natural colours. Above that the palette will remain similar but the finish will be a rough ‘natural’ textured finish to reflect the design vision, the rougher finish will incorporate the acoustic/noise reduction features. Finally, the cantilevers and canopies have been classified as ‘edge details’ by the design vision team and so will have a smooth concrete finish, in the same palette of warm natural tones as the other retaining wall structures.

Buried concrete elements, other than piles, in permanent contact with the soil shall be painted with two coats of cut back bitumen or equivalent. This is in addition to the waterproofing layer described in section **3.1** of this AIP.

3.12 Risks and hazards considered for design, execution, maintenance and demolition. Consultation with and/or agreement from Overseeing Organisation[6]

Early identification of risks in accordance with CDM regulations are 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 the Financial Submission.

3.14 Proposed arrangements for construction

A) Construction of structure

The structures will be constructed using the bottom-up method, to reach the invert level as soon as practicable allowing a faster construction programme

For all structures the initial excavation and works will be as follows:

- Temporary fencing installation, constructing access to work site and site preparation.
- Execution of permanent trench drain (if required) as per drainage design.
- Excavation of initial cut (2 m depth). Installation of King Post type support system (4m depth) where Archaeological limits are close. Transportation of the excavated material to a stockpile area.
- Excavation and soil nail installation. Proposed cycle; Excavate 1.5m, drill the nail hole, install and grout the nail.
- Shotcrete installation. Proposed cycle; placing of bearing plate, washer and hex nut installation, placing of mesh reinforcement, placing of formers for drain holes and finally spraying of shotcrete to required thickness.
- Repeat the two cycles above to reach the final invert excavation level.

The Cut and Cover structure will be constructed to the following sequence:

- Initial excavation works as described above.
- Execution of the permanent foundation base slab.
- Construction of the temporary works for reception of the TBM, including a ground treatment block installed by horizontal grouting and soft-eyes constructed in the cast in situ break-out wall.
- Once the final bored tunnel is complete and the TBM removed from site the portals will be stripped and construction will continue.
- Construction of the external walls up to final height, placing of non-structural backfill material between structure and soil nail wall (the backfill material will act like formwork in the temporary case) and the installation of the external waterproof membranes.
- Internal walls constructed.
- Construction of intermediate slab using pre-cast elements.
- Execution of top slab by installation of pre-cast slabs and cast in situ concrete on joints with external walls. Waterproof membrane to be placed on top of slab prior to backfilling.

- Backfilling up to final design level and final landscaping.

The TSB will be constructed to the following sequence:

- Initial excavation works as described above.
- Execution of the foundation base slab including waterproofing membrane.
- Construction of the external walls up to final height, placing of non-structural backfill material between structure and soil nail wall (the backfill material will act like formwork in the temporary case) and the installation of the external waterproof membranes.
- Installation of the intermediate pre-cast slab inside the building. Installation of the internal precast concrete elements; panels, staircases, etc.
- Execution of roof by installation of pre-cast slabs and pouring of cast in situ cantilever elements, elements to be connected by cast in situ concrete at joints with external walls. Waterproof membrane to be placed on roof prior to backfilling.
- Backfilling up to final design level.
- Construction finishes (e.g., cattle fence, landscaping, handrail etc).

B) Traffic management

It is anticipated that traffic management will not be required as the Eastern portal structures do not interact with the existing A303. This will be confirmed during detailed design.

C) Service diversions

No existing services in place.

D) Interface with existing structures

The existing A303 is within relatively close proximity to the proposed eastern portal structures. Predictions of the expected and worst case movements that the A303 could experience due to the works will be produced before the start of construction.

It is proposed to monitor the A303 using a series of automated total stations, all linked to the site control room to allow real time monitoring and alerts. RAG (Red-Amber-Green) trigger levels would be agreed with Highways England and the asset owner, along with associated actions that the construction works would implement. In addition, the movements would be reviewed at regular shift/daily meetings and compared against predictions for that phase to identify trends and, if necessary, pre-emptively implement mitigations before trigger levels are reached.

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. The cut-and-cover tunnel and TSB will be designed for a minimum uniform characteristic surcharge action of 20kN/m^2 applied at Ground Level.

The ground adjacent to the retained cut will be a 1:2 slope as per HE requirements, so a lower surcharge of 5kN/m^2 has been applied to the retained cut structures only.

Dispersal of load through fill shall be in accordance with PD 6694-1:2011.

Assumed characteristic densities used for the design of soil nails:

Reinforced concrete:	25kN/m^3
Highway surfacing:	24kN/m^3
Soil density:	20kN/m^3

Groundwater:	Groundwater level for detailed design will be the extreme event level + 20% allowance for climate change. This is below the formation level of the proposed structures.
Soil Nail Loads:	Soil nails shall be designed as a passive system with a nominal load of around 20kN applied following installation.

B) Snow, wind and thermal actions

Wind and snow loads are not significant for the design of the structure. Thermal actions on the retained cut and exposed elements of the TSB will be considered during detailed design, due to the level of fill above they are not considered significant for the cut and cover tunnel.

C) Actions relating to normal traffic under AW regulations and C&U regulations[7]

LM1 and LM2 as per the UK National Annex to BS EN1991-2:2003 and PD6688-2:2011. The design will consider the most onerous loading during its operational life.

D) Actions relating to General Order traffic under STGO regulations[8]

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

Escape footpath in place which will be designed for accidental axle loads in accordance with BS EN 1991-2 and PD6688-2:2011.

F) Actions relating to Special Order traffic, provision for exceptional abnormal indivisible; loads including location of vehicle track on deck cross-section[9,10]

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 walls, roof slabs and other elements of the structure and superstructure 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, this will be reviewed as part of the threat and vulnerability assessment to be undertaken during detailed design.

The Design Fire to be used for passive structural fire protection shall be represented by the Rijkswaterstaat (RWS) time-temperature fire curve, a peak temperature of 1350 ºC and for a period of 120 minutes. To mitigate the effects of fire on the structural integrity the design will allow for the presence of 2kg/m3 of Polypropylene fibres in the concrete (exact quantity TBC in detailed design) which will act to reduce spalling. Fire will be treated as an accidental load case with the aim of maintaining structural stability in the fire and post-fire phase.

H) Actions during construction

Changing loads on the embedded retaining walls due to the excavation and construction sequence will assessed in accordance with BS EN 1997-1. Specific loading, e.g., due to any heavy lifting/craneage required, will be assessed on an individual basis.

I) Any special action not covered above[11]

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

The road is not on a Highways England advisory heavy or high load route. No provision has been made for any future tunnel designation as an advisory heavy or high load route.

No provision has been made for future widening due to the nature of the Development Consent Order.

