

Flint Street,
Fartown,
Huddersfield
HD1 6LG

APPROVAL IN PRINCIPLE FOR DESIGN

STEEL COLUMN AND CONCRETE PANELLED KING POST RETAINING WALL SUPPORTING THE HIGHWAY AT A6024 WOODHEAD ROAD AT HOLMBRIDGE, HOLMFIRTH, HD9 2NW

Structure reference: K60120
Date: 15/2/2019
Revision: 06
Status: Final
Prepared by: D. Haigh
Checked by: T. Mak

DOCUMENT CONTROL

Structure title: Private steel column and concrete panelled King Post retaining walls supporting the highway A6024 Woodhead road at Holmbridge, Holmfirth.

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1. HIGHWAY DETAILS

1.1. Type of highway

1.1.1. Location and OS Map / Grid reference

Location: A6024, Woodhead Road, Holmbridge, Holmfirth

OS Map: OL1: Peak District

Grid Ref (X, Y): 412274 : 406879

1.2. Permitted traffic speed

30 mph

1.3. Existing restrictions

None

2. SITE DETAILS

2.1. Obstacles crossed

The land below the proposed retaining structure will be used to build a single detached dwelling.

3. PROPOSED STRUCTURE

3.1. Description of structure and design working life

The scheme is to provide support to the Highway at A6024 Woodhead Road, to allow the excavation of earthworks below for the construction of a new single detached dwelling.

Construction of the new dwelling will require the construction of a steel column and concrete panelled King Post retaining walls to support the adjacent public highway.

Based upon BS EN 1990:2002 the proposed structure will have a design working life of 120 years.

3.2. Structural type

Steel column and concrete panelled King Post retaining walls.

3.3. Foundation type

Steel column and concrete panelled King Post retaining walls.

3.4. Span arrangements

The Retained height of the proposed King Post retaining walls supporting the highway will, at its highest point, be no more than approximately 7.0 high above the formation level of the new dwelling superstructure foundations.

In proximity to the supported highway, the length of the King Post retaining wall will be approximately 18.0m long.

The steel columns will be positioned at 2.0m centre to centre, and the length of the concrete panels is 1950mm. There is a 25mm allowance on each end to allow for tolerances and generally this achieves a tight enough fit while allowing some give to install the panel, but also for differing levels of expansion between the materials.

3.5. Articulation arrangements

The King Post retaining walls will only be considered to support the highway.

The mass of the proposed new dwelling, garage and the earth in front of the wall will not be considered in the stability checks of the wall.

The two ends of the King Post retaining wall will be supported by buttress returns. However, these buttresses will not be considered in the structural design of the King Post retaining wall.

The stability of the proposed King Post retaining wall structure by its own self-weight and construction does not rely upon the mass of the new dwelling superstructure that could be demolished at a future date.

Buttress returns, formed using king post columns and concrete panels, will be provided at each end of the proposed steel column and concrete panelled king post retaining wall. The stability provided by these buttresses, will not be considered in the structural design of the main kingpost retaining wall which directly supports the highway.

However, the steel column and concrete panel buttresses will be designed to support the adjacent existing burr wall and embankment which retains the highway.

The design of the buttress, and the loads considered will be the same as the main highway retaining structure.

3.6. Classes and levels

The classes and levels stated below apply to both the whole structure as well as all individual structural components.

3.6.1. Consequence class

CC2

3.6.2. Reliability class

RC2

3.6.3. Inspection level

IL2

3.7. Road restraint systems requirements

The existing boundary wall and pedestrian / road restraints will not be affected. The existing parapet wall is a minimum 900mm high by 420mm wide.

3.8. Proposed arrangements for future maintenance and inspection**3.8.1. Traffic management**

All works will be undertaken within the boundary of the proposed development therefore no permanent traffic management for the highway will be required.

Access to the exposed section of retaining wall will be via the driveway access to the property.

The proposed dwelling will be built tight to the king post retaining wall structure, thus limiting inspection following completion. Therefore, it is proposed to fill the overbreak between the king post wall, and main house wall with a lean mix concrete to form one integrated structure.

During future maintenance works temporary traffic management may be required for deliveries of materials to site and should this be the case then all relevant applications and consents will be obtained prior to works commencing.

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

Access to the site will be by using the existing entrance and access off the A6024 Woodhead Road.

3.9. Environment and sustainability

There are no environmental factors which need to be considered in the close proximity to the proposed development.

3.10. Durability. Materials and finishes

For structural elements specify material strengths, exposure classes, finishes etc., and list the relevant codes/standards.

Item	Material	Finish / Location
Steel Columns	Steelwork columns will be BS EN 10025 Part2:2004 S355GPJR, set into holes grouted with grade C35 concrete. Weathering is limited due to minimal exposure to oxygen or open air. Assume one face is against concrete and the other face is against sand/sandstone (which is considered fairly inert). Site does not appear contaminated nor was an aggressive chemical environment noted in the ground investigation.	120 year design life provided by sacrificial allowance in the steelwork. An assumed corrosion rate of 0.02mm per year in accordance with BS EN 1993-5:2007. The Steel sections have been increased to allow for this. No specific finishes proposed. Exposed steel above ground level to have two coats of red oxide paint.
Concrete Panels	Prestressed concrete panels with concrete characteristic strength of 60 N/mm ² . Steel cable strand wire reinforcing to BS5986/1980 with Fpu = 1770 N/mm ² .	The concrete panels to be used have a design life of 120 years.
Drainage	No will drainage provided behind the wall. Any water accumulation will seep through the joints within panels. A 100mm land drain will be provided in the easement between the retaining wall and new dwelling.	
Waterproofing	Not required to earth face of King Post walling, as per designers' details.	

