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## **East Sussex County Council Transport and Environment**

### **Bexhill to Hastings Link Road S07 Combe Haven Underbridge Approval in Principle**

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**Project:** Bexhill to Hastings Link Road  
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**1. HIGHWAY DETAILS****1.1 Type of highway**

Over: Bexhill to Hastings Link Road (BHLR) which is a single carriageway 2-lane rural all purpose road. 12.0m carriageway with 2.5m verge on the east side and 2.5m verge on west side.

Under: N/A

**1.2 Permitted traffic speed**

Over: 60 mph (96 kph)

Under: N/A

**1.3 Existing restrictions**

None

**2. SITE DETAILS****2.1 Obstacles crossed**

The bridge crosses Combe Haven Stream which flows from west to east. The channel width, measured between the tops of opposing banks is approximately 7.40m at its widest point below the footprint of the structure.

**3. PROPOSED STRUCTURE****3.1 Description of structure**

The structure is a single span underbridge carrying BHLR over Combe Haven Stream. The deck consists of inverted prestressed concrete T-beams with concrete infill. The deck is integral with reinforced concrete abutment walls supported on a piled foundation. The reinforced concrete wingwalls are set perpendicular to the abutment walls.

The parapet stringcourse will be cast in situ reinforced concrete.

The OS grid reference for the structure is 574843.8E, 110012.5N.

**3.2 Structural type**

The structure is a single span integral bridge designed as a frame-type integral bridge in accordance with BA 42/96.

Wingwalls cantilever from the rear of the abutment.

**3.3 Foundation type**

Reinforced CFA concrete piled foundation.

**3.4 Span arrangements**

Single clear span of 11.4m with zero skew

**3.5 Articulation arrangements**

The structure is an integral bridge which does not require deck articulation or movement joints. BD33/94 Type 2 (Asphaltic plug) joints are proposed at the approach

embankment/deck interfaces.

Thermal movement of the bridge deck is resisted by passive earth pressure behind the abutment wall and rotational stiffness of the end supports.

**3.6 Types of road restraint systems**

The proposed road restraint system requirement has been confirmed by a RRRAP assessment. A metal N2/W4 vehicle parapet 1000mm high with mesh infill will be provided to comply with the requirements of TD19/06.

**3.7 Proposed arrangements for maintenance and inspection**

**3.7.1 Traffic management**

Close inspection or maintenance of the deck soffit over the waterway will require an underbridge unit and hence a single lane closure of the link road will be necessary.

**3.7.2 Access**

Over the waterway, the deck soffit can be accessed by underbridge unit from the carriageway above.

A minimum 2m wide maintenance platform is provided in front of the abutments. 1.5m minimum clear headroom is provided from the maintenance platform level to the precast beam soffit.

Inspection and maintenance of the remaining deck soffit, abutments and wing walls can be carried out from ground level using a platform or ladder to reach upper levels.

Foundations will not be visible or accessible for inspection.

**3.8.1 Materials and finishes**

Concrete	Element	Limiting Exposure Class	
C48/60	Prestressed T beams	XD1	
C40/50	Infill deck slab	Top	XC3
		Cantilever soffit	XD3
		Parapet plinths	XD3
C32/40	Abutment, exposed face below deck	XD1	
	Abutment, wingwalls exposed side faces	XD3	
	Abutment, wingwalls buried	DC-1	
C32/40	CFA Piles	DC-4z. Note A	
Note A	ACEC class is AC-4z in natural ground therefore Design Chemical Class for pile design will be DC-4z. Refer to Geotechnical Summary Sheet for detail.		
<b>Reinforcement</b>	All reinforcement to be grade 500B or 500C deformed bars to BS 4449:2005		
<b>Parapets</b>	Painted (HA Type IV), galvanised steel.		

**Backfill to abutments and retaining walls**      Fill material to structures to be Class 6N or 6P in accordance with DoT Specification for Highway Works.

#### **Concrete Finishes**

Deck soffit ie PC beam soffits	F5
Surfaces to receive waterproofing	U4
Top of parapet plinth	U3
Sides of parapet plinth	F3
Abutment	F2
Wingwalls	F6 (grooved patterned profile finish)
Buried formed surfaces	F1
Buried unformed surfaces	U1

#### **Protection**

The top deck surface will be protected with a proprietary spray applied bridge deck waterproofing system to SHW CI 2003.

All accessible concrete surfaces greater than 150mm below finished ground level to receive waterproofing to below ground concrete surfaces in accordance with the SHW CI 2004.

### **3.8.2 Sustainability issues**

Conventional construction materials are proposed; therefore, no significant sustainability issues are foreseen.

### **3.9 Risks and hazards considered**

Standard construction methods are anticipated with normally associated risks and hazards. A design hazard log and risk assessment process is active for the scheme.

### **3.10 Estimated cost of proposed structure together with other structural forms considered and the reasons for their rejection including comparative whole-life costs with dates of estimates.**

The relative advantages, disadvantages and costs of various structural forms are discussed and appraised in Owen Williams reports No. 262701/012 'BHLR Structures Options Report'.

### **3.11 Proposed arrangements for construction**

#### **3.11.1 Traffic management**

N/A

#### **3.11.2 Service diversions**

N/A

#### **3.11.3 Interface with existing structures**

N/A

## **4. DESIGN CRITERIA**

### **4.1 Live loading , Headroom**

#### **4.1.1 Loading relating to normal traffic under AW regulations and C&U regulations**

Full HA loading in accordance with BD 37/01

**4.1.2 Loading relating to General Order traffic under STGO regulations**

37.5 units of HB loading on any one notional lane only in accordance with BD 37/01.

**4.1.3 Footway or footbridge live loading**

Verge loading in accordance with BD 37/01

**4.1.4 Loading relating to Special Order Traffic, provision for exceptional abnormal loads or indivisible loads, including location of vehicle track on deck cross-section**

N/A

**4.1.5 Any special loading not covered above**

Approach embankments founded on soft ground will be subjected to advance works surcharging and/or ground treatment eg band drains or controlled modulus column installation, in advance of structural piling. Any residual lateral load or negative skin friction effects resulting from approach embankment loadings will be assessed and included in the design loadings for the bridge piled foundations.

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

N/A

**4.1.7 Minimum headroom provided**

The minimum headroom below bridge beams and concrete infill shall not be less than 1.5m after allowing for deflections arising from dead load, live load and settlement.

In addition, the soffit level of the deck shall be at a level greater than or equal to the 100 year flood level +20% flood flow plus 600mm freeboard.

**4.1.8 Authorities consulted and any special conditions required**

**Authority Consulted**

1: British Telecom

2: EDF Energy

3: ESCC Planning

4. ESCC

5. Environment Agency

**Special Requirement**

1x90mm PVC duct required over structure.

1x150mm duct required over structure.

Planning Condition number 5. Bridge abutments are to be set back 2m from top of waterway channel banks to facilitate green corridor and soft bank solution.

1.5m minimum maintenance headroom to underside of structure.

600mm freeboard to be provided above water level during 100yr return period flood + 20% flood flow.



## 4.2 List of relevant documents from the TAS

See Appendix A

### 4.2.1 Additional relevant standards

BS 8500; Part 1; 2006	Concrete; Complementary British Standard to BS EN 206-1; Method of specifying and guidance for the specifier
BS 8500; Part 2; 2006	Concrete; Complementary British Standard to BS EN 206-1; Specification for constituent materials and concrete
CHE Memorandum 227/08	The Impregnation of Reinforced and Prestressed Concrete Highway Structures Using Hydrophobic Pore Lining Impregnants

### 4.3 Proposed Departures from Standards given in 4.2 and 4.2.1

None

### 4.4 Proposed methods for dealing with aspects not covered by Standards in 4.2 and 4.2.1

N/A

## 5. STRUCTURAL ANALYSIS

### 5.1 Methods of analysis proposed for superstructure, substructure and foundations

The structure will be analysed in accordance with the recommendations given in PCA publication 'Integral abutments for prestressed beam bridges' by B.A Nicholson.