4.3 Proposed minimum headroom to be provided

New construction headroom in accordance with Table 4.1 of CD 127 will be provided in the verge beneath the cantilever slab. As the cantilever extends over the verge and not the main carriageway it is considered to not be especially vulnerable to vehicular impact and so is an Overbridge for headroom purposes. The provided headroom is in line with what is provided for Green Bridge 4 and the Bored Tunnel.

4.4 Authorities consulted and any special conditions required

The Stakeholder Design Consultation Group (SDGC) comprises of representation from English Heritage Trust, Historic England, The National Trust and Wiltshire Council. This group, and the organizations stakeholders represented by the group, will be consulted throughout the detailed design process.

The Tunnel Design Safety Coordination Group (TDSCG) will also be consulted during design as requirements from that group may have structural impacts as well as ventilation / MEP / system requirements.

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

The proposed Technical Approval Schedule is included in **Appendix A**.

4.6 Proposed departures from standards listed in 4.5

No departures are currently anticipated for the eastern portal structures at this stage.

4.7 Proposed departures from standards concerning methods for dealing with aspects not covered by standards listed in 4.5

To be confirmed at the detailed design stage. None identified at this time.

4.8 Proposed safety critical fixings

No structural safety critical fixings are proposed.

Any other safety critical fixings will be designed in accordance with CD372 “Design of post-installed anchors and reinforcing bar connections in concrete” formerly IAN 104/15 and CIRIA C778. This will be carried out in detailed design.

5. STRUCTURAL ANALYSIS

5.1 Methods of analysis proposed for superstructure, substructure and foundations[12]

Closed form solutions have been used for the initial assessment to size the reinforced concrete elements for this stage of design. Upon award of the detailed design, a structural analysis model will be created using software such as STAAD.

Soil nails will be designed in accordance with BS 8006-2. Soil parameters will be factored in accordance with BS EN 1997-1.

Analysis for the concrete facing will be carried out by manual calculations in accordance with BS EN 1992-1-1:2004 +A1:2004, BS EN 1997-1:2004 + A1:2013, and BS EN 1990:2002 + A1:2005 and the associated national annexes.

The structure was checked against floatation using the final design water level. In the temporary case de-watering will not be required as the expected water level is lower than the required excavation level.

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

The reinforced concrete structure has been simplified as shown below with fixed-fixed connections and fixed supports:

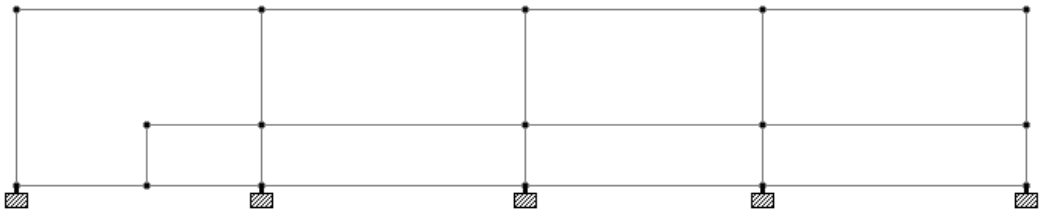

Figure 5-2-1: Idealised STAAD Model

The below table is composed of the loadings utilised in both the closed form calculations as well as for input into the STAAD model:

Load	Location	Load Type
Fill Weight	Top slab	Uniformly distributed
Self-Weight	Whole structure	Uniformly distributed
Hydrostatic Pressure	External Walls	Triangular
Vehicular Load	Intermediate slab	Uniformly distributed
Uplift Pressure	Base slab	Uniformly distributed

Table 5-2: Input Load Parameters

The soil nail retaining structure has been analysed using SLOPE-W ver 10.2.1.19666, a proprietary slope analysis programme developed by GeoSlope international Ltd.
The figure below shows the idealised structure analysis diagram.

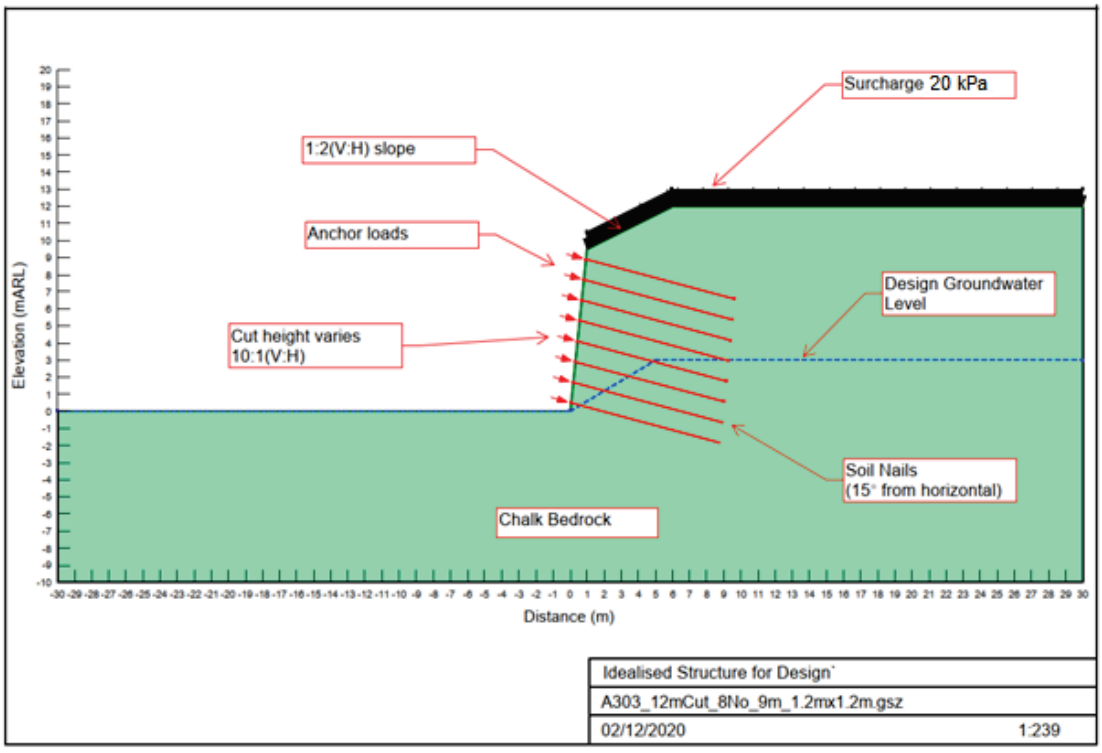

Figure 5-2-2: Idealised Model

5.3 Assumptions intended for calculation of structural element stiffness

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

The stiffness of soil nails will be based on the gross cross section properties making allowance for predicted losses due to corrosion at the end of the structure's working life.

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

Refer to **Appendix B** for preliminary soil design parameters.

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

At the transition between the portal structure and the retained cut there will be a change in foundation type as the concrete base slab stops and conventional highway pavement construction begins.
At this location the highway foundation design will have to be carefully considered to minimise the potential for differential settlement.