3.11. Risks and hazards considered for design, execution, maintenance and demolition. Consultation with and/or agreement from Principal Designer

The principal designer (to be advised by main/principal contractor) will review and provided a full detailed construction method statement and risk assessment.

Some factors to be considered will include, but not be limited to:

- Maintenance of vehicular/pedestrian access during construction
- Working at height
- Stability of the adjacent land, structures and the highway
- Existing utility services
- Manual handling of heavy objects
- Pumping of concrete and lean fill mix: spillages onto the highway.
- Deliveries of materials to site from the highway (if applicable)
- Use of large heavy (and high) plant adjacent to the highway.
- The principal designers on the project will be ALE Piling. Relevant insurance certificates will be provided prior to commencement confirming that they have adequate provision of cover for this role.

3.12. 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)

The estimated cost of the proposed structure is excluding/including Statutory Undertakers costs.

£ 56,000 (fifty six thousand pounds) excluding Statutory Undertakers costs.

3.13. Proposed arrangements for construction

3.13.1. Construction of structure

- a) Initially, a full structural/ dilapidation survey of the adjoining drystone highway burr wall and the adjoining carriageway complete with photos will be undertaken by suitably qualified and experienced structural engineer and a copy of the report be submitted to Council's structures team for information. Any essential repairs to the wall will have to be completed prior to the commencement of piling works on site.
- b) The Contractor will set up an appropriate monitoring system for both vibration and movement to ensure that the piling works and the subsequent excavations do not have any adverse impact on the highway burr wall. Survey targets will be attached to the various points along the face of the wall including the parapet wall. Surveying methods will be used to measure any significant lateral deformation and distortion of the highways assets using theodolites, taping and EDM (Electronic Distance Measurement).

- c) Regular checks of the targets will be carried out to note any movement in the highway wall and the adjoining carriageway. Any movement will be reported immediately to the Engineer and the council's structures section. No further work will be undertaken until adequate remedial measures are put in place, as advised by the Structural Engineer following consultation with the Council's highway structures team.
- d) All remedial measures will be approved by the council's structures section. Possible remedial measures may include, temporary steel props (short term solution), construction of masonry piers or full height buttress walls and in the worst case full reconstruction of the highway wall to new standards. The final solution will be determined by the extent, severity and failure mode. Augured piles produce continuous vibrations at low energy levels. The vibration at the toe of the wall, is to be monitored throughout piling work. Vibration will be monitored using geophones or accelerometers, with transducers connected to the wall to record in three orthogonal directions. The transducers record the peak particle velocity ppv in units of mm/s.
- e) In the final situation, it is anticipated that there will be no change to the condition of the retaining walls.

All construction works will be undertaken from within the boundary of the site, negating the need for any traffic management. Briefly, reception pits will be bored into the substrata to allow the installation of steel King Posts. The steel King Posts will be grouted into the reception pits. The rock substrata will be excavated between the posts in 2.0m wide bays to allow the installation of concrete panel supports. The concrete panels will then be backfilled to support the substrata and highway above.

The construction of the king post retaining wall will commence from the lowest retained height.

3.13.2. Traffic management

It is unlikely that any traffic management along the public highway will be required during the construction of the new dwelling.

If traffic management is required, then it is to be agreed with the Kirklees Council's Highways Service prior to the commencement of the works.

3.13.3. Service diversions

Statutory Service plans to be obtained and presence of services to be confirmed before construction of the new retaining wall is started.

Additionally, hand dug trial hole excavation pits will be carefully undertaken prior to commencement of works to establish the exact location of any services present.

3.13.4. Interface with existing structures

Where applicable, a 25mm polystyrene or cork based compression joint is to be installed along the interfaces with any existing structures.

4. DESIGN CRITERIA

4.1. Actions

4.1.1. Permanent actions

All permanent actions as outlined in BS EN 1991-1-1:2002 and associated National Annex

4.1.2. Snow, Wind and Thermal actions

Snow loading not considered (NA to BS EN 1991-1-3 NA.4.1.1).

Thermal – movement joints will be specified where necessary.

Wind loading will not be considered, since the surcharge loads from the highway will far exceed any expected wind loads acting upon the king post retaining wall.

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

10.0 kNm² minimum surcharge in accordance with BS 8002:2015.

4.1.4. Actions relating to General Order traffic under STGO regulations

20kN/m² surcharge in accordance with BS 8002:2015.

4.1.5. Footway or footbridge variable actions

A minimum allowance of 5.0 kN/m² shall be applied in the garden areas at the top of the wall in accordance with Section 4.5.1.5 (Table 7) of BS 8002:2015 Code of Practice for Earth Retaining Structures.

