

Optimal Structural Engineers Ltd

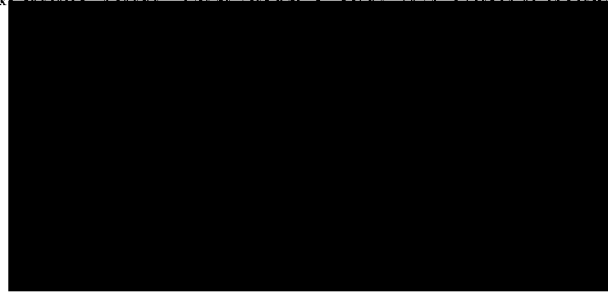
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APPROVAL IN PRINCIPLE

Granary Way Retaining Wall

Structure Ref No: 8158

Toddington Lane, Littlehampton, West Sussex

Revision A

7 February 2019

APPROVAL IN PRINCIPLE

(Retaining Wall), Eurocodes

Name of Project:	Toddington Lane, Littlehampton, West Sussex
Name of Bridge or Structure:	Granary Way Retaining Wall
Structure Ref No:	8158

1. HIGHWAY DETAILS

1.1 Type of highway:	Local feeder road
1.2 Permitted traffic speed	30 mph
1.3 Existing restrictions	The structure backs onto an urban road with a tight bend.

2. SITE DETAILS

2.1 Obstacles crossed

Toddington Lane provides access to a large number of properties and as such the proposed works are intended to cause as little disruption as possible.

3. PROPOSED STRUCTURE

3.1 Description of structure and design working life

The proposed structure is a 32.3 m long kingpost retaining wall, comprising UC section steel posts anchored into 400 mm diameter concrete piles bored into the ground at a maximum spacing of about 2.5m. The retained ground is supported using precast concrete panels that span horizontally between the steel posts. The structure is to be clad in engineering brick fully concealing the construction behind. The retaining wall provides support to the rear gardens to properties at Nos. 16 and 17 Granary Way, Wick, Littlehampton. A close-board fence 1.8 m high in planted concrete pockets is located at the top of the retaining wall. The fence height of any replacement fences must be limited to a maximum of 1.8 m and shall remain in the ownership and full responsibility of the homeowners. The said rear gardens, and hence the retaining wall back onto Toddington Lane, a public road. The design life of the retaining wall is 100 years.

3.2 Structural type

Steel UC king post cantilevered wall with transverse spanning precast concrete panels. UC's embedded in 400 mm diameter concrete piles up to approximately 4.4m long.

3.3 Foundation type

The foundation of the retaining wall shall take the form of embedded cantilever piles at maximum spacing of 2.5m.

3.4 Span arrangements

The kingposts shall span vertically up to a maximum retained height of 1.65m. The precast panels retaining the earth shall span horizontally, up to a maximum of 2.45m.

3.5 Articulation arrangements

Vertical movement joints are provided in the brickwork facing at no more than 6m horizontal spacing.

3.6 Classes and levels

<i>3.6.1 Consequence class</i>	CC1
<i>3.6.2 Reliability class</i>	RC1
<i>3.6.3 Inspection level</i>	IL1

3.7 Road restraint systems requirements

The property boundary which the retaining wall follows has sharp turns on plan which create a hazard for road users. A vehicle restraint system is deemed inappropriate for this location. To mitigate against the hazard, a dwarf wall is built in front of the retaining wall and the gap between the two walls is infilled with mass concrete. The acute change in direction of the wall is therefore averted.

Road Safety Audits RSA1 and RSA2 (combined) have been undertaken by Mayer Brown Ltd whose conclusions were that “no material increase in risk to road users will arise as a result of the proposals as submitted.”

3.8 Proposed arrangements for future maintenance and inspection

3.8.1 Traffic management

None is envisaged as the retaining wall is located off the highway in private land.

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

The retaining wall is off the highway and it should be possible to access and carry out routine maintenance with minimal disruption to the road traffic.