As both sections are founded on chalk the potential for differential ground movement is minimal, but this will be reviewed at detailed design.

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[13]

N/A

7. CHECK

7.1 Proposed category and design supervision level

The reinforced concrete structural design will be Category 3 and Design Supervision Level 3 following the project detail design award. Prior to this, internal checking and reviewing procedures will be adhered to.

The soil nail design will be Category 2 and Design Supervision Level 2 following the project detail design award. Prior to this, internal checking and reviewing procedures will be adhered to.

7.2 If category 3, name of proposed independent checker

To be appointed following the project detail design award.

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

It is anticipated that the permanent works category 3 check would include checking the proposed construction sequence and checking of loads applied to temporary propping at defined temporary propping locations.

8. DRAWINGS AND DOCUMENTS

8.1 List of drawings (including numbers) and documents accompanying the submission[14]

Table 8-1: List of Drawings

No.	Title
HE551506-BGR-STU-SWSREP0Z-DR-S-0001	LONG SECTION ALONG THE EASTBOUND CARRIAGEWAY FACING NORTH
HE551506-BGR-STU-SWSREP0Z-DR-S-0002	LONG SECTION ALONG THE WESTBOUND CARRIAGEWAY FACING NORTH
HE551506-BGR-STU-SWSREP0Z-DR-S-0003	EASTERN TUNNEL APPROACH SHEET 1 OF 4
HE551506-BGR-STU-SWSREP0Z-DR-S-0004	EASTERN TUNNEL APPROACH SHEET 2 OF 4
HE551506-BGR-STU-SWSREP0Z-DR-S-0005	EASTERN TUNNEL APPROACH SHEET 3 OF 4
HE551506-BGR-STU-SWSREP0Z-DR-S-0006	EASTERN TUNNEL APPROACH SHEET 4 OF 4

9. THE ABOVE IS SUBMITTED FOR ACCEPTANCE

We confirm that details of the temporary works design will be/have been15 passed to the permanent works designer for review.[16]

Signed _____
Name _____ Design Team Leader
Engineering Qualifications _____[17]
Name of Organisation _____
Date _____

Signed _____
Name _____ Check Team Leader
Engineering Qualifications _____[17]
Name of Organisation _____
Date _____

10. THE ABOVE IS REJECTED/AGREED[15] SUBJECT TO THE AMENDMENTS AND CONDITIONS SHOWN BELOW[18]

Signed _____
Name _____
Position held _____
Engineering Qualifications _____[17]
TAA _____
Date _____

Notes

[1] For a bridge, give over and/or under.
[2] Include weight, height, width and any environmental restrictions at or adjacent to the bridge.
[3] The design working life of the structure,including temporary structure, and replaceable structural parts should be given. They should be expressed as a number of years rather than a range of years. A design working life should be based on the DMRB if stated. Otherwise it may be based on the guidance given in the Overseeing Organisation's current requirements for the use of Eurocodes for the design of highway structures.
[4] State the classes and levels for the whole structure, as well as those for the individual structural elements if higher or lower. See the Overseeing Organisation's current requirements for the use of Eurocodes for the design of highway structures.
[5] For concrete structures, give applicable exposure classes for particular structural elements. For all material strengths given, list the relevant codes/standards.
[6] Designers should confirm that they have reviewed the risks and hazards identified in the AIP and are satisfied. Also see clause 2.27.
[7] e.g., Load Models 1 and 2, BS EN 1991-2 [Ref 4.N]
[8] e.g., SV model vehicle in Load Model 3, BS EN 1991-2 [Ref 4.N]
[9] e.g., SOV model vehicle in Load Model 3, BS EN 1991-2 [Ref 4.N] and /or individual vehicle which includes the following information as applicable:

- gross weight of the vehicle in tonnes and vehicle type and number;
- axle load and spacing (longitudinally and transversely);
- air cushion in tonnes over area applied (in metres, longitudinally and transversely);
- single or twin tyres and wheel contact areas.

[10] If in doubt, the heavy or high load route requirements should be confirmed by the relevant administration e.g., Abnormal Indivisible Load team in Highways England. 11) e.g., seismic action, atmospheric icing, floating debris etc.
[12] List the main structural elements for superstructure, substructure and foundation. If the designs of the superstructure, substructure and/or foundation are carried out by different teams, refer to clause 2.84.
[13] When the ground investigation report becomes available, an addendum to the AIP, covering section 6, is to be submitted to the TAA. The addendum is to have its own sections 8, 9 and 10 to provide a list of drawings, documents and signatures.
[14] Include, without limitation:

- technical approval schedule (TAS);
- general arrangement drawing;
- relevant extracts from the ground investigation report;
- departures;
- relevant correspondence and documents from consultations.

[15] Delete as appropriate.
[16] This statement is applicable to temporary works design AIP only.
[17] CEng MICE, CEng MIStructE or equivalent.
[18] AIP is valid for three years after the date of agreement by the TAA. If the construction has not yet commenced within this period, the AIP is to be re-submitted to the TAA for review.

Appendix A – Technical Appraisal Schdule (TAS)

Eurocodes and associated UK National Annexes			
Eurocode part	**Title**	**Amendment / Corrigenda**	***Notes***
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~~	
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	-	

Eurocodes and associated UK National Annexes			
Eurocode part	**Title**	**Amendment / Corrigenda**	***Notes***
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 +A1:2020 to BS EN 1991-2:2003	**UK National Annex to Eurocode 1: Actions on structures. Traffic loads on bridges**	**Corrigendum No.1 Amendment June 2020**	**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 1-1: 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	-	
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 structures – Part 3: Liquid retaining and containment structures	-	

Eurocodes and associated UK National Annexes			
Eurocode part	**Title**	**Amendment / Corrigenda**	***Notes***
BS EN 1992-4:2018	Eurocode 2: Design of concrete structures – Part 4: Design of fastenings for use in concrete		
NA to BS EN 1992-4:2018	UK National Annex to Eurocode 2: Design of concrete structures – Part 4: Design of fastenings for use in concrete		
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 – Part 1-5 Plated structural elements	+ A1:2016 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	

Eurocodes and associated UK National Annexes			
Eurocode part	**Title**	**Amendment / Corrigenda**	***Notes***
~~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	

Eurocodes and associated UK National Annexes			
Eurocode part	**Title**	**Amendment / Corrigenda**	***Notes***
~~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 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 + A2:2014~~	~~Eurocode 5: Design of timber structures – Part 1-1 General – common rules and rules for buildings~~	~~+ A2:2014 Incorporating corrigendum June 2006~~	
~~NA to BS EN 1995-1-1:2004 + A2:2014~~	~~UK National Annex to Eurocode 5: Design of timber structures – Part 1-1 General – common rules and rules for buildings~~	~~+ A2:2014~~	
~~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~~	~~+A1:2012 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~~	~~+A1:2012~~	