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

A departure from approved standards is proposed as it is extremely unlikely that the A6024 would be used to transport abnormal loads through Holmbridge Village due to the narrow and steep nature of the surrounding roads.



4.1.7. Accidental actions

The proposed structure is set below the existing highway parapet wall and as such no vehicle impact will be considered in the structural design of the proposed structure.

A site survey of the existing parapet wall has confirmed that it is an unreinforced masonry construction, with a minimum height of 900mm high above highway level and a minimum width of 420mm. As part of the development works, the height of the parapet wall will be increased to 1100mm high, to ensure compliance with highways standards.

A risk assessment of the existing parapet wall has been undertaken in accordance with the DfT “Guidance on the design, Assessment and Strengthening of Masonry Parapets on Highways Structures” document.

The risk assessment has confirmed that increasing the height of the existing parapet wall to 1100mm high reduces the Fatal Accident Rate for death by impact from debris existing the parapet wall when impacted by a vehicle. The calculated FAR value is also significantly less than the FAR when travelling by a motorbike, and we consider this to be acceptable.

4.1.8. Action during execution

The retaining wall is to be backfilled in accordance with the MCHW and surcharge loadings are to be derived based on the requirements of PD 6694-1:2011. Therefore, compaction pressures imposed on the wall during construction do not need to be considered. (PD 6694-1:2011 CL 7.3.3).

4.1.9. Any special action not covered above

None

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

A departure from approved standards is proposed as it is extremely unlikely that the A6024 would be used to transport abnormal loads through Holmbridge village due to the narrow and steep nature of the surrounding roads.

4.3. Minimum headroom provided

Not Applicable.

4.4. Authorities consulted, and any special conditions required

Kirklees Council

4.5. Standards and documents listed in the Technical Approval Schedule

TAS dated July 2018 - See appendix A.

Additional relevant DoT standards published since the above edition of the TAS including amendments, are listed as follows:

None.

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

Due to the narrow nature of the supported highway and topography of the surrounding area it is highly unlikely that an abnormal loading would be routed along the A6024 Woodhead Road through Holmbridge village. Therefore, a departure from the approved standard, BS8002:2015 is proposed whereby the surcharge loading on the highway has been reduced to 20 kN/m².

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

The developer must be satisfied that all architects/ designer/ geotechnical engineers/ structural engineers/ principal designer and principal contractor and sub-contractor or specialist sub-contractors commissioned on this project, all have adequate insurance arrangements (i.e. Professional indemnity insurance at £5 million and Employers and Public Liability of £10 million) and confirm this in writing

The King Post retaining wall will be designed and detailed to meet current Highways standards.

The proposed King Post retaining wall will be a private wall and as such its maintenance liability will rest with the titleholder of the adjoining land.

5. STRUCTURAL ANALYSIS

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

The design of the steel column and concrete panelled King Post retaining wall will be in accordance with all applicable Eurocodes, adopting a design life of 120 years.

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

Proposed King Post Retaining Wall Structure

Please see drawing MDL-2431-001.REV.05

5.3. Assumptions intended for calculation of structural element stiffness

Calculations Assumptions:

Code of practice

Code of practice or reference document	Eurocode 7 ULS Design Approach 1 Combination 2
Application of pressures for stability	Not applicable for FOS=1 on moments
FOS on moments (stability check)	1.00
ULS factor on Tan(Phi) values	1.25
ULS fFactor on drained cohesion values	1.25
ULS factor on undrained cohesion values	1.40
ULS factor on active soil pressures	1.00
ULS factor on passive soil pressures	1.00
ULS factor on active water pressures	1.00
ULS factor on passive water pressures	1.00
ULS factor on loads applied to the soil	1.30
ULS factor on loads applied to the wall	1.30
FOS on embedment (stability check)	1.00
Correction factor on cantilever embedment	1.20

Wall analysis detail options

Nominal Phi for load distribution	30.0 Degrees
Depth of water filled tension cracks	.0 m
Density of water	10.0 kN/m3
Minimum equivalent fluid density	5.0 kN/m3
Depth of passive softened soil	1.0 m
Continuity model for wall analysis	Pins at second and lower props

Deflection parameters

Wall moment of inertia	19340 cm4/m
Wall Youngs modulus	210000000 kN/m2

Interpretation of Soils Report:

Soils and ground water initial data (Soils data given for active and passive sides)

Initial Ground Water level 180

Top Level m	Description	Bulk Dens kN/m3	Sat' Dens kN/m3	Young Mod kN/m2	Young Inc. kN/m3	Cu C' kN/m2	C Inc. kN/m3	Phi Deg	Wall Shear Ratio	Ka Kp	Kac Kpc
185.36	MG/TS-Clay-Sand	18.00	18.50	5500	0			28 28	.50 .50	.32 3.81	
184.06	Weath UKG-Ls Si	18.00	19.00	11200	0			30 30	.50 .50	.29 4.29	
181.36	UKG-Ex Weak San	20.00	20.50	19600	0			32 32	.50 .50	.27 4.85	
	Granular Fill	18.00	20.00	0	5000			35		.27	
	Construction sequence							35		3.69	

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

The King Post retaining wall has been designed using active pressures, assuming the wall is immobile and with NO passive pressure.

In the global stability conditions, the active pressure, K_a , has been used.