For the construction phase, the distribution of bending moments and shear forces in the deck will be determined by use of a simply supported line beam analysis.

For in service effects the deck analysis will be split into two stages. Firstly a grillage analysis will be undertaken assuming pinned supports at the abutments. The analysis will determine the maximum sagging moments in the deck, shear force distribution and vertical reactions. Transverse thermal and shrinkage effects will be considered in the design and appropriate measures taken to allow for these effects.

Secondly, a portal frame analysis of the deck and abutment stem walls will be undertaken, making allowance for the deck being monolithic with its supports and modelling soil structure interaction. The analysis will make allowance for the restraint to shrinkage and creep due to continuity over the supports. The analysis will return the maximum hogging moments in the deck and evaluate the rotation to be applied to the pileheads in the piled foundation design.

Load effects envelopes will be determined for the prestressed concrete beams which will be designed to Class 1 and Class 2 conditions.

Abutment stem walls will be designed for load effects determined from the portal frame analysis.

Retaining walls will be analysed by hand calculation.

Piled foundations will be analysed using appropriate industry standard software, considering a single representative pile and taking account of soil structure interaction effects including the lateral movements and rotational effects induced by deck load effects. Pile spacing is such that pile group effects are not considered to be appropriate.

Additional lateral loading on piles arising from potential approach embankment settlement will be analysed and added to pile loads arising from the deck and abutment analyses.

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

Refer to Appendix D for diagram of idealised structure(s).

**5.3 Assumptions intended for calculation of structural element stiffness**

Element stiffness for concrete members will be determined in accordance with BS5400; Part 4; 1990; Clause 4.4 using full elastic uncracked member cross sections ignoring the presence of reinforcement.

**5.4 Proposed earth pressure coefficients (  $k_a$ ,  $k_0$ , or  $k_p$  ) to be used in the design of earth retaining elements**

Earth pressure coefficients used in the calculation of lateral earth pressures at the rear of a full-height frame integral abutment will be calculated in accordance with the requirements and recommendations contained in BA 42/96 'The Design of Integral Bridges'. The earth pressure coefficients used in the calculation of the 'K' and 'at rest' earth pressures at the rear of the abutment shall be based on upper bound 6N granular backfill properties of density = 22kN/m<sup>3</sup>, maximum  $\phi'$  = 45°,  $K_0$  = 0.6 and  $K_p$  = 12.6 when considering adverse effects.

The earth pressure coefficients used in the calculation of the earth pressures at the rear of the cantilever wingwalls will be based on the guidance presented in "Integral Abutments for Prestressed Beam Bridges" by BA Nicholson 1998.

For the analysis of the free standing earth retaining wingwalls a representative peak angle of friction of 35° will be used, for which  $k_a$  = 0.27;  $k_p$  = 3.69 and  $k_0$  = 0.43 (calculated in accordance with BD 30/87).  $k_a$  will be used for stability calculations and  $k_0$  for structural element design.

**6. GEOTECHNICAL CONDITIONS**

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

Section 2 of the Geotechnical Report has not been completed at this stage.

**6.2 Geotechnical Report Highway Structure Summary Information (Form C)**

A draft Geotechnical Report Highway Structure Summary sheet based on the information available in Part 1 of the Geotechnical Report is attached in Appendix C. A full Geotechnical Report Highway Structure Summary sheet and extracts from the completed Geotechnical Report Section 2 will be produced following development of the Geotechnical Report.

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

The structure is founded on piles extending to the Ashdown Formation. A maximum differential settlement of 10mm between abutments will be considered.

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

The preliminary choice of foundation is discussed in the draft Geotechnical Report Highway Structure Summary sheet contained in Appendix C. Part 2 of the Geotechnical Report, including Section 2 Highway Structures, is expected to be completed in Phase 2 of the project.

## 7. CHECKING

### 7.1 Proposed category of structure

Category 2 in accordance with BD2/05

### 7.2 If Category 3, name of proposed Independent checkers.

N/A

### 7.3 Erection proposals or temporary works for which an independent check will be required, listing parts of the structure affected with reasons for recommending an independent check.

N/A

## 8. DRAWINGS AND DOCUMENTS

### 8.1 List of drawings and documents accompanying the submission.

Appendix A List of relevant documents from TAS dated February 2009

Appendix B	Drawing No	Title
	B1297000-PH1/1600.06a/9071	S07 Combe Haven Underbridge AIP General Arrangement

Appendix C	Geotechnical Information	Draft Geotechnical Report Highway Structure Summary Sheet.
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Appendix D	Idealised Structure	
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**9 THE ABOVE IS SUBMITTED FOR ACCEPTANCE**

9.1 Submission by designer

Signed



Name: P Blackie  
Position: Structures team leader, Jacobs  
Engineering Qualifications: BEng (Hons), CEng MICE

Date 17/08/12

9.2 Endorsement by contractor

Signed

Name: .....

Engineering Qualifications:.....

Position:....., Hochtief Vinci Joint Venture

Date:

**10. THE ABOVE IS REJECTED/AGREED SUBJECT TO THE AMENDMENTS AND CONDITIONS SHOWN BELOW.**

Reviewed .....

Name:.....

Engineering qualifications.....

Date: .....

Signed .....

Name:.....

TAA

Engineering qualifications.....

Date: .....



## Appendix A List of Relevant Documents

Schedule of Design Documents Relating to Highway Bridges and Structures; February 2009

### **British Standards**

BS 5268; Part 2; 2002	Structural Use of Timber
BS 5400	Steel concrete and composite bridges
Part 1; 1988	General Statement (see BD 1 )
Part 2; 1978	Specification for loads (see BD 1 )
Part 3; 2000	CP for design of steel bridges (see BD 1)
Part 4; 1990	CP for design of concrete bridges (see BD 2 )
Part 5; 1979	CP for design of composite bridges (see BD 16)
Part 9; 1983	Bridge bearings (see BD 20)
Part 10; 1980	CP for fatigue (see BD 9)
BS 5628; Part 1; 1992	Unreinforced Masonry
BS 5930; 1999	Site Investigations
BS 6031; 1981	Earthworks
BS 8002; 1994	Earth retaining structures
BS 8004; 1986	Foundations
BS 8148; 1991	The structural use of aluminium
BS EN 1317-1-1998; Road Restraint Systems – Part 1	Terminology and general criteria for test methods
BS EN 1317-2-1998; Road Restraint Systems – Part 2	Performance classes, impact test acceptance criteria and test methods for safety barriers
BS EN 1317-3-2000; 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	Terminals and transitions
BS EN 14388; 2005	Road traffic noise reducing devices – Specification

### **Miscellaneous**

~~Circular Roads No 61/72 – Routes for heavy and high abnormal loads.~~

~~Railway Group Approved Code of Practice GC/RC5510: Recommendations for the Design of Bridges (2000)  
(for full list of other Network Rail Standards, refer to RSSB, Railway Safety and Standards Board)~~

~~Simplified Tables of External Loads on Buried Pipelines (1986)~~

~~Traffic Management Act 2004~~

***The Manual of Contract Documents for Highway Works (MCDHW)***

Volume 1: Specification for Highway Works 1998, including amendments to November 2007

Volume 2: Notes for Guidance on the Specification for Highway Works 1998, including amendments to November 2007