Eurocodes and associated UK National Annexes			
Eurocode part	**Title**	**Amendment / Corrigenda**	***Notes***
~~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 +A1:2014 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~~	~~+A1:2014~~	
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+A1:2014 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	-	
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~~	~~-~~	

Eurocodes and associated UK National Annexes			
Eurocode part	**Title**	**Amendment / Corrigenda**	***Notes***
~~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 + A2:2013~~	~~Eurocode 9: Design of aluminium structures – Part 1-1 General structural rules~~	~~+ A2:2013 Incorporating corrigendum March 2014~~	
~~NA to BS EN 1999-1-1:2007 + A1:2009~~	~~UK National Annex to Eurocode 9: Design of aluminium structures – Part 1-1 General structural rules~~	~~National Amendment No.1 Corrigendum No.1~~	
~~BS EN 1999-1-3:2007 + A1:2011~~	~~Eurocode 9: Design of aluminium structures – Part 1-3 Structures susceptible to fatigue~~	~~+ A1:2011~~	
~~NA to BS EN 1999-1-3:2007 + A1:2011~~	~~UK National Annex to Eurocode 9: Design of aluminium structures – Part 1-3 Structures susceptible to fatigue~~	~~+ A1:2011~~	
~~BS EN 1999-1-4:2007 +A1:2011~~	~~Eurocode 9: Design of aluminium structures – Part 1-4 Cold formed structural sheeting~~	~~+ A1:2011 Corrigendum November 2009~~	
~~NA to BS EN 1999-1-4:2007~~	~~UK National Annex to Eurocode 9: Design of aluminium structures – Part 1-4 Cold formed structural sheeting~~	~~-~~	

Bsi Published Documents *For guidance only unless clauses are otherwise specified in CD 350 Appendix A.*		
Published Document reference	**Title**	**Notes**
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 in PD 6687-1, this is now clause 4.21.4 in PD 6687-1

Eurocodes and associated UK National Annexes			
Eurocode part	**Title**	**Amendment / Corrigenda**	***Notes***
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 6688-1-4:2015~~	~~Background paper to the UK National Annex to BS EN 1991-1-4~~	~~See CD 350 Appendix A for additional guidance.~~	
PD 6688-1-7:2009 +A1:2014	Recommendations for the design of structures to BS EN 1991-1-7	See CD350 clause 3.7 and Appendix B 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 6694-1:2011 + A1:2020~~	**~~Recommendations for the design of structures subject to traffic loading to BS EN 1997-1~~**	**~~See CD 350 Appendix A for additional guidance.~~** **~~Amended 27 May 2020~~** **(Temporarily withdrawn due to technical errors)**	
~~PD 6695-1-9:2008~~	~~Recommendations for the design of structures to BS EN 1993-1-9~~	~~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 6695-2:2008 + A1:2012 Incorporating Corrigendum No.1~~	~~Recommendation for the design of bridges to BS EN 1993~~	~~See CD 350 Appendix A for additional guidance.~~	
~~PD 6696-2:2007 + A1:2012~~	~~Background paper to BS EN 1994-2 and the UK National Annex to BS EN 1994-2~~	~~See CD 350 Appendix A for additional guidance.~~	
~~PD 6698:2009~~	~~Recommendations for the design of structures for earthquake resistance to BS EN 1998~~	~~See CD 350 section 7 for additional guidance.~~	
~~PD 6702-1:2009+A1:2019~~	~~Structural use of aluminium. Recommendations for the design of aluminium structures to BS EN 1999~~	~~Amended 31 May 2019~~	
~~PD 6703:2009~~	~~Structural bearings – Guidance on the use of structural bearings~~		
~~PD 6705-2:2020~~	~~Structural use of steel and aluminium. Execution of steel bridges conforming to BS EN 1090-2. Guide~~	~~Replaces PD 6705-2:2010 + A1:2013~~	
~~PD 6705-3:2009~~	~~Recommendations on the execution of aluminium structures to BS EN 1090-3~~		

Execution Standards referenced in British Standards or Eurocodes		
Execution Standard reference	**Title**	**Notes**
~~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 1090-2:2018~~	~~Execution of steel structures and aluminium structures. Technical requirements for the execution of steel structures~~	~~Supersedes BS EN 1090-2:2008+A1:2011~~
~~BS EN 1090-3:2019~~	~~Execution of steel structures and aluminium structures – Part 3: Technical requirements for aluminium structures~~	~~Supersedes BS EN 1090-3:2008~~
BS EN 13670:2009 Incorporating corrigenda October 2015 and November 2015	Execution of concrete structures	

Product Standards referenced in British Standards or Eurocodes		
Product Standard reference	Title	Notes
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*

Product Standards referenced in British Standards or Eurocodes		
Product Standard reference	Title	Notes
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*
~~PD CEN/TR 16949:2016~~	~~Road Restraint System – Pedestrian restraint system - Pedestrian parapets~~	~~*Bsi Published Document / CEN Technical Report published in July 2016*~~ ~~*(This document should not be used. The requirements of BS 7818:1995 apply.)*~~
~~Draft prEN 1317-7~~	~~Road restraint systems - Part 7: Performance classes, impact test acceptance criteria and test methods for terminals of safety barriers~~	~~*Draft prEN 1317-7 for public comment published in June 2012*~~ ~~*(This document should not be used. All terminals should continue to be in accordance with ENV1317-4.)*~~
~~PD CEN/TS 17342:2019~~	~~Road restraint systems - Motorcycle road restraint systems which reduce the impact severity of motorcyclist collisions with safety barriers~~	~~*Replaces* PD CEN/TS 1317-8:2012~~ ~~*(This document should not be used.)*~~
~~PD CEN/TR 17081:2018~~	~~Design of fastenings for use in concrete – Plastic design of fastenings with headed and post-installed fasteners~~	
~~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~~	

Product Standards referenced in British Standards or Eurocodes		
Product Standard reference	Title	Notes
~~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~~
BS EN 10080:2005	Steel for the reinforcement of concrete – Weldable reinforcing steel - General	
~~BS EN 10210-1:2006~~	~~Hot finished structural hollow sections of non-alloy and fine grain steels – Part 1: Technical delivery conditions~~	

Product Standards referenced in British Standards or Eurocodes		
Product Standard reference	Title	Notes
~~BS EN 10210-2:2019~~	~~Hot finished structural hollow sections – Part 2: Tolerances, dimensions and sectional properties~~	~~Supersedes BS EN 10210-2:2006~~
~~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 14388:2005	Road traffic noise reducing devices	There is a 2015 version, however the 2015 version is not harmonised.
BS EN 15050:2007 + A1:2012	Precast concrete products – Bridge elements	See CD 350 clause 3.8.1 for additional guidance.