3.9 Environment and sustainability

The retaining wall construction will use conventional materials of steel, concrete and brick and therefore no significant sustainability issues are foreseen.

3.10 Durability. Materials and finishes

The piles are to be concrete for the piles to be C28/35. The exposure classes applicable are XC2/XF1. Finishes for the concrete piles to be U1.

The kingposts and shelf angles are to be in S275-JR steel. The steelwork is to be galvanised to 85µm and painted with two coats of bituminous paint.

The infill panels are to be precast prestressed concrete (PCC) panels by Naylor Baywall in C40/50 concrete.

The cladding brickwork to be Wienerberger Terca Class B Engineering Brick Red in M6 mortar (Designation (ii)) above the splash zone, and M12 mortar (Designation (i)) for the DPC courses in the splash zone.

3.11 Risks and hazards considered for design, execution, maintenance and demolition.

The Principal Designer organisation for the project will be Persimmon Homes Thames Valley. The CDM-A will be Mr Martin Edgley. The main risk posed by the construction, or subsequent demolition, is the collapse of the unsupported earth bank during the execution. The banks shall be cut back in segments no longer than 2.5 m at any one time and supported and sloped at 20 degrees to the vertical. Prior to any works commencing a competent contractor to perform a risk assessment and take appropriate measures to mitigate against any identified risk. All hazards to be mitigated against in as far as is reasonably practical. The risks to be mitigated against include exposure of the operatives and the public to movement and operation of plant, the potential exposure to heavy lifting for the operatives, exposure to exhaust fumes for operatives in near confined spaces. The area also accommodates a number of buried and overhead services presenting risks to such hazards as electrocution.

3.12 Estimated cost of proposed structure together with other structural forms considered

TBC by nominated contractor. A kingpost retaining wall is proposed due to the location of the proposed works. The kingpost retaining wall is the only feasible option whose installation process limits severe disruption to the operation of Toddington Lane. Precast concrete L-shaped were another option but were discounted due to potential differential settlement as the base was likely to lie over soft clay sandwiched between two layers of granular raised beach deposits. Furthermore, significant excavated spoil volumes required for the construction were not desirable as there is limited area to safely store excavated material far enough away from the open excavations. Sheet pile walls were another option but were discarded because they would create a curtain cutting off the groundwater flow from the higher ground. Also, a continuous curtain would require that services passing in between the kingposts as per proposed design would require to be rerouted. There is limited road servitude behind the wall for that kind of operation. A reinforced cantilever ground bearing retaining wall was discarded due to potential differential settlement as the base was likely to lie over soft clay sandwiched between two layers of granular raised beach deposits. Furthermore, significant excavated volumes required for the construction were not desirable as there is limited area to safely store excavated material far enough away from the open excavations. All the discarded schemes would have resulted in significant disruption of traffic on Toddington Lane.

3.13 Proposed arrangements for construction

3.13.1 Construction of structure

From offsite, core 400 diameter holes to depth as required by the kingpost to be installed. Using a tremie or similar, fill the bore with concrete to the desired top of pile level. Position, plumb and orient the UC kingpost as required and then plunge the column to the required top of steel level. Ensure plumb and orientation are maintained. Repeat the procedure for all king post positions. With the concrete well set and cured, excavate the ground in between two kingposts to create a channel for the free draining granular material and room for slotting in the PCC Baywall panel. Provide temporary timbering to support the excavated bank, buttressing back to the king posts. When the full height excavation has been attained, fix the shelf angle to the kingposts and apply two coats of bituminous paint to all the exposed steelwork faces. Ensure the complete steel surface area and fixings are bitumen painted by the end of the operation. When the paint has dried up, lower the PCC panels and pack tight against the flanges. Backfill the gap with 6N/6P granular material and compact in 300 mm thick layers maximum, whilst at the same time withdrawing the temporary planking. Continue the operation until the back fill comes to within 150 mm of the final ground level. When all bays are thus constructed build the cladding brickwork, ensuring that stainless steel ties are plug and screwed onto the PCC planks at 900 mm horizontal centres and 450 mm vertical centres. Install movement joints in line with the plans.