Volume 3: Highway Construction Details 1991, including amendments to May 2007

***The Design Manual for Roads and Bridges (DMRB)***

**Bridges and Structures ( BA Series )**

*Reproduced on following pages*

**Bridges and Structures ( BD Series )**

*Reproduced on following pages*

**Bridges and Structures, Technical Memoranda ( BE Series )**

*Reproduced on following pages*

***Traffic Engineering and Control, Standards ( TD Series )***

TD 9/93 Road layout and geometry. Highway link design

TD 19/06 Requirement of Road Restraint Systems & correction No. 1

TD 27/05 Cross Sections and headroom

TD 36/93 Subways for pedestrians and cyclists, layout and dimensions

***Highways, Advice Notes ( HA Series )***

HA 59/92 Mitigating Against Effects on Badgers

HA 80/99 Nature Conservation Advice in Relation to Bats

HA 84/01 (1) Nature Conservation and Biodiversity

HA 97/01 Nature Conservation Management Advice in Relation to Dormice

HA 98/01 Nature Conservation Management Advice in Relation to Amphibians

***Highways, Standards (HD Series )***

HD 22/08 Managing Geotechnical Risk



**ADVICE NOTES - BRIDGES AND STRUCTURES (BA SERIES)**

BA-9/81	The Use of BS 5400: Part 10: 1980. Code of Practice for Fatigue Amendment No. 1
BA-16/97	The Assessment of Highway Bridges and Structures. Amendment No. 1 Amendment No. 2
BA-19/85	The Use of BS 5400: Part 3: 1982
BA-24/87	Early Thermal Cracking of Concrete Amendment No. 1
BA-26/94	Expansion Joints for Use in Highway Bridge Decks
BA-28/92	Evaluation of Maintenance Costs in Comparing Alternative Designs for Highway Structures
BA-30/94	Strengthening of Concrete Highway Structures Using Externally Bonded Plates
BA-34/90	Technical Requirements for the Assessment and Strengthening Programme for Highway Structures
BA-35/90	Inspection and Repair of Concrete Highway Structures
BA-36/90	The Use of Permanent Formwork
BA-37/92	Priority Ranking of Existing Parapets
BA-38/93	Assessment of the Fatigue Life of Corroded or Damaged Reinforcing Bars
BA-39/93	Assessment of Reinforced Concrete Half-joints
BA-40/93	Tack Welding of Reinforcing Bars
BA-41/98	The Design and Appearance of Bridges
BA-42/96	The Design of Integral Bridges [Incorporating Amendment No. 1 dated May 2003]
BA-43/94	Strengthening, Repair and Monitoring of Post-tensioned Concrete Bridge Decks
BA-44/96	Assessment of Concrete Highway Bridge and Structures
BA-47/99	Waterproofing and Surfacing Concrete Bridge Decks
BA-50/93	Post-tensioned Concrete Bridges: Planning, Organisation and Methods for Carrying Out Special Inspections
BA-51/95	The Assessment of Concrete Structures Affected by Steel Corrosion
BA-52/94	The Assessment of Concrete Highway Structures Affected by Alkali-Silica Reaction
BA-53/94	Bracing Systems and the Use of U-Frames in Steel Highway Bridges
BA-54/94	Load Testing for Bridge Assessment
BA-55/06	The Assessment of Bridge Substructures and Foundations, Retaining Walls and Buried Structures
BA-56/96	The Assessment of Steel Highway Bridges and Structures
BA-57/01	Design for Durability
BA-58/94	Design of Bridges and Concrete Structures with External Unbonded Prestressing
BA-59/94	Design of Highway Bridges for Hydraulic Action
BA-61/96	The Assessment of Composite Highway Bridges
BA-67/96	Enclosure of Bridges
BA-68/97	Crib Retaining Walls
BA-72/03	Maintenance of Road Tunnels

**ADVICE NOTES - BRIDGES AND STRUCTURES (BA SERIES)**

BA-74/06	Assessment of Scour at Highway Bridges
BA-80/99	Use of Rock Bolts
BA-82/00	Formation of Continuity Joints in Bridge Decks
BA-83/02	Cathodic Protection for Use in Reinforced Concrete Highway Structures
BA-84/02	Use of Stainless Steel Reinforcement in Highway Structures
BA-85/04	Coatings for Concrete Highway Structures & Ancillary Structures
BA-86/06	Advice Notes on the Non-Destructive Testing of Highway Structures
BA-87/04	Management of Corrugated Steel Buried Structures
BA-88/04	Management of Buried Concrete Box Structures
BA-92/07	The Use of Recycled Concrete Aggregates in Structural Concrete
BA-93/09	Structural Assessment of Bridges with Deck Hinges

**STANDARDS - BRIDGES AND STRUCTURES (BD SERIES)**

BD-2/05	Technical Approval of Highway Structures
BD-7/01	Weathering Steel for Highway Structures
BD-9/81	Implementation of BS-5400: Part 10: 1980. Code of Practice for Fatigue
BD-10/97	Design of Highway Structures in Areas of Mining Subsidence
BD-12/01	Design of Corrugated Steel Buried Structures with Spans Greater than 0.9 Metres and up to 8.0 Metres
BD-13/06	Design of Steel Bridges. Use of BS-5400: Part 3: 2000
BD-15/92	General Principles for the Design and Construction of Bridges. Use of BS 5400: Part 1: 1988
BD-16/82	Design of Composite Bridges. Use of BS-5400: Part 5: 1979 Amendment No. 1
BD-20/92	Bridge Bearings. Use of BS-5400: Part 9: 1983
BD-21/01	The Assessment of Highway Bridges and Structures
BD-24/92	Design of Concrete Bridges. Use of BS 5400: Part 4: 1990
BD-27/86	Materials for the Repair of Concrete Highway Structures
BD-28/87	Early Thermal Cracking of Concrete Amendment No. 1
BD-29/04	Design Criteria for Footbridges
BD-30/87	Backfilled Retaining Walls and Bridge Abutments
BD-31/01	The Design of Buried Concrete Box and Portal Frame Structures
BD-33/94	Expansion Joints for Use in Highway Bridge Decks
BD-34/90	Technical Requirements for the Assessment and Strengthening Programme for Highway Structures
BD-35/06	Quality Assurance Scheme for Paints and Similar Protective Coatings
BD-36/92	Evaluation of Maintenance Costs in Comparing Alternative Designs for Highway Structures
BD-37/01	Loads for Highway Bridges

**STANDARDS - BRIDGES AND STRUCTURES (BD SERIES)**

BD 41/97	Reinforced Clay Brickwork Retaining Walls of Pocket Type and Grouted Cavity type Construction Use of BS 5628: Part 2: 1995
BD 42/00	Design of Embedded Retaining Walls and Bridge Abutments
BD 43/03	The Impregnation of Reinforced and Prestressed Concrete Highway Structures using Hydrophobic Pore-Lining Impregnants
BD 44/95	The Assessment of Concrete Highway Bridges and Structures
BD 45/93	Identification Marking of Highway Structures
BD 46/92	Technical Requirements for the Assessment and Strengthening Programme for Highway Structures [Stage 2—Modern Short Span Bridges]
BD 47/99	Waterproofing and Surfacing of Concrete Bridge Decks
BD 48/93	The Assessment and Strengthening of Highway Bridge Supports
BD 49/04	Design Rules for Aerodynamic Effects on Bridges
BD 50/92	Technical Requirements for the Assessment and Strengthening Programme for Highway Structures Stage 3—Long Span Bridges
BD 51/98	Portal and Cantilever Signs/Signal Gantries
BD 53/95	Inspection and Records for Road Tunnels
BD 54/93	Post-tensioned Concrete Bridges, Prioritisation of Special Inspections
BD 56/96	The Assessment of Steel Highway Bridges and Structures
BD 57/01	Design for Durability
BD 58/94	The Design of Concrete Highway Bridges and Structures with External and Unbonded Prestressing Design of Highway Bridges for Vehicle Collision Loads
BD 60/04	Design of Highway Bridges for Vehicle Collision Loads
BD 61/96	The Assessment of Composite Highway Bridges
BD 62/07	As Built, Operational and Maintenance Records for Highway Structures
BD 63/07	Inspection of Highway Structures
BD 65/97	Design Criteria for Collision Protector Beams
BD 67/96	Enclosure of Bridges
BD 68/97	Crib Retaining Walls
BD 70/03	Strengthened/Reinforced Soils and Other Fills for Retaining Walls and Bridge Abutments Use of BS8006: 1995, incorporating Amendment No. 1 (Issue 2 March 1999)
BD 74/00	Foundations
BD 78/99	Design of Road Tunnels
BD 79/06	The Management of sub Standard Highway Structures
BD 81/02	Use of Compressive Membrane Action in Bridge Decks
BD 82/00	Design of Buried Rigid Pipes
BD 84/02	Strengthening of Concrete Bridge Supports Vehicle Impact Using Fibre Reinforced Polymers
BD 85/08	Strengthening Highway Structures Using Externally Bonded Fibre Reinforced Polymer
BD 86/07	The Assessment of Highway Bridges and Structures For The Effects of Special Types General Order (STGO) and Special Order (SO) Vehicles
BD 87/05	Maintenance Painting of Steelwork