British Standards		
British Standard reference	Title	Notes
BS 4449:2005+A3:2016	Steel for the reinforcement of concrete	No longer covers plain round bar. (See BS4482 up to 12mm dia, see BS EN 10025-1 for larger sizes and dowels. See BS EN 13877-3 for dowel bars in concrete pavements.)
BS 5896:2012	Specification for high tensile steel wire and strand for the prestressing of concrete	
BS 7818:1995	Specification for pedestrian restraint systems in metal	Incorporating Corrigendum No.1 May 2004 and Corrigendum No.2 September 2006 Currently the requirements of BS 7818:1995 are to be used instead of PD CEN/TR 16949:2016
BS 8002:2015	Code of practice for earth retaining structures	
BS 8004:2015 +A1 2020	Code of practice for foundations	Amendment +A1:2020

British Standards		
BS 8006-1:2010+A1:2016	Code of practice for strengthened/reinforced soils and other fills	
BS 8500-1:2015+A2:2019	Concrete – Complementary British Standard to BS EN 206: Method of specifying and guidance for the specifier.	Incorporating Corrigendum No.1 and Corrigendum No.2 June 2020 Amendment +A2:2019
BS 8500-2:2015+A2:2019	Concrete – Complementary British Standard to BS EN 206 : Specification for constituent materials and concrete.	Amendment +A2:2019
BS 8666:2005	Scheduling, dimensioning, bending and cutting of steel reinforcement for concrete	Incorporating Amendment No.1

The Manual Contract Document for Highway Works (MCHW)		
MCHW reference	Title	*Notes*
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*
MCHW Volume 3: February 2017	Highway Construction Details	

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	

The Design Manual for Roads and Bridges (DMRB)		
DMRB reference	Title	Notes
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 Revision 0	Technical approval of highway structures	Supersedes BD 2/12
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 363 Revision 0~~	~~Design rules for aerodynamic effects on bridges~~	~~Replaces BD 49/01~~
~~CD 364 Revision 0~~	~~Formation of continuity joints in bridge decks~~	~~Replaces BA 82/00~~

The Design Manual for Roads and Bridges (DMRB)		
DMRB reference	Title	Notes
CD 365 Revision 1	Portal and cantilever signs/signals gantries	Replaces BD 51/14, IAN 193/16, BE 7/04
CD 366 Revision 0	Design criteria for collision protection beams	Replaces BD 65/14
~~CD 368~~ ~~Revision 0~~	~~Design of fibre reinforced polymer bridges and highway structures~~	~~Replaces BD 90/05~~
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 375~~ ~~Revision 1~~	~~Design of corrugated steel buried structures~~	~~Supersedes BD 12/01~~
CD 377 Revision 2	Requirements for road restraint systems	Supersedes TD 19/06
CD 622 Revision 1	Managing geotechnical risk	Replaces HD 22/08, BD 10/97 and HA 120/08
CS 461 Revision 0	Assessment and upgrading of in-service parapets	Supersedes BA 37/92 and IAN 97/07
GD 304 Revision 2	Designing health and safety into maintenance	Replaces IAN 69/15
LA 104 Revision 1	Environmental assessment and monitoring	Supersedes HA 205/08, HD 48/08, IAN 125/15, and IAN 133/10
LA 106 Revision 1	Cultural heritage assessment	Supersedes HA 208/07, HA 60/92, HA 75/01
LA 110 Revision 0	Material assets and waste	Supersedes IAN 153/11
~~LA 113~~ ~~Revision 1~~	~~Road drainage and the water environment~~	~~Supersedes HD 45/09~~
~~LD 119~~ ~~Revision 0~~	~~Roadside environmental mitigation and enhancement~~	~~Formerly LA 119, which superseded HA 65/94 and HA 66/95~~
Interim Advice Notes		
IAN reference	Title	Notes

The Design Manual for Roads and Bridges (DMRB)		
DMRB reference	Title	Notes
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	
CIRIA C778	Management of safety-critical fixing. Guidance for the managements and design of safety critical fixing	

Appendix B – Geotechnical Design Report Summary

GEOTECHNICAL ASSESSMENT SHEET			
Project: A303 Amesbury to Berwick Down		Rev: 2	Calc No: GAS/001/R0
Structure Name: Soil Nail Cuttings (East and West Approaches and Portals)			Date: February 2021
Prepared: DW	Checked: AD	Reviewed: AD	Job No: B2390300

Exploratory Holes:	**References:**
Western Approach Ch. 6600 to 7200 16174-SSTP49, 16174-SSTP50, 16174-SSTP51, 21762-STP134 **Western Portal Ch. 7200 to 7400** 16174-SSTP52, 16174-DTP14, 16174-DTP15 **Eastern Portal Ch. 10400 to 10500** R507A, 16174-DTP34, 16174-R24 **Eastern Approach Ch. 10500 to 10700** 16174-STP55, 16174-STP56	i. Jacobs UK Ltd. (2020) A303 Amesbury to Berwick Down – Exploratory Hole Location Plan and Geological Long Section, Drawing No. HE551506-BGR-GEN-SWMLM00Z-DR-GE-0008 ii. A303 Tender – Tunnel Ground Model Technical Note iii. Mott MacDonald (2001) Site Interpretative Investigation Report: Phase I Main Ground Investigation, Report No. 57334/UWG/REP/STONEHENGE/INTPII/B/October 2001 iv. Mott MacDonald (2002) Site Interpretative Investigation Report: Phase II Main Ground Investigation, Report No. 57334/UWG/REP/STONEHENGE/INTPII/B/April 2002 v. Balfour Beatty-Costain JV and Halcrow-Gifford JV (2006) A303 Stonehenge Improvement Preliminary Geotechnical Report, Report No. P1A-GEO-GEN-R002C. vi. Arup Atkins JV (2016) A303 Amesbury to Berwick Down, Preliminary Sources Study Report, Report No. HE551506-AA-HGT-SWI-RP-CX-000004. vii. Highways England (2018) A303 Amesbury to Berwick Down6.3 Environmental Statement Appendices: Appendix 10.1 Preliminary Ground Investigation Report, Report No. TR010025-000426-6-3. viii. A303 Stonehenge – Phase 6 and 7 Ground Investigation – Final Factual Report on Ground Investigation (2019). ix. Ground Investigation Phase 7A (i) Report (2019). x. CIRIA (2002) Engineering in Chalk. CIRIA: London.

Proposed Structure:

The current proposal is to construct permanent soil nails, along the western and eastern approaches and portals to the new bored tunnel on the A303, to stabilise the slope faces. The slope faces will be inclined at 10:1 (V:H) (approx. 84°) and the soil nails will consist of 32mm diameter galvanized high yield steel self drilling hollow bars, grouted into 100mm diameter holes, inclined at 15° from the horizontal. Although the nails are galvanised, an additional 2mm corrosion allowance over the design life of the structure has been included giving a diameter of 28mm. This will be reviewed during the next phase of the design. The length of the soil nails will vary based on the slope height. In addition, there is an average 2.5m high, 1:2 (V:H) back slope that is present above the soil nailed face.