3.13.2 Traffic management

Where the boring machine is likely to interfere with the traffic flow, one lane on Toddington Lane can be closed to allow work to continue whilst not completely cutting off traffic flow.

3.13.3 Service diversions

None is envisaged as the moving of services is what resulted in the need to construct the retaining wall.

3.13.4 Interface with existing structures

A private shed on the line of the retaining wall is to be removed and reinstalled after the construction of the retaining wall.

4. DESIGN CRITERIA

4.1 Actions

4.1.1 Permanent actions

Self-weight of single skin cladding brickwork on shelf angle of 2.2 kN/m².

Lateral earth pressure of a clay bank.

4.1.2 Snow, Wind and Thermal actions

Wind pressure from fence over of 0.322 kN/m² based on assessment.

~~4.1.3 Actions relating to normal traffic under AW regulations and C&U regulations⁷~~

~~4.1.4 Actions relating to General Order traffic under STGO regulations⁸~~

~~4.1.5 Footway or footbridge variable actions~~

~~4.1.6 Actions relating to Special Order traffic, provision for exceptional abnormal indivisible loads including location of vehicle track on deck cross section^{9,10}~~

~~4.1.7 Accidental actions~~

4.1.8 Action during construction

Lateral earth pressure of a clay bank.

4.1.9 Any special action not covered above¹¹

A surcharge of 2.5 kN/m² is adopted considering the fact that the backyards to Nos. 16 and 17 Granary Way are not accessible to vehicular traffic because the gaps between the houses cannot accommodate such.

~~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~~

~~4.3 Minimum headroom provided~~

~~4.4 Authorities consulted and any special conditions required~~

West Sussex County Council.

~~4.5 Standards and documents listed in the Technical Approval Schedule~~

See Appendix A.

~~4.6 Proposed Departures relating to departures from standards given in 4.5~~

None

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

~~4.8 (Wales only) List of record of options and choices (for Categories 2 and 3 checks)~~