**STANDARDS - BRIDGES AND STRUCTURES (BD SERIES)**

<del>BD-89/03</del>	<del>The Conservation of Highway Structures</del>
<del>BD-90/05</del>	<del>Design of FRP Bridges and Highway Structures</del>
<del>BD-91/04</del>	<del>Unreinforced Masonry Arch Bridges</del>
<del>BD-94/07</del>	<del>Design of Minor Structures</del>
<del>BD-95/07</del>	<del>Treatment of Existing Structures on Highway widening Schemes</del>

**TECHNICAL MEMORANDA - BRIDGES (BE SERIES)**

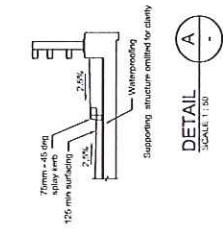
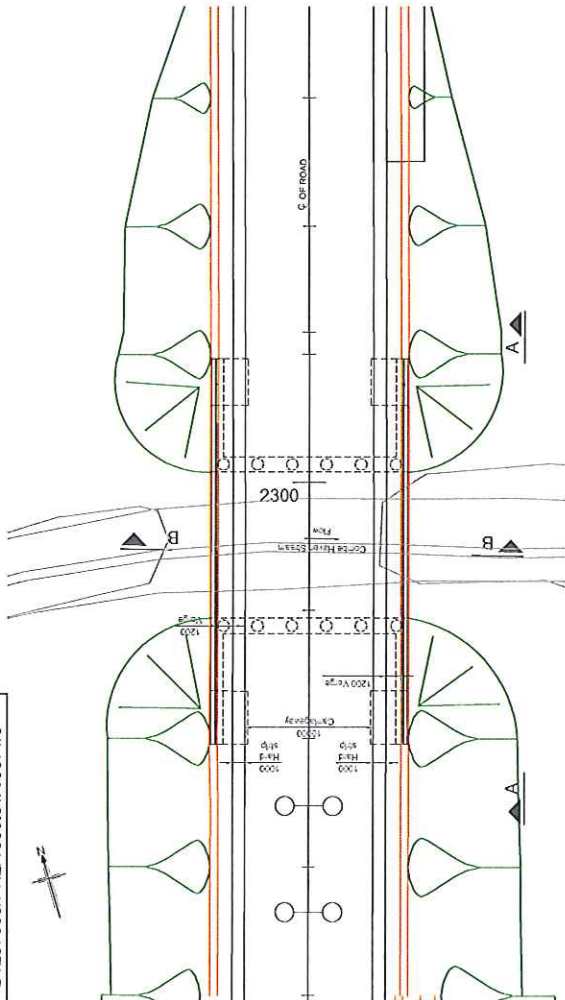
<del>BE-13</del>	<del>Fatigue Risk in Bailey Bridges</del>
<del>BE-23</del>	<del>Shear Key Decks Amendment No. 1 to Annex</del>
<del>BE-5/75</del>	<del>Rules for the Design and Use of Freyssinet Concrete Hinges in Highway Structures</del>
<del>BE-7/04</del>	<del>Departmental Standard (Interim) Motorway Sign/Signal Gantries</del>

**INTERIM ADVICE NOTES (IAN)**

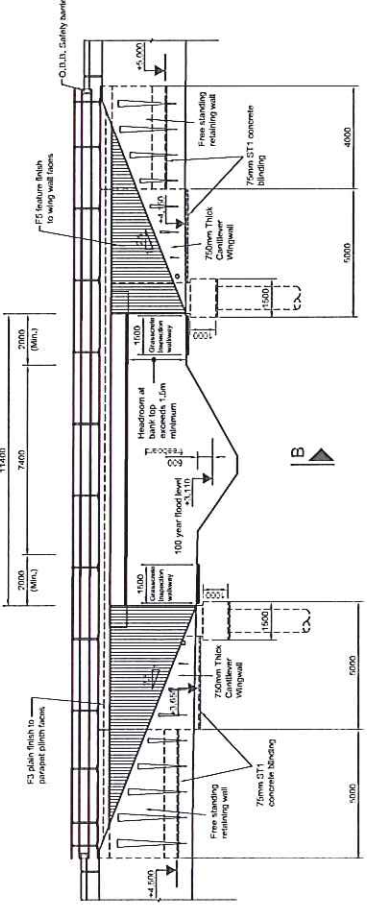
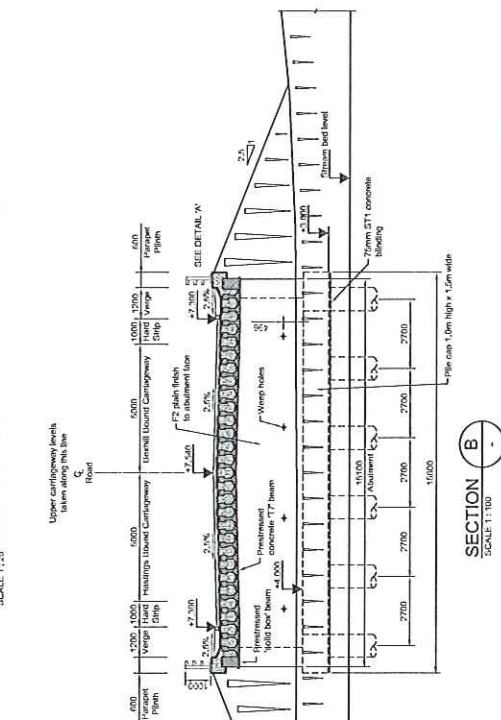
<del>IAN-117/08 Rev-1</del>	<del>Certification of combined kerb and drainage products</del>
<del>IAN-116/08</del>	<del>Nature conservation advice in relation to bats</del>
<del>IAN-104/07</del>	<del>The Anchorage of Reinforcement and Fixings in Hardened Concrete</del>
<del>IAN-97/07</del>	<del>Assessment and upgrading of existing parapets</del>
<del>IAN-96/07r1</del>	<del>Guidance on implementing Results of Research on Bridge Deck Waterproofing</del>
<del>IAN-95/07</del>	<del>Revised Guidance Regarding the Use of BS8500(2006) For the Design and Construction of Structures Using Concrete</del>
<del>IAN-91/07</del>	<del>Interim Advice on the identification of "Particularly at Risk" supports</del>
<del>IAN-70/06</del>	<del>Implementation of New Reinforcement Standards</del>
<del>IAN-69/05</del>	<del>Design for Maintenance</del>
<del>IAN-48/03</del>	<del>Measures To Minimise The Risk of Sulphate Attack (Including Thaumasite) - New Construction and Structures Under Construction</del>
<del>IAN-47/02</del>	<del>Post Tensioned Grouted Duct concrete Bridges</del>
<del>IAN-41/02</del>	<del>European Cement Standards</del>
<del>IAN-05/96</del>	<del>BD 24/92 The Design of Concrete Highway Bridges and Structures. Use of BS 5400: Part 4:1990</del>
<del>IAN-04/96</del>	<del>BD 44/95 The Assessment of Concrete Highway Bridges and Structures</del>
<del>IAN-03/96</del>	<del>BA-50/93 Post Tensioned concrete Bridges</del>