Existing Ground Level:

The existing ground levels were obtained from topography and relevant boreholes approximately located along the proposed carriageway. The proposed carriageway level and existing ground level is as follows:

Section	Existing Ground Level	Proposed Carriageway Level
Western Approach	~101mAOD to 98mAOD	~90mAOD to 87mAOD
Western Portal	~98mAOD to 102mAOD	~87mAOD to 85mAOD
Eastern Portal	~ 94mAOD to 90mAOD	~78mAOD to 79mAOD
Eastern Approach	~ 90mAOD to 85mAOD	~79mAOD to 83mAOD

Ground Conditions and Models

Western Approach

Estimated from exploratory holes: 16174-SSTP49, 16174-SSTP50, 16174-SSTP51 and 21762-STP134 which are all offset from the proposed carriageway.

Table 1: Stratigraphy for Western Approach

Stratum	Elevation to top of stratum (mAOD)	Depth to top of stratum (mBGL)	Thickness (m)	Description
Structureless Chalk (Dc)	95.8	0.0	1.5	Granular chalk soil
Structureless Chalk (Dm)	94.3	1.5	>1.1[1]	Cohesive chalk soil
Weathered Chalk	95.5 to 96.2	0.0[2]	0.4 to 0.7	Chalk rock/soil
Structured Chalk	95.1 to 97.3	0.0[2] to 0.7	>1.2 to >1.6	Chalk rock

Notes

[1]The exploratory holes noted for the Western Approach were relatively shallow and in some cases the Chalk Rock was not encountered.

[2]Where the borehole is off-centre from the proposed carriageway, the ground level along the alignment is much lower than the borehole elevation and so the stratum appears to be at "Ground Level".

Western Portal

Estimated from exploratory holes: 16174-SSTP52, 16174-DTP14 and 16174-DTP15 which are all offset from the proposed carriageway.

Table 2: Stratigraphy for Western Portal

Stratum	Elevation to top of stratum (mAOD)	Depth to top of stratum (mBGL)	Thickness (m)	Description
Topsoil	97.2 to 100.2	0.1 to 0.9[1]	0.2	Topsoil
Structureless Chalk (Dc)	95.5 to 100.0	0.0 to 1.1	0.8 to 1.4	Granular chalk soil
Weathered Chalk	94.7 to 99.2	0.8 to 3.2	0.5 to >1.9	Chalk rock/soil
Structured Chalk	94.1 to 98.7[2]	1.4 to 1.6	1.5[3] to >3.2	Chalk rock

Notes

[1]The geological cross section indicates that some of the borehole elevations were below the ground level and this is due to the offset of these holes from the proposed alignment.
[2]DTP15 indicates a layer of Competent Chalk between Weathered Chalk

Eastern Portal

Estimated from exploratory holes: R507A, 16174-DTP34 and 16174-R24 which are all offset from the proposed carriageway.

Table 3: Stratigraphy for Eastern Portal

Stratum	Elevation to top of stratum (mAOD)	Depth to top of stratum (mBGL)	Thickness (m)	Description
Weathered Chalk	90.0	0.0	19.6	Chalk rock/soil
Structured Chalk	70.4 to 94.2	0.0[1] to 19.6	>0.7 to >15.0	Chalk rock

Notes

[1]Where the borehole is off-centre from the proposed carriageway, the ground level along the alignment is much lower than the borehole elevation and so the stratum appears to be at "Ground Level".

Eastern Approach

Estimated from exploratory holes: 16174-STP55 and 16174-STP56 which are all offset from the proposed carriageway.

Table 4: Stratigraphy for Eastern Approach

Stratum	Elevation to top of stratum (mAOD)	Depth to top of stratum (mBGL)	Thickness (m)	Description
Topsoil	82.2	0.5[1]	0.2	Topsoil
Structureless Chalk (Dc)	80.8	1.9	0.3	Granular chalk soil
Weathered Chalk	80.5	2.2	0.7	Chalk rock/soil
Structured Chalk	79.8 to 86.8	0.0[2] to 2.9	>1.0	Chalk rock

Notes

[1]The geological cross section indicates that some of the borehole elevations were below the ground level and this is due to the offset of these holes from the proposed alignment.
[2]Where the borehole is off-centre from the proposed carriageway, the ground level along the alignment is much lower than the borehole elevation and so the stratum appears to be at "Ground Level".

Groundwater

Groundwater monitoring in the vicinity of the scheme indicates general seasonal variations of between 8m and 10m beneath the dry valleys and around 15m below interfluve areas (valleys between watercourses).

An assessment was undertaken to identify the groundwater levels from Drought Low levels to Extreme High levels. The Extreme High levels are indicated in the Geological cross section as being beneath the base excavation of the approaches and portals. For the purpose of this assessment, an additional 40% has been added to account for climate change. The groundwater level increased to a maximum of 3.0m above road level.

During the design life of the structure, the groundwater will be allowed to drain through the shotcrete facing to sit between the tanked wall and the shotcrete face of the soil nailed slope. In this instance, the groundwater pressure will be balanced behind the front and the back of the soil nail facing. For the purpose of the soil nail stability assessment, the groundwater level was drawn down from 3.0m above road level down to road level. This approach is conservative as there will be a higher pressure behind the wall than in reality.

Summary of Soil Parameters

Mott MacDonald undertook an interpretation of design parameters for Chalk within their Ground Investigations in 2001. These are given in Table 5.

Table 5: Derived properties for Chalk (Mott MacDonald, 2001)

Stratum	Unit weight of soil, γ (kN/m^3)	Drained cohesion, c' (kPa)	Effective angle of friction, ϕ' (°)	Unconfined Compressive Strength, UCS (MPa)
Cut-and-cover Tunnels				
Chalk	Not given	Not given	35.0	Not given
Bored Tunnels				
Grade IV (Poor Quality)	Not given	0.0	35.0	2.0
Grade III (Reasonable Quality)	Not given	N/A	N/A	2.0
Grade II (Reasonable Quality)	Not given	N/A	N/A	2.0

Further interpretation of parameters was undertaken by Jacobs as part of the Tunnel Ground Model Technical Note. The interpretation takes into consideration ground investigations up to 2018, which include the Balfour Beatty-JV/Halcrow-Gifford JV report (2006), Atkins Arup JV report (2016) and Highways England report (2018), as referenced at the start of this sheet. These parameters are summarised in Table 6.

Table 6: Derived properties for Chalk (Jacobs, 2020)

Stratum	Unit weight of soil, γ (kN/m³)	Drained cohesion, c' (kPa)	Effective angle of friction, ϕ' (°)
Structureless Chalk (Dm)	19.0 to 21.0	Not given	Not given
Structureless Chalk (Dc)	19.0 to 21.0	Not given	28.6 to 34.8
Structured Chalk	16.0 to 23.0	Not given	38.7 to 42.8

Additional ground investigations, Phase 6, 7 and 7A, were undertaken in 2019 and their associated factual reports, referenced at the start of the sheet, were completed the same year. However, the Ground Investigation Report, discussing the results of the 2019 ground investigation, is yet to be completed. This report will be used for the next stage of the design process.