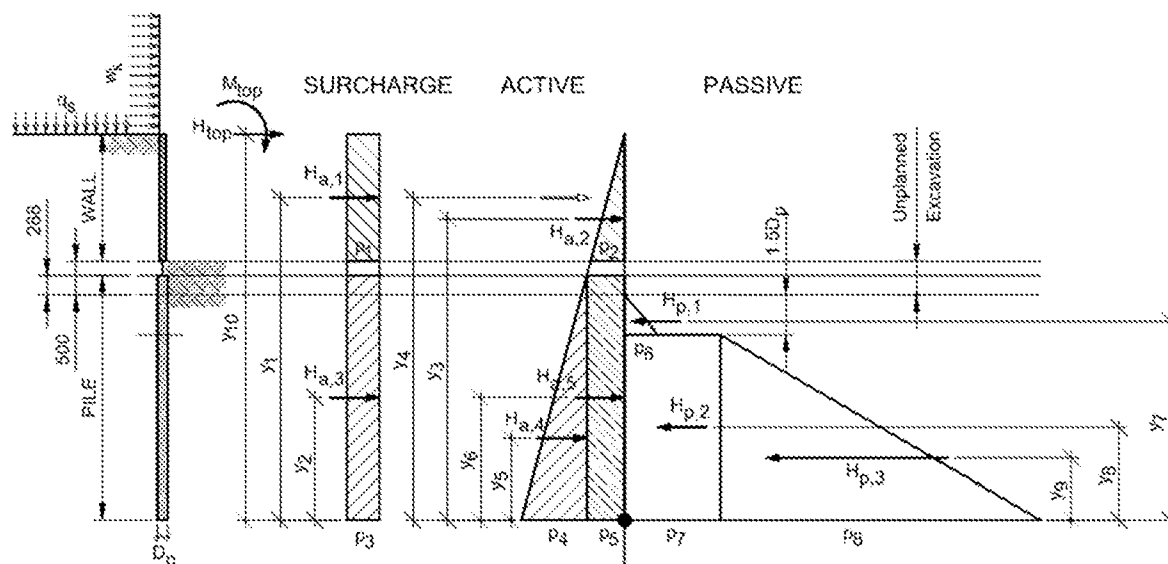
5. STRUCTURAL ANALYSIS

5.1 Methods of analysis proposed for superstructure, substructure and foundations

The fixed earth cantilever wall model is analysed using an Excel spreadsheet. The deflections and effects of actions for the kingpost shelf angle are analysed using Prokon commercial analysis programme.

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

The cantilever retaining wall is analysed as using the fixed earth model, with a pivot fixed in the ground about which the wall rotates.



5.3 Assumptions intended for calculation of structural element stiffness

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

Aeolian Deposits - soil bulk density = 20 kN/m²

Average plasticity index of between 15 and 20.

Effective angle of shearing resistance $\phi = 27$ degrees.

From the angle of shearing resistance, the adopted passive and active pressure coefficients are determined from BS EN 1997 (EC7) for Design Approach 1 (DA1) and Combination 1 (C1) and Combination 2 (C2) as follows:

$$\text{DA1-C1: } K_p = 3.847 \quad K_a = 0.324$$

$$\text{DA1-C2 } K_p = 3.060 \quad K_a = 0.384$$

The at rest lateral earth pressure is not applicable as the ground in front of the PCC panels is excavated first before the panels are placed and backfilled afterwards.

6. GEO TECHNICAL CONDITIONS

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

Geotechnical Design Report not available for this project. However, a Geotechnical Investigative Letter Report, L-18426j-2.4.2-18-S649-SAM “Site Investigation at Mill Lane, Littlehampton” dated 19 December 2018 was prepared for the site by IDOM Merebrook Ltd. The lateral earth pressure coefficients K_a and K_p for the cohesive material quoted in the report are too conservative as the proposed design requires that there be a drainage layer between the retained clay and the precast concrete panels, so near hydrostatic pressures are not likely to develop at the soil/retaining wall interface. As such the values of K_a and K_p used (see 5.4 above) are derived from the drained state internal angle of friction.

The letter report L-18426j-2.4.2-18-S649-SAM is based on two boreholes drilled at either end of the proposed retaining wall. Strata into which the piles will be embedded was plotted by taking the interpolation between the boreholes and establishing a perpendicular to each kingpost. The profile is summarised on drawing number OP1314/404 “Anticipated Ground Conditions Retaining Wall Foundation”. This comprises topsoil/made ground up to 0.5 m deep underlain by a layer of very soft silty sandy clay tending to soft to firm clay up to 1.m deep. Beneath this layer lies a layer of raised beach deposits (loose to medium dense sand) up to 0.95m deep over a layer of soft to firm clay/ firm gravelly clay up to 0.74m deep. Another layer of raised beach deposits (loose to medium dense sand) up to 1.975 m deep lies beneath and over a structureless chalk layer up to 0.3 m deep over a structured chalk layer proven up to 1.5 m thick.

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

The Geotechnical Investigative Letter Report, L-18426j-2.4.2-18-S649-SAM “Site Investigation at Mill Lane, Littlehampton” dated 19 December 2018 was prepared for the site by IDOM Merebrook Ltd was used to confirm the ground conditions and they were similar to those given in the Ground Investigation Report for the nearby bridge over the railway line. The recommended ground design parameters are given in 5.4 above.

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

Not deemed critical therefore not explicitly considered.

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

None is expected. The design values were extracted from the Geotechnical Investigative Letter Report, L-18426j-2.4.2-18-S649-SAM “Site Investigation at Mill Lane, Littlehampton” dated 19 December 2018 and the Ground Investigation Report No. R01/rev00 entitled “Proposed Enabling Infrastructure, North Littlehampton” by Peter Brett Associates and dated December 2016.