## Appendix B Drawings

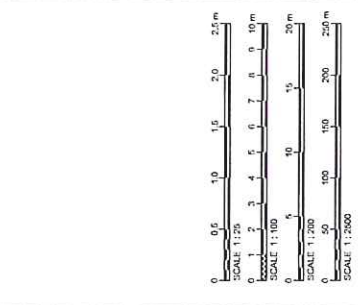
Drawing No	Title
B1297000-PH1/1600.06a/9071	S07 Combe Haven Underbridge AIP General Arrangement



**FULLY INTEGRATED ABUTMENT DECK CONNECTION**  
SCALE: 1:25



- NOTES**
- All dimensions in millimeters unless noted otherwise.
  - All levels in metres above Ordnance Datum - Newlyn.
  - Do not scale from this drawing.
  - Backfill to be BK or BP.
  - All external surfaces to have 20 x 25mm chamfers.
  - Both abutments to be backfilled simultaneously with a level difference not exceeding 0.5m.
  - Cuttings shall be provided in the roadside channels immediately to the south (left) side of the bridge to reverse the flow of surface water across the pavement / subgrade transition.
  - Approach embankments constructed in advance of bridge works. Retention structures on both abutments to limit differential settlement where necessary.



Client	HOCHTIEFMINICI JOINT VENTURE EAST SUSSEX COUNTY COUNCIL
Project	BEXHILL TO HASTINGS LINK ROAD
Contract No.	COMBE HAVEN UNDERBRIDGE GENERAL ARRANGEMENT
Drawing No.	FOR INITIAL COMMENT
Scale	AS SHOWN ON AT DO NOT SCALE
Revision	1/2/2020
Drawing Number	B1297000-PH2/1600.01A/9071_0

This drawing is not to be used in whole or part other than for the purpose and project as defined on this drawing. Refer to the contract for full terms and conditions.

## Appendix C Geotechnical Information

**BEXHILL TO HASTINGS LINK ROAD**  
**GEOTECHNICAL SUMMARY INFORMATION**

<b>STRUCTURE NAME</b>	<b>CHAINAGE and OS Grid Reference</b>			
S07 - Combe Haven Underbridge	Ch 2300	OS: 574843.8E, 110012.5N		
<b>Rev: 2</b>	<b>DESIGN LIFE: 120 years</b>			
<b>SOILS/GEOLOGY</b>	<b>RELEVANT EXPLORATORY HOLES:</b> BH116, BH117 (URS Investigation,2009)			
<b>Strata</b>	<b>Typical depths</b>			
Alluvium	4.47 to -0.97 m OD			
Ashdown Formation	below -0.97m OD			
<b>PREVIOUS GROUND HISTORY</b>	Agricultural Land			
<b>CONTAMINATED GROUND RISK ASSESSMENT REQUIRED</b>				No
<b>GROUNDWATER</b>				
<p>Groundwater was encountered initially at levels between 2.73m OD (1.1m bgl – BH116) and 3.27m OD (1.2m bgl – BH117) within Alluvium and rose only in BH116 to level of 2.93m OD (0.9m bgl) after 20 minutes. A second groundwater strike encountered confined groundwater within Ashdown Formation at levels between -0.97m OD (4.8m bgl – BH116) and -2.53m OD (6.7m bgl – BHH117) and rose to levels of between -2.23m OD (6.7m bgl – BH117) and 3.43m OD (0.4m bgl – BH116) in 20 minutes. A third confined groundwater was encountered within the Ashdown Formation in BH117 at a level of -3.93m OD (8.4m bgl) and rose to a level of 2.47m OD (2m bgl) after 20 minutes. No monitoring was carried out.</p> <p>Allowing for seasonal fluctuations, the preliminary design groundwater level is assumed to be at foundation level.</p>				
<b>EARTH PRESSURE VALUE <math>K_0^*</math> <math>K_a^*</math> <math>K_p^*</math></b>				
See Section 5.4 of the AIP.				
<b>TYPE OF FOUNDATION</b>	Pile Foundation			
<b>BEARING CAPACITY</b>	N/A			
Structure Element	Founding Stratum	Founding Level (m OD)	Footing Size	Allowable Bearing Pressure (kN/m <sup>2</sup> )






<b>PILE DESIGN</b>					
Structure Element	Founding Stratum	Toe Level (m OD)	Pile dia (m)	Pile length (m)	Pile working Load (kN)
East and West abutment	Ashdown Formation	East abutment = -14 West abutment = -14.5	0.9	17.0	1600
<p>Note: Pile lengths and toe levels are approximate.</p> <p>Pile type: CFA</p> <p>Criteria for selecting pile toe level: Pile capacity</p> <p>Allowance for negative skin friction within design: Yes</p>					
<b>SETTLEMENT</b>					
Differential settlement to be allowed for between adjacent supports: 10mm					
Differential settlement to be allowed between structure and approach embankment : 20mm (within 10 metres of the interface between structures and approach embankments)					
<b>CHEMICAL ANALYSIS</b>					
<p><b>Buried Concrete classification:</b></p> <p>The results of chemical tests on soil samples taken within the rural areas indicate pH values ranging between 3.8 to 9.4 and sulfates (2:1 Water Extract) values of between 10 to 900mg/l. The recommended Design Sulfate and Concrete Classification based on BRE Special Digest 1 (2005) are DS-2 and AC-3z respectively.</p>					
<b>NOTES</b>					
<ol style="list-style-type: none"> <li>The ground sequence at the site is Top Soil, Alluvium and Ashdown Formation. The boreholes indicate the maximum combined thickness of Top Soil and Alluvium to be 5.50m.</li> <li>Based on the formation level, the structure will likely be founded on soft Alluvium layer, which is underlain by stiff clays, dense sands of the Ashdown Formation. The low shear strength of the Alluvium layer prevents its use as a bearing stratum. The risk of excessive settlements and failure is high. To transfer the structural loads to the competent stiff to very stiff /very weak to weak interbedded Ashdown Formation, pile foundations are recommended.</li> <li>The behaviour of the groundwater indicates likely presence of confined aquifer. This should be considered during construction.</li> </ol>					

S:\M - BEXHILL BOREHOLE LOC. File: J:\BEXHILL - BOREHOLE\ACTUAL REPORT DATA\BEXHILL - HASTINGS URS ALL.DPJ Printed: 14/01/2009 12:28:06  
 URS Corporation Ltd, Horne Lane, Bedford MK40 1TS, Telephone: 01234 240441 www.URS.com

Contract No: 49325727
Project: Bexhill - Hastings Link Road
Client: East Sussex County Council

  
 Record of Borehole  
**BH116**

SAMPLES & In situ TESTS			STRATA					
Depth	Type/ No.	SPT/U4 (Blows)	Water	Reduced Level (mOD)	Legend	Depth (Thickness)	DESCRIPTION	
0.15	D1					0.50	Soft, dark brown orange brown mottled slightly sandy silty CLAY. Sand is fine. Occasional rootlets. (TOPSOIL)	
0.30	D2			3.33				
0.50	D3							Soft, grey to red brown, occasional orange and grey mottled slightly sandy silty CLAY. Sand is fine. (ALLUVIUM)
1.00	D4							
1.20	B5 U1X	(5 - 0mm)						
2.00	U1 D6	(30 - Unrecorded)		1.83			2.00	Soft light grey green fine sandy CLAY. (ALLUVIUM)
2.50	D7 SPT8 B9	N=16 (3/3/4/3/4/5)			1.33		2.50	Stiff to very stiff, fissured, thinly laminated yellow brown CLAY. Laminations are stained grey, orange brown and black. (ASHDOWN BEDS)
3.00	U3	(44 - Unrecorded)						
3.50	D10 B11							
4.00	U4	(50 - Unrecorded)						
4.50	D12 SPT13 B14	N=30 (3/3/6/6/12/6)						Slightly sandy and becoming silty from 4.5m bgl. Sand is fine.
5.00	D15				-0.97		4.80	Dense, yellow brown fine SAND and frequent lithorelics of yellow brown stained black and orange brown, angular to subangular, fine to coarse very weak sandstone. (ASHDOWN BEDS)
5.50	B16							
6.00	D17 SPT18	N=31 (6/16/13/6/5/7)						
6.50	B19							Sand is silty from 6.5m bgl.