Ground Model Adopted for Design of Soil Nails

Based on the above ground models, the slope stability assessment was undertaken based on a worst-case full depth of Weathered Chalk material, based on exploratory hole R507A. The Chalk properties given by Mott MacDonald and Jacobs were not extensive. Moderately conservative parameters, in Table 7, were determined by guidance within CIRIA C574 and engineering knowledge based on previous projects undertaken in Chalk. These chosen parameters were then checked against the properties derived in Table 5 and Table 6.

Additionally, a separate slope stability assessment was undertaken for the 2.5m high, 1:2 (V:H) back slope. It was assumed that the full depth of this slope was made up of cohesive Structureless Chalk (Dm).

Table 7: Chalk properties used in slope stability assessments

Stratum	Unit weight of soil, γ (kN/m³)	Drained cohesion, c' (kPa)	Effective angle of friction, ϕ' (°)
Structureless Chalk (Dm)	20.0	1.0	30.0
Weathered Chalk	20.0	2.0	34.0

Surcharge

A nominal permanent surcharge of 5kPa was applied to the slopes of the retained cut and up to 2.0m from the crest of the slope to account for any pedestrian and light maintenance plant loading. Beyond 2.0m from the crest of the slope, a permanent surcharge of 20kPa was applied, based on the scope provided for the project.

The cut and cover tunnel will be designed to take a 20kPa surcharge across its full extent, including the soil nail walls, in the permanent case (i.e. after the backfill has been placed over the roof slab).

Soil Nail Considerations

The cutting depths of the approaches and portals range from 4.0m to 16.0m. The large variation in range gives rise to the use of several different lengths of soil nail, as well as number of rows, that provide adequate bond resistance to prevent instability of the slopes. The proposed arrangement is given in Table 8.

Table 8: Proposed arrangement of soil nail cutting faces

Total Cutting Height (m)	Facing Height (m)	Number of nails rows	Nail length (m)	Spacing	
				Vertical	Horizontal
16.5	14.0	12	10.0	1.0	1.2
15.5	13.0	11	9.0	1.2 (0.7 Top)	1.2
14.5	12.0	10	9.0	1.2	1.2
13.5	11.0	9	9.0	1.2	1.2
12.5	10.0	8	9.0	1.2	1.2
11.5	9.0	7	8.0	1.2	1.2
10.5	8.0	7	8.0	1.2 (0.7 Top)	1.2
9.5	7.0	6	8.0	1.2	1.2
8.5	6.0	5	7.0	1.2	1.2
7.5	5.0	4	7.0	1.2	1.2
6.5	4.0	3	7.0	1.2	1.2
5.5	3.0	3	6.0	1.2	1.2
4.5	2.0	2	6.0	1.2 (0.7 Top)	1.2

Some of the cutting heights require smaller vertical spacing than 1.2m in the top nail in order to maintain adequate stability in the top of the soil nail face.

The soil nails will be constructed in a diamond formation.

Facing Considerations

It is proposed that the soil nails will be faced with a rigid facing comprised of shotcrete with a reinforced steel mesh.

Construction Issues

An archaeological area that is adjacent to the cutting and runs parallel to the top of the back slope along the approaches and portals, must be avoided when installing the soil nails. There is a minimum required clearance of 4.0m from the top of the back slope cutting to the soil nail.

GEOTECHNICAL ASSESSMENT SHEET			
Project: A303 Amesbury to Berwick Down		Rev: 2	Calc No: GAS/001/R0
Structure Name: Soil Nail Cuttings (East and West Approaches and Portals)			Date: February 2021
Prepared: DW	Checked: AD	Reviewed: AD	Job No: B2390300

Conclusions and Recommendations

- Soil nail lengths vary from 6.0m to 10.0m depending on the cutting depth;
- The number of rows of soil nails varies from 2 to 12 depending on the cutting depth;
- The soil nails will be constructed in a diamond formation;
- An archaeological area, that begins from the top of the back slope cutting, must be avoided when installing the nails. A minimum of 4.0m clearance from the top of the back slope cutting to the soil nail is required; and
- The assessment assumes Weathered Chalk as the full cutting depth, however, it is recommended, at detailed design, to refine the ground model for each relevant chainage and also to review the parameters used for the Chalk. A refinement of the ground model and parameters may allow a reduction in soil nail lengths.

Appendix C – Relaxation and Departure from Standard Submission Form

No departures are anticipated for the Eastern portal structural design at this stage.

Appendix D – CDM Designer's Risk Register

Potential hazards and risk have been identified at this early stage and risks will continue to be considered as the design develops. A detailed risk register will be developed during detailed design.

DESIGN HAZARD ELIMINATION AND REDUCTION REGISTER

highways england

Project Name	Design Stage	Engineering Discipline	Structure	Date	Document Reference
A303 Amesbury to Berwick Down (Stonehenge)	Tender Design	Geotechnics	Eastern and Western Portals and Retained Cuts	25 November 2020	**Quality Submission**