K_a (as per above table)

K_o (Topsoil-Sand) $= 1 - \sin 28 = 0.53$

K_o (Weathered Kinderscout Grit) $= 1 - \sin 30 = 0.50$

K_o (Kinderscout Grit) $= 1 - \sin 32 = 0.47$

6. GEOTECHNICAL CONDITIONS

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

A full geotechnical report has been undertaken by Rogers Geotechnical Services, reference number J4094/17/E, dated February 2018.

The findings of the geotechnical investigation have been adhered to in full.

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

A full geotechnical report has been undertaken by Rogers Geotechnical Services, reference number J4094/17/E, dated February 2018.

There are no anticipated ground movements or settlement due to embankment loading, mineral extraction, or flow of water.

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

The new King Post retaining walls will be socketed into the sandstone bedrock therefore differential settlement is not considered to be a structural concern.

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

A full geotechnical report has been undertaken by Rogers Geotechnical Services, reference number J4094/17/E, dated February 2018.

7. CHECK

7.1. Proposed Category and Design Supervision Level

Category 1

7.2. If Category 3, name of proposed Independent Checker

Not applicable.

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

- 1) Erect any temporary fencing, barriers and signage to ensure safety of public and workers throughout the construction period.
- 2) Locate all services, by reviewing maps available, but by also undertaking trial holes, excavate by hand to ensure exact location of any services present.
- 3) Form temporary access ramping with well compacted hardcore backfill to approved design.
- 4) Drill reception pits for upper level of King Post wall, insert steel columns and grout holes with concrete.
- 5) Working one bay at a time, remove access ramp back fill, break out rock and install concrete panelling supports to form wall.
- 6) Back fill overbreak between concrete panels and exposed rock face with lean mix concrete pour and leave to cure before excavating adjacent bay.
- 7) For upper sections of the wall, back fill in layers to required level using well compacted granular fill material to approved specification.
- 8) Repeat steps (4) to (7) for lower level of King Post retaining wall.
- 9) Form buttressing walls at either end of retaining wall prior to constructing main dwelling superstructure.

N.B. A more detailed method statement for the construction of the King Post retaining walls will be provided by the King Post wall designers and contractors responsible for the work prior to construction commencing. This will form part of the pre-construction phase pack for the CDM regulations on the project.

8. DRAWINGS AND DOCUMENTS

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

8.1.1. Drawings (See appendix B)

Reference	Title
MDL-2431-001.REV.05	Marsh Design Limited Sketch of Idealised Structure
15054D	ADP Architectural Drawings Site Sections
MDL-2431-002-REV.03	Site Plan Showing Location of King Post Retaining Walls

8.1.2. Documents (See appendix C)

Reference	Title
J4094/17/E	RGS Geotechnical Report
WO1103.01 – REV.1	ALE Piling – Preliminary Structural Calculations

9. THE ABOVE IS SUBMITTED FOR ACCEPTANCE

Signed	<u></u>
Name	<u>David Haigh</u>
Engineering Qualifications	<u>B.Eng</u>
Name of Organisation	<u>Marsh Design Limited</u>
Date	<u>15/2/2019</u>

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

Signed	<u></u>
Name	<u>Farhad Khatibi</u>
Position held	<u>Principal Engineer (Structures)</u>
Engineering Qualifications	<u>BSc (Hons) Civil Eng, MSc</u>
TAA	<u>Kirklees Council</u>
Date	<u>18/02/2019</u>

(*)

- (i) Submission of satisfactory structural calculations for the design of new private king post pile burr wall.
- (ii) Submission of satisfactory Design and Check Certificate (Category 1) in compliance with the approved AIP Rev 06 and BD2/12 for the new private king post pile burr wall.
- (iii) Submission of "Construction Compliance Certificate" in accordance with BD2/12.

For and on behalf of Kirklees Council

APPENDIX A

LIST OF RELEVANT DESIGN DOCUMENTS

TECHNICAL APPROVAL SCHEDULE (TAS)

Schedule of Documents Relating to Design of Highway Bridges and Structures

(All documents are taken to include revisions current as of 13 July 2018)

The Designer is responsible for ensuring that the standards and references given in the schedule are correct and up to date. Tick all the documents used (✓)

Eurocodes and associated UK National Annexes				
Used	Reference	Title	Amendment / Corrigenda	
	Eurocode 0	Basis of structural design		
	BS EN 1990:2002 +A1:2005	Eurocode 0: Basis of structural design	+A1:2005 Incorporating corrigenda December 2008 and April 2010	See BD100 Annex A 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 BD100 Annex A 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	-	
	~~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 to BS EN 1991-1-3:2003 +A1:2015~~	~~UK National Annex to Eurocode 1: Actions on structures. General Actions. Snow loads~~	~~+A1:2015 Incorporating corrigendum No.1~~	
	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	-	
	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	-	