Boring Progress and Water Observations									Chiselling			Water Added		GENERAL REMARKS
Date	Time	Hole Depth	Cas'g Depth	Cas'g Dia	Water Depth	Rose to	Time (mins)	Sealed (m)	From	To	Time (hh:mm)	From	To	
16/01/09	14.00	1.10	0.00	150	1.10	0.90	20							
16/01/09	16.30	4.50	3.00	150	0.40									
17/01/09	08.00	4.50	3.00	150	0.40									
17/01/09	09.00	4.80	3.00	150	4.80	0.40	20							

Logged by: JB Checked by: CAB Status: Draft	Equipment: Cable Percussion Rig - Dando 2000 Contractor: Southern Testing Laboratories Ltd	Location: 574855.5 E 109986.7 N	Ground Level: 3.83 mAOD	Date: 16/12/2008 Start 17/12/2008 End	Scale: 1:40.0 Sheet 1 of 3
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Draft  
 150mm casing to 3.0m bgl.  
 U100 samples taken using double weight  
 During logging no visible or olfactory evidence of contamination.  
 Zone of weathering interpreted from from Spinks et al. 1993: (V); (IV); (III); (II); (I).

Site: BEXHILL BOREHOLE LOG File: J:\BEXHILL\BEXHILL\BEXHILL TO HASTINGS LINK ROAD\TECHNICAL\FACTUAL REPORT DATA\BEXHILL - HASTINGS URS ALLOP1 Printed: 14/09/2008 12:28:08  
 URS Corporation Ltd Home Lane, Bexhill MK40 1TS Telephone: 01234 240641 www.urscorp.com

Contract No: 49325727		 Record of Borehole <b>BH116</b>
Project: Bexhill - Hastings Link Road		
Client: East Sussex County Council		

SAMPLES & In situ TESTS			STRATA					Instrument/ Backfill
Depth	Type/ No.	SPT/U4 (Blows)	Water	Reduced Level (mOD)	Legend	Depth (Thick- ness)	DESCRIPTION	
8.20	SPT20 B21	N=6 (3/4/0/0/3/3)			•••••		Loose at 8.2m bgl.	
9.00	SPT22 B23	N=30 (4/9/14/5/4/7)			•••••		Dense at 9.0m bgl.	
10.00	SPT24	N=42 (4/6/6/7/10/19)			•••••		Dense at 10.0m bgl.	
10.50	B25				•••••			
11.00	D26 SPT27	N=84 (10/16/18/16/22/28)		-7.17	x x x x	11.00	Very dense yellow brown sandy SILT and lithorelics of subangular fine to medium very weak sandstone. Sand is fine. (ASHDOWN BEDS)	
11.50	B28			-7.67	x x x x	11.50	Very stiff, light to dark grey CLAY and frequent lithorelics of angular to subangular fine to coarse mudstone. (ASHDOWN BEDS)	
12.50	D29 SPT30 B31	N=38 (12/12/8/7/9/14)			•••••			
13.50	D32				•••••			
14.00	SPT33	N=80 (7/9/10/20/26/24)		-10.17	•••••	14.00	Very weak, thinly laminated dark grey angular to subangular, fine to coarse MUDSTONE. Partially weathered to a very stiff grey clay. (ASHDOWN BEDS)	
14.50	B34				•••••			

Boring Progress and Water Observations									Chiselling			Water Added		GENERAL REMARKS
Date	Time	Hole Depth	Cas'g Depth	Cas'g Dia	Water Depth	Rose to	Time (mins)	Sealed (m)	From	To	Time (hh:mm)	From	To	

Draft  
 150mm casing to 3.0m bgl.  
 U100 samples taken using double  
 weight  
 During logging no visible or  
 olfactory evidence of contamination.  
 Zone of weathering interpreted from  
 from Spinks et al. 1993: (V); (IV);  
 (III); (II); (I).

Logged by: JB Checked by: CAB Status: Draft	Equipment: Cable Percussion Rig - Dando 2000 Contractor: Southern Testing Laboratories Ltd	Location: 574855.5 E 109986.7 N	Ground Level: 3.83 mAOD	Date: 16/12/2008 Start 17/12/2008 End	Scale: 1:40.0 Sheet 2 of 3
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S:\M\BEXHILL BORCHOLE LOG File: J:\BEXHILL BORCHOLE LOG\BEXHILL TO HASTINGS LINK ROAD\TECHNICAL\ACTUAL REPORT DATA\BEXHILL - HASTINGS URS ALL.GPJ Printed: 14/08/2009 12:28:09  
 URS Corporation Ltd Home Lane Bedford MK40 1TS Telephone: 01234 340341 www.urscorp.com

Contract No: 49325727
Project: Bexhill - Hastings Link Road
Client: East Sussex County Council

  
 Record of Borehole  
**BH116**


SAMPLES & In situ TESTS			STRATA						
Depth	Type/No.	SPT/U4 (Blows)	Water	Reduced Level (mOD)	Legend	Depth (Thickness)	DESCRIPTION		Instrument/Backfill
15.50	D35 SPT36	N=>65 (8/14/15/19/31/75mm/-)							
16.00	B37								
				-12.97		16.80	Very weak, thinly laminated dark grey angular to subangular, fine to coarse weathered MUDSTONE. (ASHDOWN BEDS)		
17.00	D38 SPT39	N=>28 (15/22/28/75mm/-/-)							
				-13.57		17.40			
17.40	D40						End of Borehole at 17.40m		



Boring Progress and Water Observations									Chiselling			Water Added		GENERAL REMARKS
Date	Time	Hole Depth	Cas'g Depth	Cas'g Dia	Water Depth	Rose to	Time (mins)	Sealed (m)	From	To	Time (hh:mm)	From	To	
17/01/09	16.30	17.40	3.00	150	0.40				16.80	17.00	00:15			
									17.00	17.40	01:00			

Draft  
 150mm casing to 3.0m bgl.  
 U100 samples taken using double weight  
 During logging no visible or olfactory evidence of contamination.  
 Zone of weathering interpreted from from Spinks et al. 1993: (V); (IV); (III); (II); (I).