7. CHECK

7.1 Proposed Category and Design Supervision Level

Category 0 and DSL1.

~~*7.2 If Category 3, name of proposed Independent Checker*~~

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

None.

8. DRAWINGS AND DOCUMENTS

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

- (i) OP1314_401C_Toddington Lane Retaining Wall Details Sheet 1 of 2
- (ii) OP1314_402B_Toddington Lane Retaining Wall Details Sheet 2 of 2
- (iii) OP1314_403_Location of Services on Plan in Relation to Retaining Wall
- (iv) OP1314_404_Anticipated Ground Conditions Retaining Wall Foundation
- (v) OP1314_405_Retaining Wall Location Plan

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

Signed _____

Name Dr Tinozivashe Zhou

Design Team Leader

Engineering Qualifications BSc(Eng'g) Hons, Meng, PhDName of Organisation Optimal Structural Engineers LtdDate 1 August 2018**10. THE ABOVE IS REJECTED/AGREED SUBJECT TO THE AMENDMENTS AND CONDITIONS SHOWN BELO W¹⁸**

Signed _____

Name Andrew CookPosition held EngineerEngineering Qualifications BEng CEng MICE ¹⁷TAA West Sussex County CouncilDate 20/02/2019

APPENDIX A TECHNICAL APPROVAL SCHEDULE (TAS)

Schedule of Documents Relating to Design of Highway Bridges and Structures using Structural Eurocodes

British Standards (Non-conflicting with Eurocodes)		
Document Reference	Title	Date
BS 8500	Concrete. Complementary British Standard to BS EN 206-1. Method of specifying and guidance for the specifier	2006
~~BS EN 1317-1~~	~~Road Restraints Systems — Terminology and general criteria for test methods~~	~~1998~~
~~BS EN 1317-2~~	~~Road Restraint Systems — Performance classes, impact test acceptance criteria and test methods for safety barriers~~	~~1998~~
~~BS EN 1317-3~~	~~Road Restraint Systems — Performance classes, impact test acceptance criteria and test methods for crash cushions~~	~~2000~~
~~DD ENV 1317-4~~	~~Road Restraint Systems — Performance classes, impact test acceptance criteria and test methods for terminals and transitions of safety barriers~~	~~2002~~
~~BS EN 1337-1:~~	~~Structural bearings. General design rules~~	~~2000~~
~~BS EN 14388~~	~~Road traffic noise reducing devices. Specifications.~~	~~2005~~
~~BS EN 15050~~	~~Precast concrete products. Bridge Elements~~	~~2007~~

Eurocodes			
Eurocode Part	Title	Publication Date	UK National Annex Publication Date
Eurocode 0	Basis of Structural Design		
BS EN 1990	Eurocode 0: Basis of structural design	2002	2004
Eurocode 1	Actions on Structures		
BS EN 1991-1-1	Actions on structures – Part 1-1: General actions – Densities, self-weight and imposed loads for buildings	2002	2005