Eurocodes and associated UK National Annexes

Used	Reference	Title	Amendment / Corrigenda	
	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 BD100 for additional guidance.
	BS EN 1991-2:2003	Eurocode 1: Actions on structures. Traffic loads on bridges	Corrigenda December 2004 and February 2010	See BD100 Annex A for additional guidance.
	NA to BS EN 1991-2:2003	UK National Annex to Eurocode 1: Actions on structures. Traffic loads on bridges	Corrigendum No.1	See BD100 Annex A 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 structure — Part 3: Liquid retaining and containment structures	-	
	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	Eurocode 3: Design of steel structures — Part 1-4 General rules — Supplementary rules for stainless steels	-	
	NA to BS EN 1993-1-4:2006	UK National Annex to Eurocode 3: Design of steel structures — Part 1-4 Supplementary rules for stainless steels	-	

Eurocodes and associated UK National Annexes

Used	Reference	Title	Amendment / Corrigenda	
	BS EN 1993-1-5:2006+A1:2017	Eurocode 3: Design of steel structures — Part 1-5 Plated structural elements	Corrigendum April 2009, +A1:2017 Amendment No. 1	
	NA to BS EN 1993-1-5:2006	UK National Annex to Eurocode 3: Design of steel structures — Part 1-5 Plated structural elements	-	
	BS EN 1993-1-6:2007	Eurocode 3: Design of steel structures — Part 1-6 Strength and stability of shell structures	+ A1:2017 Amendment No. 1	
	BS EN 1993-1-7:2007	Eurocode 3: Design of steel structures — Part 1-7 Plated structures subject to out of plane loading	Corrigendum April 2009	
	BS EN 1993-1-8:2005	Eurocode 3: Design of steel structures — Part 1-8 Design of joints	Corrigenda December 2005, September 2006, July 2009 and August 2010	
	NA to BS EN 1993-1-8:2005	UK National Annex to Eurocode 3: Design of steel structures — Part 1-8 Design of joints	-	
	BS EN 1993-1-9:2005	Eurocode 3: Design of steel structures — Part 1-9 Fatigue	Corrigenda December 2005, September 2006 and April 2009	
	NA to BS EN 1993-1-9:2005	UK National Annex to Eurocode 3: Design of steel structures — Part 1-9 Fatigue	-	
	BS EN 1993-1-10:2005	Eurocode 3: Design of steel structures — Part 1-10 Material toughness and through thickness properties	Corrigenda December 2005, September 2006 and March 2009	
	NA to BS EN 1993-1-10:2005	UK National Annex to Eurocode 3: Design of steel structures — Part 1-10 Material toughness and through thickness properties	-	
	BS EN 1993-1-11:2006	Eurocode 3: Design of steel structures — Part 1-11 Design of structures with tension components	Corrigendum April 2009	
	NA to BS EN 1993-1-11:2006	UK National Annex to Eurocode 3: Design of steel structures — Part 1-11 Design of structures with tension components	-	
	BS EN 1993-1-12:2007	Eurocode 3: Design of steel structures — Part 1-12 Additional rules for the extension of EN 1993 up to steel grades S 700	Corrigendum April 2009	
	NA to BS EN 1993-1-12:2007	UK National Annex to Eurocode 3: Design of steel structures — Part 1-12 Additional rules for the extension of EN 1993 up to steel grades S 700	-	
	BS EN 1993-2:2006	Eurocode 3: Design of steel structures — Part 2 Steel bridges	Corrigendum July 2009	
	NA + A1:2012 to BS EN 1993-2:2006	UK National Annex to Eurocode 3: Design of steel structures — Part 2 Steel bridges	+ A1:2012	
	BS EN 1993-5:2007	Eurocode 3: Design of steel structures — Part 5 Piling	Corrigendum May 2009	
	NA + A1:2012 to BS EN 1993-5:2007	UK National Annex to Eurocode 3: Design of steel structures — Part 5 Piling	+ A1:2012	
	Eurocode 4	Design of composite steel and concrete structures		

Eurocodes and associated UK National Annexes

Used	Reference	Title	Amendment / Corrigenda	
	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 + A1:2008	UK National Annex to Eurocode 5: Design of timber structures – Part 1-1 General – common rules and rules for buildings	+ A1:2008 Incorporating National Amendment No. 2	
	BS EN 1995-2:2004	Eurocode 5: Design of timber structures – Part 2 Bridges	-	
	NA to BS EN 1995-2:2004	UK National Annex to Eurocode 5: Design of timber structures – Part 2 Bridges	-	
	Eurocode 6	Design of masonry structures		
	BS EN 1996-1-1:2005	Eurocode 6: Design of masonry structures – Part 1-1 General rules for reinforced and unreinforced masonry structures	Corrigenda February 2006 and July 2009	
	NA to BS EN 1996-1-1:2005 + A1:2012	UK National Annex to Eurocode 6: Design of masonry structures – Part 1-1 General rules for reinforced and unreinforced masonry structures	Corrigendum October 2015	
	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 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	

Eurocodes and associated UK National Annexes

Used	Reference	Title	Amendment / Corrigenda	
	BS EN 1997-2:2007	Eurocode 7: Geotechnical design – Part 2 Ground investigation and testing	Corrigendum June 2010	
	NA to BS EN 1997-2:2007	UK National Annex to Eurocode 7: Geotechnical design – Part 2 Ground investigation and testing	-	