Ref:	Phase C/M/D	Activity	Potential Hazards	Risk	Person(s) Affect	L	S	R	Design Measures to Eliminate Hazards	Design Measures to Reduce Risk	Residual risk information to be provided going forward	L	S	R	Included on Drawing/Document No.'s - References
1.0	C	Excavation / Site Preparation	Unidentified/uncharted live services	Injury to site personnel. Damage to existing infrastructure. Damage to plant and equipment. Changes to design	Site personnel	4	4	16	Site Investigation and PAS128 compatible survey Desk Study	Services should be located and manged as far as possible during the pre-construction phase, and Information identified on combined service drawings. Where possible, service diversions or de-energisation should be designed for.	Contractor to undertake appropriate surveys prior to excavation	2	4	8	
2.0	C	Excavation / Site Preparation	Unforeseen Ground conditions	Founding stratum failure or deformation in excess of structure serviceability limits resulting in structure/ infrastructure damage. Disruption to construction owing to unforeseen ground conditions, incorrect stratigraphy and ground parameters	Site personnel	3	4	12	Site Investigation Desk Study	The ground conditions across the site should be established in the detailed design stage. All Factual data should be made available to Contractor.	Follow advice of designers, any ground improvement required to be undertaken by Contractor	2	4	8	
3.0	C	Excavation / Site Preparation	Unexploded ordnance	Injury to site personnel. Damage to plant and equipment. Damage to adjacent properties.	Site personnel	2	4	8	Site Investigation Desk Study	Preparation of Method Statements for the works	Tool Box talks to highlight low risk and actions	1	4	4	
4.0	C	Construction of Cut and Cover and Retained Cut	In-situ construction works	Injury to workforce	Site personal	4	4	16	Design to allow the offsite manufacture where possible to ensure controlled conditions.	Identification and Communication of design advice such as guidance on the equipment to be used	Competent contractor to be used and detailed construction risk assessment to be completed upon reward of detailed design	3	4	12	
5.0	C	Construction of Cut and Cover and Retained Cut	High level in areas of work. Working at height – there will be a need for works to be carried out at high level.	Falls from height, injury and death.	Site personnel	3	5	15	Design to allow the offsite manufacture of as many elements as possible for lifting using machinery. This would eliminate as far as reasonable possible the need for onsite working at height. Insutu works required to ensure water proofing requirements. Precast will be investigates for detailed design.	Identification and Communication of design advice such as guidance on the equipment to be used, leading edge protection, guidance on harnessing operatives if necessary and PPE to be used	Contractor to follow design advice and follow appropriate working at height procedures.	2	5	10	
6.0	C	Construction of Cut and Cover and Retained Cut	Crane movement and Lifting of materials	Dropping of heavy items, material during construction resulting in injury and death, and damage to materials and tunnel.	Site personnel	3	5	15	The use of mechanical hoists to be designed where possible to reduce lifting	Identification and Communication of design advice including the correct procedure for lifting materials and the use of crash/protection decks	Contractor to follow design advice and follow appropriate lifting procedures. Protection/Crash decks to be designed	2	5	10	
7.0	C	Construction of Cut and Cover and Retained Cut	Open Excavations	Collapse of excavations causing injury and death, and damage to plant	Site personnel	3	4	12	Temporary works to be designed (with shoring as necessary) to prevent collapse of any excavations	Appropriate exclusion zones and design measures to be put in place to mitigate the damage and injury caused by potential collapse of excavations. Methods statements to be prepared for works	Contractor to follow design advice and follow appropriate procedures	1	4	4	
8.0	C & M	Construction of Cut and Cover and Retained Cut	Portential for confined space working	Injury to workforce	Site personal	3	4	12	Design in order to prevent confined space through access and venthilation etc.	N/A	Contractor to follow design advice and build to design	1	1	1	
9.0	C	Construction of Cut and Cover and Retained Cut	Excessive uplift ressure on base slab	Excessive deflection of slab, injury to personnel	Site personnel	4	4	16	Design out heave pressure, for instance, through the use of drainage to ensure even uplift pressure	Design slab and piles to resist maximum uplift pressure	Contractor to follow design advice and build to design	1	4	4	
10.0	C	Construction of Cut and Cover and Retained Cut	Excessive loading on walls from retained side due to over excavation prior to the highways construction	Excessive deflection on walls, injury to workforce	Site personnel	4	4	16	N/A	Design of props in the temporary case in order to prevent the deflection of the retaining wall	Contractor to follow design advice and build to design	2	4	8	
11.0	C	Construction of Cut and Cover and Retained Cut	Ground water higher than predicted in site investigation	Excessive uplift forces on the base slab causing damage to the base slab and injury to personnel	Site personnel and public	4	4	16	Further site investigation to establish maximum ground water level	Design for conservative values of uplift forces	Contractor to follow design advice and build to design	2	4	8	
12.0	C	Construction of Cut and Cover and Retained Cut	Interface with operational highways during the construction of highways infrastructure	Accidents involving site personnel and members of the public causing injury and potential death, damage to vehicles and plant	Site personnel and public	4	4	16	Design with consideration of nearby existing A303 to avoid site boundary interface. Where ointerface occurs lane closures as necessary.	Design for traffic management during the detailed design process.	Contractor to follow design advice and follow appropriate procedures and avoid site boundary interface with nexisting A303.	2	4	8	
13.0	C	Construction of Cut and Cover and Retained Cut	Impacts of Depressurization/Dewatering	Excessive settlement and structural damage caused to surrounding infrastructure, compromising stability	Public and site personnel	4	4	16	Further Site Investigation and Desk Study to fully understand local conditions when designing	Ensuring that suitable cut off is designed for	Contractor to follow design advice and build to design. Contractor to also carry out surveys on site before building to confirm geological conditions	3	4	12	
14.0	C	Excavation / Site Preparation	Contaminated Ground/groundwater, including unknown contamination (unlikely due to nature of site)	Risk to human health, controlled water receptors, buried service and structures	Site personnel and users	2	3	6	Site Investigation Desk Study	Report to be made available to Contractor.	Isolation of areas known to be contamination (if any). Excavation and removal of zone for off site disposal to a licenced landfill facility under appropriate Risk Assessments and Method Statements. Tool box talks to raise awareness of risks and actions in the event of encountering contamination. Protection of groundwater monitoring installations	1	3	3	
15.0	C & M	Operation of Highways	Terrorist attack	Injury to public	Public	2	4	8	N/A	Security management and security features of building to be designed at detailed design stage, specialist advise to be sought at design stage	Contractor to follow design advice and build to design	1	4	4	
16.0	M	Repair and maintenance of operational highway, street furniture and landscaping	Difficulty in conducting repairs over operational highway	Vehicular accidents during maintenance causing injury and death	Public and site personnel	3	4	12	Design should be robust to ensure functionality of operational highway and design out maintenacne requirement s where possible. Maintenance regime to be designed to reduce disruption and enable remote moitoing. Footpath and tunnel services building incorperated into design.	Safety features (such as walkways) to be designed at detailed design stage. Maintenance regime to be determined at detailed design stage	Residual risk information to be included in O&M manuals and the Health and Safety File. Closing the operational highway mitigates the risk of injury caused	1	4	4	
17.0	D	Use of highways by heavy vehicles	Overloading of highways base slab	Loading of road base slab exceeding the highways loading designed for, causing excessive deflection and damage to the roads, and injury to public	Public	3	4	12	Specifying restrictions on highways loading to prevent the use of the road by vehicles which are heavier than anticipated	Slab to be designed for loading from heavy vehicles according to highways standards and maximum loading to be made clear for the appropriate signage	Residual risk information to be included in O&M manuals and the Health and Safety File, signage to be put up on the highway to restrict vehicles heavier than anticipated	2	4	8	
18.0	D	Decomissioining of structure	Demolitionmay result in confined space, falling material	Injury to workforce	Site personnel	4	4	16	Intended decomissioning of tunnel to be by backfilling site, not demolition.	N/A	Proposed decomissioing to be inlcuded in O&M manuals and Health and Saferty File.	1	4	4	
								0						0	

Phase	
C	Construction
M	Maintain/Clean
D	Demolish/Adapt

Hierarchy of Mitigation

1. Eliminate hazard - design out
2. Reduce risk at source - amend design
3. Provide risk information - add to design

Prepared by:	Team Badger													Date:	10 February 2021
Reviewed by:	Team Badger Internal													Date:	
Approved by:	Team Badger Internal													Date:	