Logged by: JB Checked by: CAB Status: Draft	Equipment: Cable Percussion Rig - Dando 2000 Contractor: Southern Testing Laboratories Ltd	Location: 574855.5 E 109986.7 N	Ground Level: 3.83 mAOD	Date: 16/12/2008 Start 17/12/2008 End	Scale: 1:40.0 Sheet 3 of 3
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SHYK BEXHILL BOREHOLE LOG File: J:\BID\FORD-JOB\BEXHILL TO HASTINGS LINK ROAD\TECHNICAL\FACTUAL REPORT DATA\BEXHILL-HASTINGS URS ALL.GPJ Printer: 14/03/2009 12:28:10  
 URS Corporation Ltd Home Lane Bedford Way 113 Telephone: 01254 340401 www.urscorp.com

Contract No: 49325727		 Record of Borehole <b>BH117</b>
Project: Bexhill - Hastings Link Road		
Client: East Sussex County Council		

SAMPLES & In situ TESTS			STRATA						
Depth	Type/ No.	SPT/U4 (Blows)	Water	Reduced Level (mOD)	Legend	Depth (Thickness)	DESCRIPTION	Instrument/ Backfill	
0.10	CS1				// // // //	0.50	Soft, medium brown, slightly sandy CLAY with frequent rootlets. (TOPSOIL)		
0.20	CS2								
0.50	CS3				3.97	// // // //	0.50		Soft, thickly laminated, orange/brown sandy CLAY with occasional grey/brown mottles and rootlets. Sands are fine. (ALLUVIUM)
1.00	CS4								Becoming slightly sandy from 1.0m bgl.
1.30	D5				3.17	// // // //	1.30		Soft, very closely fissured, mottled grey/brown and orange/brown, slightly sandy CLAY with rare rootlets. Sands are fine. (ALLUVIUM)
1.50	U6	(9 - 400mm)							
2.00	D7				2.47	// // // //	2.00		Firm, very closely fissured, grey/brown CLAY, with rare, dark orange iron staining. (ALLUVIUM)
2.50	U8	(15 - 450mm)					(1.00)		
3.00	D9 SPT10	N=6 (10/11/2/2)			1.47	// // // //	3.00		Soft, very closely fissured, blue/grey CLAY, with rare orange/brown mottles. (ALLUVIUM)
3.30	D11						(1.00)		
3.50	U12	(50 - 450mm)							
4.00	D13				0.47	// // // //	4.00		Firm, very closely fissured, mottled blue/grey and orange/brown CLAY. (ALLUVIUM)
4.50	U14	(50 - 450mm)					(1.00)		
5.00	D15 SPT16	N=25 (2/4/5/6/6/8)			-0.53	// // // //	5.00		Stiff, very closely fissured, blue/brown/grey CLAY, with frequent blue/grey mottling. (ASHDOWN BEDS)
5.45	D17				-1.03	// // // //	5.50		Stiff, fissured, thinly laminated, mottled maroon and light blue/grey CLAY with rare patches of orange/brown sand. (ASHDOWN BEDS)
5.50	U18	(60 - 450mm)							Becoming light blue/grey CLAY with fragments of mudstone below 5.7m bgl.
6.00	D19				-1.53	// // // //	6.00		Stiff, very closely fissured, blue/grey CLAY, with occasional lithorelics of weak, medium, sub-angular, blue/grey mudstone. (ASHDOWN BEDS)
6.50	U20	(80 - 450mm)							
7.00	D21 SPT22 W22	N=36 (5/9/12/8/8/8)							
7.50	U23	(120 - 250mm)							

Boring Progress and Water Observations									Chiselling			Water Added		GENERAL REMARKS
Date	Time	Hole Depth	Cas'g Depth	Cas'g Dia	Water Depth	Rose to	Time (mins)	Sealed (m)	From	To	Time (hh:mm)	From	To	
06/01/09	13.00	1.20	0.00	150	1.20									
06/01/09	16.00	7.00	4.00	150	7.00	6.70	20							
06/01/09	16.20	7.00	4.00	150	6.70									
07/01/09	08.00	7.00	4.00	150	1.40									

Logged by: HH Checked by: CAB Status: Draft	Equipment: Cable Percussion Rig - Dando 2000  Contractor: Southern Testing Laboratories Ltd	Location: 574836.5 E 110035.3 N	Ground Level: 4.47 mAOD	Date: 06/01/2009 Start 07/01/2009 End	Scale: 1:40.0  Sheet 1 of 2
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Draft 150mm casing to 4.0m bgl. During logging no visible or olfactory evidence of contamination. Chiseled from 9.0 - 9.35m and 9.55 - 9.6m. Zone of weathering interpreted from from Spinks et al. 1993: (V); (IV); (III); (II); (I).

SHM - BEXHILL BOREHOLE LOG File: J:\BID\FORD\JOB\BID\CAST SUSSEX COUNTY COUNCIL\49325727 BEXHILL TO HASTINGS LINK ROAD\TECHNICAL\FACTUAL REPORT DATA\GINT\BEXHILL - HASTINGS URS ALLOP.J Pinned: 14/01/2009 12:23:16  
 URS Corporation Ltd Home Lane, Bedford MK43 1TS Telephone: 01294 340044 www.urscorp.com

Contract No: 49325727	<b>URS</b>
Project: Bexhill - Hastings Link Road	Record of Borehole
Client: East Sussex County Council	<b>BH117</b>

SAMPLES & In situ TESTS			STRATA					
Depth	Type/No.	SPT/U4 (Blows)	Water	Reduced Level (mOD)	Legend	Depth (Thickness)	DESCRIPTION	Instrument/Backfill
8.00	D24						Lithorelics of mudstone becoming medium to coarse and harder below 8.0m bgl.	
8.30	D25			-3.83		8.30	Stiff very closely fissured grey-blue mottled orange-brown CLAY with frequent lithorelics of weak dark blue-grey subangular to sub-rounded fine to medium MUDSTONE. (ASHDOWN BEDS)	
8.40	W26	(120 - 300mm)						
8.50	U27			-4.33		8.80		
9.00	D28 SPT29 B30	N=100 (18/7/20mm/20/50/30/30mm <sup>1-3</sup> )					Very dense orange/brown SAND, with frequent lithorelics of weak, medium to coarse, angular SANDSTONE. (ASHDOWN BEDS)	
9.35	SPT31	N=60 (25/50mm/40/60/70mm <sup>1-3</sup> )			9.60			
End of Borehole at 9.60m								

Boring Progress and Water Observations									Chiselling			Water Added		GENERAL REMARKS
Date	Time	Hole Depth	Cas'g Depth	Cas'g Dia	Water Depth	Rose to	Time (mins)	Sealed (m)	From	To	Time (hh:mm)	From	To	
07/01/09	09.00	8.40	4.00	150	8.40	2.00	20		9.30	9.35	00:15			
07/01/09	09.45	9.60	4.00	150	2.00				9.55	9.60	00:15			

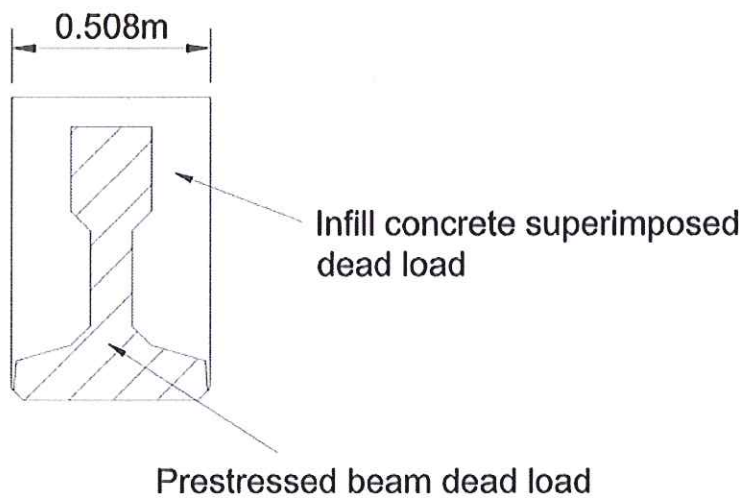
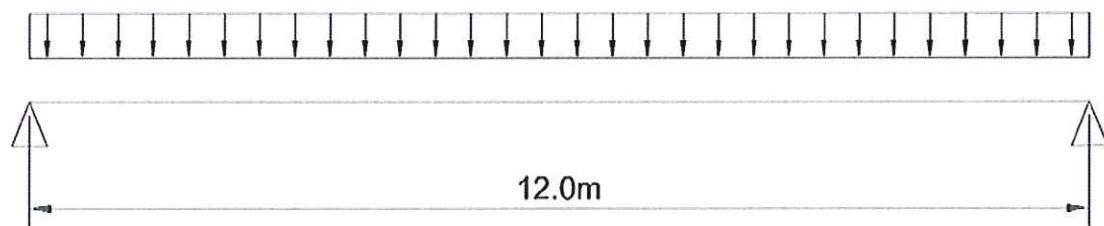
Logged by: HH Checked by: CAB Status: Draft	Equipment: Cable Percussion Rig - Dando 2000 Contractor: Southern Testing Laboratories Ltd	Location: 574836.5 E 110035.3 N	Ground Level: 4.47 mAOD	Date: 06/01/2009 Start 07/01/2009 End	Scale: 1:40.0 Sheet 2 of 2
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Draft  
 150mm casing to 4.0m bgl.  
 During logging no visible or olfactory evidence of contamination.  
 Chiseled from 9.0 - 9.35m and 9.55 - 9.6m.  
 Zone of weathering interpreted from from Spinks et al. 1993: (V); (IV); (III); (II); (I).