	Eurocode 8	Design of structures for earthquake resistance		
	BS EN 1998-1:2004 + A1:2013	Eurocode 8: Design of structures for earthquake resistance – Part 1 General rules, seismic actions and rules for buildings	Corrigendum June 2009, January 2011 and March 2013	
	NA to BS EN 1998-1:2004	UK National Annex to Eurocode 8: Design of structures for earthquake resistance – Part 1 General rules, seismic actions and rules for buildings	-	
	BS EN 1998-2:2005+A2:2011	Eurocode 8: Design of structures for earthquake resistance – Part 2 Bridges	Corrigenda February 2010 and February 2012	
	NA to BS EN 1998-2:2005	UK National Annex to Eurocode 8: Design of structures for earthquake resistance – Part 2 Bridges	-	
	BS EN 1998-5:2004	Eurocode 8: Design of structures for earthquake resistance – Part 5 Foundations, retaining structures and geotechnical aspects	-	
	NA to BS EN 1998-5:2004	UK National Annex to Eurocode 8: Design of structures for earthquake resistance – Part 5 Foundations, retaining structures and geotechnical aspects	-	
	Eurocode 9	Design of aluminium structures		
	BS EN 1999-1-1:2007 + 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

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

BSI Published Documents

Used	Reference	Title	
	PD 6688-1-1:2011	Recommendations for the design of structures to BS EN 1991-1-1	See BD100 Annex B for additional guidance.
	PD 6688-1-4:2015	Background paper to the UK National Annex to BS EN 1991-1-4	See BD100 Annex B for additional guidance.
	PD 6688-1-7:2009 +A1:2014	Recommendations for the design of structures to BS EN 1991-1-7	See BD100 clause 2.17 and Annex B for additional guidance.
	PD 6688-2:2011	Recommendations for the design of structures to BS EN 1991-2	See BD100 Annex B for additional guidance.
	PD 6687-1:2010	Background paper to the UK National Annexes to BS EN 1992-1 and BS EN 1992-3	See BD100 clauses 2.15, 2.16 and Annex B for additional guidance.
	PD 6687-2:2008	Recommendations for the design of structures to BS EN 1992-2:2005	See BD100 clause 2.16 and Annex B for additional guidance.
	PD 6695-1-9:2008	Recommendations for the design of structures to BS EN 1993-1-9	See BD100 Annex B for additional guidance.
	PD 6695-1-10:2009	Recommendations for the design of structures to BS EN 1993-1-10	See BD100 Annex B for additional guidance.
	PD 6695-2:2008 + A1:2012 Incorporating Corrigendum No.1	Recommendation for the design of bridges to BS EN 1993	See BD100 Annex B 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 BD100 Annex B for additional guidance.
	PD 6694-1:2011	Recommendations for the design of structures subject to traffic loading to BS EN 1997-1	See BD100 Annex B for additional guidance.
	PD 6698:2009	Recommendations for the design of structures for earthquake resistance to BS EN 1998	See BD100 Annex A for additional guidance.
	PD 6703:2009	Structural bearings – Guidance on the use of structural bearings	
	PD 6705-2:2010 + A1:2013	Recommendations for the execution of steel bridges to BS EN 1090-2	Amended 30 April 2013
	PD 6705-3:2009	Recommendations on the execution of aluminium structures to BS EN 1090-3	
	PD 6702-1:2009	Structural use of aluminium. Recommendations for the design of aluminium structures to BS EN 1999	

Execution Standards referenced in British Standards or Eurocodes

Used	Reference	Title	
	BS EN 1090-1:2009+A1:2011	Execution of steel structures and aluminium structures - Part 1: Requirements for conformity assessment of structural components	
	BS EN 1090-2:2018	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 1090-3:2008	Execution of steel structures and aluminium structures – Part 3: Technical requirements for aluminium structures	
	BS EN 13670:2009 Incorporating corrigenda October 2015 and November 2015	Execution of concrete structures	

Product Standards referenced in British Standards or Eurocodes			
Used	Reference	Title	
	BS EN 206:2013	Concrete—Specification, performance, production and conformity	Corrigendum May 2014
	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.	<i>Draft BS EN 1317-4 for public comment published in June 2012</i>
	BS EN 1317-5:2007+A2:2012	Road Restraint Systems — Part 5 — Product requirements and evaluation of conformity for vehicle restraint systems	<i>Incorporating corrigendum August 2012 Draft prEN 1317-5 for public comment published in December 2013</i>
	PD CEN/TR 16949:2016	Road Restraint System — Pedestrian restraint system – Pedestrian parapets	<i>Bsi Published Document / CEN Technical Report published in July 2016 (This document should temporarily not be used. The requirements of BS 7818:2015 apply.)</i>
	Draft prEN 1317-7	Road restraint systems – Part 7: Performance classes, impact test acceptance criteria and test methods for terminals of safety barriers	<i>Draft prEN 1317-7 for public comment published in June 2012</i>
	PD CEN/TS 1317-8:2012	Road restraint systems – Part 8: Motorcycle road restraint systems which reduce the impact severity of motorcyclist collisions with safety barriers	<i>Bsi Published Document / CEN Technical Specification published in May 2012</i>
	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	
	BS EN 1337-5:2005	Structural bearings — Part 5: Pot bearings	
	BS EN 1337-6:2004	Structural bearings — Part 6: Rocker bearings	
	BS EN 1337-7:2004	Structural bearings — Part 7: Spherical and cylindrical PTFE bearings	
	BS EN 1337-8:2007	Structural bearings — Part 8: Guide bearings and restraint bearings	
	BS EN 1337-9:1998	Structural bearings — Part 9: Protection	
	BS EN 1337-10:2003	Structural bearings — Part 10: Inspection and maintenance	
	BS EN 1337-11:1998	Structural bearings — Part 11: Transport, Storage and Installation.	
	BS EN 1794-1:2018	Road traffic noise reducing devices — Non-acoustic performance Part 1: Mechanical performance and requirements	Supersedes previous version BS EN 1794-1:2011
	BS EN 1794-2:2011	Road traffic noise reducing devices — Non-acoustic performance Part 2: General safety and environmental requirements	