Eurocodes			
Eurocode Part	Title	Publication Date	UK National Annex Publication Date
BS EN 1991-1-3	Actions on structures – Part 1-3: General actions – Snow loads	2003	2005
BS EN 1991-1-4	Actions on structures – Part 1-4: General actions – Wind actions	2005	2008
BS EN 1991-1-5	Actions on structures – Part 1-5: General actions – Thermal actions	2004	2007
BS EN 1991-1-6	Actions on structures – Part 1-6: General actions – Actions during execution	2005	2008
BS EN 1991-1-7	Actions on structures – Part 1-7: General actions – Accidental actions	2006	2008
~~BS EN 1991-2~~	~~Actions on structures – Part 2: Traffic loads on bridges~~	~~2003~~	~~2008~~
Eurocode 2	Design of Concrete Structures		
BS EN 1992-1-1	Design of concrete structures – Part 1-1: General rules and rules for buildings	2004	2005
~~BS EN 1992-2~~	~~Design of concrete structures – Part 2: Concrete bridges – Design and detailing rules~~	~~2005~~	~~2007~~
~~BS EN 1992-3~~	~~Design of concrete structures – Part 3: Liquid retaining and containment structures~~	~~2006~~	~~2007~~
Eurocode 3	Design of Steel Structures		
BS EN 1993-1-1	Design of steel structures – Part 1-1: General rules and rules for buildings	2005	2008
~~BS EN 1993-1-4~~	~~Design of steel structures – Part 1-4: General rules – Supplementary rules for stainless steels~~	~~2006~~	~~2009~~
~~BS EN 1993-1-5~~	~~Design of steel structures – Part 1-5: Plated structural elements~~	~~2006~~	~~2008~~
~~BS EN 1993-1-6~~	~~Design of steel structures – Part 1-6: Strength and stability of shell structures~~	~~2007~~	~~2007~~
~~BS EN 1993-1-7~~	~~Design of steel structures – Part 1-7: Plated structures subject to out of plane loading~~	~~2007~~	~~2007~~
BS EN 1993-1-8	Design of steel structures – Part 1-8: Design of joints	2005	2008
~~BS EN 1993-1-9~~	~~Design of steel structures – Part 1-9: Fatigue~~	~~2005~~	~~2008~~

Eurocodes			
Eurocode Part	Title	Publication Date	UK National Annex Publication Date
BS EN 1993-1-10	Design of steel structures – Part 1-10: General – Material toughness and through thickness properties	2005	2009
BS EN 1993-1-11	Design of steel structures – Part 1-11: Design of structures with tension components	2006	2008
BS EN 1993-1-12	Design of steel structures – Part 1-12: Additional rules for the extension of EN 1993 up to steel grades S700	2007	2008
BS EN 1993-2	Design of steel structures – Part 2-1: Steel bridges	2006	2008
BS EN 1993-5	Design of steel structures – Part 5: Piling	2007	2009
Eurocode 4	Design of Composite and Concrete Structures		
BS EN 1994-2	Design of composite steel and concrete structures – Part 2: Bridges	2005	2007
Eurocode 5	Design of Timber Structures		
BS EN 1995-1-1	Design of timber structures – Part 1-1: General – Common rules and rules for buildings	2004	2006
BS EN 1995-2	Design of timber structures – Part 2: Bridges	2004	2006
Eurocode 6	Design of Masonry Structures		
BS EN 1996-1-1	Design of masonry structures – Part 1-1: General rules for reinforced and unreinforced masonry structures.	2005	2007
BS EN 1996-2	Design of masonry structures – Part 2: Design considerations, selection of materials and execution of masonry.	2006	2007
BS EN 1996-3	Design of masonry structures – Part 3: Simplified calculation methods for unreinforced masonry structures	2006	2007
Eurocode 7	Geotechnical design		
BS EN 1997-1	Geotechnical design – Part 1: General rules	2004	2007
BS EN 1997-2	Geotechnical design – Part 2: Ground investigation and testing	2007	2009
Eurocode 8	Design Of Structures For Earthquake Resistance		
BS EN 1998-1	Design of structures for earthquake resistance – Part 1: General rules seismic actions and rules for buildings	2005	2008

Eurocodes			
Eurocode Part	Title	Publication Date	UK National Annex Publication Date
BS EN 1998-2	Design of structures for earthquake resistance — Part 2: Bridges	2005	2009
BS EN 1998-5	Design of structures for earthquake resistance — Part 5: Foundations, retaining structures and geotechnical aspects	2005	2008
Eurocode 9	Design Of Aluminium Structures		
BS EN 1999-1-1	Design of aluminium structures — Part 1-1: Design of Aluminium Structures — General Structural rules	2007	2008
BS EN 1999-1-3	Design of aluminium structures — Part 1-3: Design of Aluminium Structures — Structures susceptible to fatigue	2007	2008
BS EN 1999-1-4	Design of aluminium structures — Part 1-4: Design of Aluminium Structures — Cold formed structural sheeting	2007	2009