## Appendix D Idealised Structure

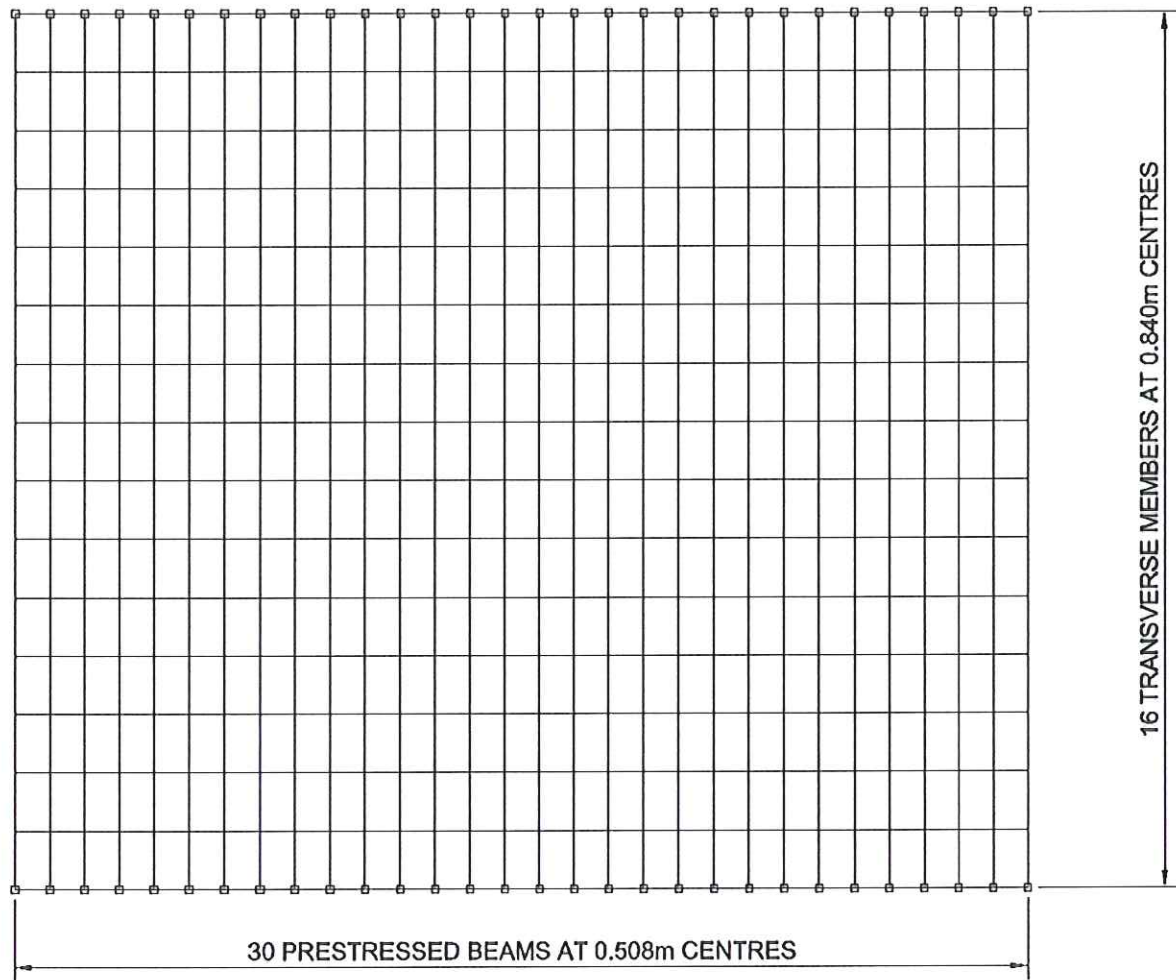
### Step 1 Simply supported line beam analysis

- Determine dead and superimposed dead bending moment and shear force distributions.
- 0.508m width beam

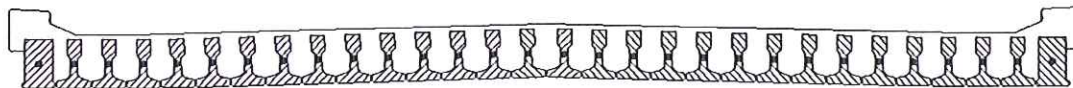


Step 2: Grillage analysis of deck

- Determine live loading combinations 1 and 3 maximum sagging moment
- Determine live loading combinations 1 and 3 shear force distributions
- Determine vertical deck design load for piles



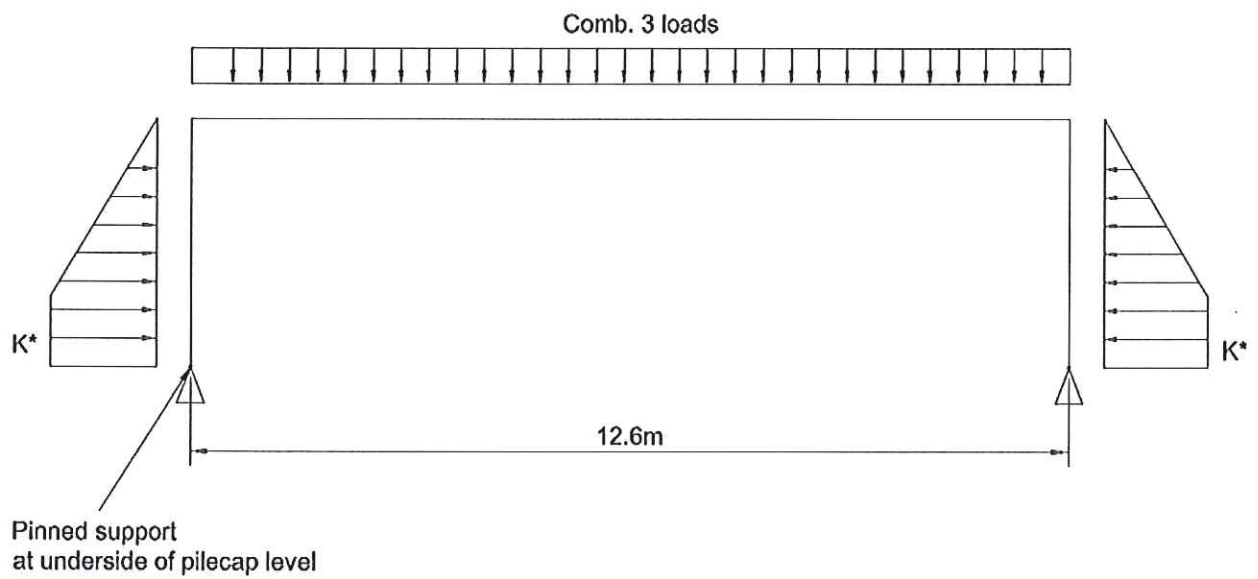
□ PINNED END SUPPORT





Step 3: Soil structure interaction analysis

- 0.508m width of deck
- Apply combination 3 live loads to deck and passive earth pressures to abutments
- Determine hogging moments at beam ends
- Determine bending moments for pile design
- Determine bending moment and shear force distribution in abutment stem walls



Step 4: Pile design

- Abutment movement and rotation applied to pileheads