Product Standards referenced in British Standards or Eurocodes

Used	Reference	Title	
	BS EN 10025-1:2004	Hot rolled products of structural steels Part 1: General technical delivery conditions.	
	BS EN 10025-2:2004	Hot rolled products of structural steels Part 2: Technical delivery conditions for non-alloy structural steels.	
	BS EN 10025-3:2004	Hot rolled products of structural steels Part 3: Technical delivery conditions for normalized/normalized rolled weldable fine grain structural steels.	
	BS EN 10025-4:2004	Hot rolled products of structural steels Part 4: Technical delivery conditions for thermomechanical rolled weldable fine grain structural steels.	
	BS EN 10025-5:2004	Hot rolled products of structural steels — Part 5: Technical delivery conditions for structural steels with improved atmospheric corrosion resistance	
	BS EN 10025-6:2004+A1:2009	Hot rolled products of structural steels — Part 6: Technical delivery conditions for flat products of high yield strength structural steels in the quenched and tempered condition.	
	BS EN 10080:2005	Steel for the reinforcement of concrete — Weldable reinforcing steel — General	
	BS EN 10210-1:2006	Hot finished structural hollow sections of non-alloy and fine grain steels — Part 1: Technical delivery conditions	
	BS EN 10210-2:2006	Hot finished structural hollow sections of non-alloy and fine grain steels — Part 2: Tolerances, dimensions and sectional properties	<i>Incorporating corrigendum no.1</i>
	BS EN 10248-1:1996	Hot rolled sheet piling of non-alloy steels. Technical delivery conditions	
	BS EN 10248-2:1996	Hot rolled sheet piling of non-alloy steels. Tolerances on shape and dimensions	
	BS EN 12063:1999	Execution of special geotechnical work. Sheet pile walls.	
	BS EN 15050:2007 + A1:2012	Precast concrete products – Bridge elements	See BD100 clause 2.18 for additional guidance.

British Standards

Used	Reference	Title	
	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	Currently the requirements of BS 7818:2015 are to be used instead of PD GEN/TR 16949:2016
	BS 8002:2015	Code of practice for earth retaining structures	
	BS 8004:2015	Code of practice for foundations	
	BS 8006-1:2010 + A1:2016	Code of practice for strengthened/reinforced soils and other fills	

British Standards

Used	Reference	Title	
	BS 8500-1:2015 + A1:2016	Concrete—Complementary British Standard to BS EN 206 : Method of specifying and guidance for the specifier.	Incorporating Corrigendum No.1
	BS 8500-2:2015 + A1:2016	Concrete—Complementary British Standard to BS EN 206 : Specification for constituent materials and concrete.	
	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)

Used	Reference	Title	
	MCHW Volume 1: May 2017	Specification for Highway Works	<i>Specification compliant with the execution standards must be used. A Departure is necessary for the parts where a compliant revision has not been published.</i>
	MCHW Volume 2: May 2017	Notes for guidance on the Specification for Highway Works	<i>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.</i>
	MCHW Volume 3: February 2017	Highway Construction Details	

The Design Manual for Roads and Bridges (DMRB)

Used	Reference	Title	
	BD 2/12	Technical Approval of Highway Structures	
	BD 7/01	Weathering steel for highway structures	<i>See IAN 124/11 Annex C for additional guidance.</i>
	BD 10/97	Design of highway structures in areas of mining subsidence	<i>See IAN 124/11 Annex C for additional guidance.</i>
	BD 12/01	Design of corrugated steel buried structures with spans greater than 0.9 metres and up to 8.0 metres	<i>See IAN 124/11 Annex C for additional guidance.</i>
	BD 29/17	Design criteria for footbridges	
	BD 33/94	Expansion joints for use in highway bridge decks	<i>See IAN 124/11 Annex C for additional guidance.</i>
	BD 35/14	Quality assurance scheme for paints and similar protective coatings	
	BD 36/92	Evaluation of maintenance costs in comparing alternative designs for highway structures	
	BD 43/03	The impregnation of reinforced and prestressed concrete highway structures using hydrophobic pore lining impregnants	
	BD 45/93	Identification markings of highway structures	
	BD 47/99	Waterproofing and surfacing of concrete bridge decks	<i>See IAN 124/11 Annex C for additional guidance.</i>

The Design Manual for Roads and Bridges (DMRB)