BSI Published Documents		
Document Reference	Title	Date
PD 6688-1-1	Background paper to the UK National Annex to BS EN 1991-1-1	2011
PD 6688-1-4	Background paper to the UK National Annex to BS EN 1991-1-4	2009
PD 6688-1-7	Recommendations for the design of structures to BS EN 1991-1-7	2009
PD 6688-2	Background to the National Annex to BS EN 1991-2: Traffic loads on bridges	2011
PD 6687-1	Background paper to the UK National Annexes to BS EN 1992	2006
PD 6687-2	Recommendations for the design of structures to BS EN 1992	2008
PD 6695-1-9	Recommendations for the design of structures to BS EN 1993-1-9	2008

BSI Published Documents		
Document Reference	Title	Date
PD 6695 1 10	Recommendations for the design of structures to BS EN 1993 1 10	2009
PD 6695 2	Recommendations for the design of bridges to BS EN 1993	2008
PD 6696 2	Background paper to BS EN 1994 2 and the UK National Annex to BS EN 1994 2	2007

BSI Published Documents		
Document Reference	Title	Date
PD 6694 1	Recommendations for the design of structures subject to traffic loading to BS EN 1997 1:2004	2011
PD 6698	Recommendations for the design of structures for earthquake resistance to BS EN 1998	2009
PD 6703	Structural bearings—Guidance on the use of structural bearings	2009
PD 6705 2	Recommendations on the execution of steel bridges to BS EN 1090 2	2010 + A1:2013

Execution Standards		
Document Reference	Title	Date
BS EN 1090 1	Execution of steel structures and aluminium structures. Requirements for conformity assessment of structural components	2009
BS EN 1090 2	Execution of steel structures and aluminium structures. Technical requirements for the execution of steel structures	2008
BS EN 1090 3	Execution of steel structures and aluminium structures. Technical requirements for the execution of aluminium structures	2008
BS EN 13670	Execution of concrete structures	2009

Miscellaneous
~~Circular Roads No 61/72 – Routes for heavy and high abnormal loads~~
Traffic Management Act 2004
Construction (Design and Management) Regulations 2007

The Manual of Contract Documents for Highway Works (MCHW)	
Title	Date of Issue
Volume 1: Specification for Highway Works	
Volume 2: Notes for Guidance on the Specification for Highway Works	
Volume 3: Highway Construction Details	

The Design Manual for Roads and Bridges (DMRB) (Non-conflicting with Eurocodes)

The following have been reproduced from the current alpha-numeric index in the DMRB, Volume 1,

Document Reference	Title	Date of Issue	Decimal Ref.
General Requirements, Standards (GG/GD Series)			
GG 101	Introduction to the Design Manual for Roads and Bridges (DMRB)	Jun 2018	0.1.2
GD 02/16	~~Quality Management Systems for Highway Design Activities~~	Nov 2016	0.2.1
Bridges and Structures, Advice Notes (BA Series)			
BA 28/92	Evaluation of Maintenance Costs in Comparing Alternative Designs for Highway Structures	Aug 1992	1.2.2
BA 41/98	~~The Design and Appearance of Bridges~~	Feb 1998	1.3.11
BA 47/99	~~Waterproofing and Surfacing Concrete Bridge Decks~~	Aug 1999	2.3.5
BA 57/01	Design for Durability	Aug 2001	1.3.8
BA 67/96	~~Enclosure of Bridges~~	Aug 1996	2.2.8
BA 82/00	~~Formation of Continuity Joints in Bridge Decks~~	Nov 2000	2.3.7
BA 83/02	~~Cathodic Protection for Use in Reinforced Concrete Highway Structures~~	Feb 2002	3.3.3
BA 84/02	~~Use of Stainless Steel Reinforced in Highway Structures~~	Feb 2002	1.3.15
BA 85/04	Coatings for Concrete Highway Structures & Ancillary Structures	May 2004	2.4.3
BA 86/06	~~Advice Notes on the Non-destructive Testing of Highway Structures~~	Aug 2006 May 2017	3.1.7
BA 92/07	~~The Use of Recycled Concrete Aggregates in Structural Concrete~~	May 2007	2.3.9