Used	Reference	Title	
	BD 51/14	Portal and cantilever signs/signal gantries	
	BD 57/01	Design for durability	<i>Not to be used. See IAN 124/11 Annex C for additional guidance.</i>
	BD 62/07	As built, operational and maintenance records for highway structures	<i>See IAN 124/11 Annex C for additional guidance.</i>
	BD 65/14	Design criteria for collision protection beams	
	BD 67/96	Enclosure of bridges	<i>See IAN 124/11 Annex C for additional guidance.</i>
	BD 68/97	Crib retaining walls	Withdrawn
	BD 78/99	Design of road tunnels	<i>See IAN 124/11 Annex C for additional guidance.</i>
	BD 82/00	Design of buried rigid pipes	Withdrawn
	BD 90/05	Design of FRP bridges and highway structures	
	BD 94/17	Design of minor structures	
	BD 100/16	The use of Eurocodes for the design of highway structures	
	BA 26/94	Expansion joints for use in highway bridge decks	<i>See IAN 124/11 Annex C for additional guidance.</i>
	BA 28/92	Evaluation of maintenance costs in comparing alternative designs for highway structures	
	BA 36/90	The use of permanent formwork	<i>Not to be used. See IAN 124/11 Annex C for additional guidance.</i>
	BA 41/98	The design and appearance of bridges	
	BA 42/96	The design of integral bridges	<i>Not to be used. See IAN 124/11 Annex C for additional guidance.</i>
	BA 47/99	Waterproofing and surfacing of concrete bridge decks	<i>See IAN 124/11 Annex C for additional guidance.</i>
	BA 57/01	Design for durability	<i>Not to be used. See IAN 124/11 Annex C for additional guidance.</i>
	BA 59/94	Design of highway bridges for hydraulic action.	<i>Not to be used. See IAN 124/11 Annex C for additional guidance.</i>
	BA 67/96	Enclosure of bridges	<i>See IAN 124/11 Annex C for additional guidance.</i>
	BA 68/97	Crib retaining walls	
	BA 82/00	Formation of continuity joints in bridge decks	
	BA 85/04	Coatings for concrete highway structures & ancillary structures	
	BA 92/07	Use of recycled concrete aggregates in structural concrete	
	TD 19/06	Requirement for road restraint systems	<i>See IAN 124/11 Annex C for additional guidance.</i>
	TD 27/05	Cross-sections and headrooms	<i>See IAN 124/11 Annex C for additional guidance.</i>
	HD 22/08	Managing geotechnical risk	

The Design Manual for Roads and Bridges (DMRB)

Used	Reference	Title	
	HA 66/95	Environmental barriers	See IAN 124/11 Annex C for additional guidance. Work on update being undertaken.
	GD 01/15	Introduction to the Design Manual for Roads and Bridges	
	GD 02/16	Quality Management Systems for Highway Design	
	GD 04/12	Standard for Safety Risk Assessment on the Strategic Road Network	

Interim Advice Notes

Used	Reference	Title	
	IAN 69/15	Designing for maintenance	
	IAN 83/06	Principal and General Inspection of Sign/Signal Gantries, and Gantries with low handrails or open mesh flooring	
	IAN 96/07r1	Guidance on implementing results of research on bridge deck waterproofing.	
	IAN 97/07	Assessment and upgrading of existing parapets	
	IAN 104/15	The anchorage of reinforcement and fixings in hardened concrete.	
	IAN 105/08	Implementation of construction (design and management) 2007 and the withdrawal of SD 10 and SD 11	
	IAN 117/08r2	Certification of combined kerb and drainage products	
	IAN 124/11 Annex C	Use of Eurocodes for the design of highway structures	
	IAN 127/10r1	The use of foamed concrete	
	IAN 131/11	Deflection of Permanent Formwork	
	IAN 136/10	Structural safety reporting	
	IAN 149/17	Existing Motorway Minimum Requirements	
	IAN 161/15	Smart Motorways	
	IAN 177/13	Introduction of the Construction Products Regulation (EU) 305/2011	
	IAN 184/16	Highways Agency Data & CAD Standard	
	IAN 186/15	In-situ concrete barriers based on proprietary designs commercialised as products	
	IAN 193/16	Requirements for the provision of access arrangements on gantries	

Miscellaneous

Used	Reference	Title	
	CHE Memorandum 227/08	The Impregnation of Reinforced and Prestressed Concrete Highway Structures using Hydrophobic Pore Lining Impregnants	CHE memoranda are internal Highways England documents and not available to external organisations. This CHE memorandum is included as a useful reference for the Technical Approval Authority.
	CIRIA C543	Bridge Detailing Guide	
	CIRIA C656	Masonry arch bridges: condition, appraisal and remedial treatment	
	CIRIA C660	Early-age Thermal Crack Control in Concrete	

Miscellaneous

Used	Reference	Title	
	CIRIA C676	Drystone retaining walls and their modifications: condition appraisal and remedial treatment	
	CIRIA C686	Safe Access for Maintenance and Repair	
	CIRIA C760	Guidance on embedded retaining wall design	
	DfT UK Roads liaison group	Provision of Road Restraint systems on Local Highway Authority Roads	October 2011

APPENDIX B

DRAWINGS

APPENDIX C

ADDITIONAL INFORMATION