Document Reference	Title	Date of Issue	Decimal Ref.
Bridges and Structures, Standards (BD Series)			
BD 02/12	Technical Approval of Highway Structures	May 2012	1.1.1
~~BD 07/01~~	~~Weathering Steel for Highway Structures~~	~~Nov 2001~~	~~2.3.8~~
~~BD 10/97~~	~~Design of Highway Structures in Areas of Mining Subsidence~~	~~May 1997~~	~~1.3.14~~
~~BD 29/17~~	~~Design Criteria for Footbridges~~	~~May 2017~~	~~2.2.8~~
~~BD 35/14~~	~~Quality Assurance Scheme for Paints and Similar Protective Coatings~~	~~Aug 2014~~	~~2.4.1~~
~~BD 36/92~~	~~Evaluation of Maintenance Costs in Comparing Alternative Designs for Highway Structures~~	~~Aug 1992~~	~~1.2.1~~
~~BD 43/03~~	~~The Impregnation of Reinforced and Prestressed Concrete Highway Structures using Hydrophobic Pore Lining Impregnants~~	~~Feb 2003~~	~~2.4.2~~
~~BD 47/99~~	~~Waterproofing and Surfacing of Concrete Bridge Decks~~	~~Aug 1999~~	~~2.3.4~~
~~BD 51/14~~	~~Portal and Cantilever Signs/Signal Gantries~~	~~May 2014~~	~~2.2.4~~
BD 57/01	Design for Durability	Aug 2001	1.3.7
BD 67/96	Enclosure of Bridges	Aug 1996	2.2.7
BD 78/99	Design of Road Tunnels	Aug 1999	2.2.9
BD 91/04	Unreinforced Masonry Arch Bridges	Nov 2004	2.2.14
BD 94/17	Design of Minor Structures	Aug 2017	2.2.1
BD 100/16	The Use of Eurocodes for the Design of Highway Structures	Nov 2016	1.3.19
Bridges and Structures, Technical Memoranda (BE Series)			
BE 7/04	Departmental Standard (Interim) Motorway Sign/Signal Gantries	Aug 2004	2.2
Traffic Engineering and Control, Standards (TD Series)			
TD 9/93	Highway Link Design Amendment No.1	Jun 1993	
		Feb 2002	6.1.1
TD 19/06	Requirement for Road Restraint Systems Correction No.1	Aug 2006	
		Feb 2008	2.2.8
TD 27/05	Cross Sections and Headrooms	Feb.2005	6.1.2
TD 36/93	Subways for Pedestrians and Pedal Cyclists Layout and Dimensions	July 1993	6.3.1

Document Reference	Title	Date of Issue	Decimal Ref.
Advice Notes – Highways (HA Series)			
HA 59/92	Mitigating Against Effects on Badgers	Feb 1997	10.4.2
HA 66/95	Environmental Barriers Technical Requirements	Sep 1995	10.5.2
HA 80/99	Nature Conservation Advice in Relation to Bats	May 1999	10.4.3
HA 81/99	Nature Conservation Advice in Relation to Otters	May 1999	10.4.4
HA 84/01	Nature Conservation and Biodiversity	Feb 2001	10.4.1
HA 97/01	Nature Conservation Management Advice in Relation to Dormice	Feb 2001	10.4.5
HA 98/01	Nature Conservation Management Advice in Relation to Amphibians	Feb 2001	10.4.6
Highways, Standards (HD Series)			
HD 22/08	Managing Geotechnical Risk	Aug 2008	4.1.2