
Specification for Tunnelling



Specification for Tunnelling

Fourth edition



The British Tunnelling Society

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Foreword

The *Model Specification for Tunnelling* was produced by the British Tunnelling Society in conjunction with the Ground Board of the Institution of Civil Engineers in order to establish a common standard for tunnelling and first published in 1997. It was revised in 2000, published as the *BTS Specification for Tunnelling* and has become the standard Specification referred to in the majority of tunnelling contracts in the UK and in many worldwide. The third edition was published in 2010 and formed the basis of specifications for major infrastructure projects such as Crossrail, Thames Tideway and HS2.

This fourth edition consolidates the experiences gained on these landmark projects and presents the updated guidance emerging from practical application of the third edition. Like the earlier editions it relies heavily on the experience of individual and corporate members of the BTS. There have been too many contributors to name individually here.

Similar to the third edition, there are major changes in the section on sprayed concrete which reflect its growth in use and development as a technique. The sections dealing with then new techniques, such as sprayed applied waterproofing membranes, have been critically reviewed and likewise reflect practical experience. All sections have been updated to reflect best current practice, changes in national standards and the new Eurocodes. We trust that the fourth edition of the BTS Specification will retain its position as trusted standard for tunnelling contracts in coming years.

We recognise that change will continue to occur in the tunnelling industry and that it will always be possible to improve this specification. Any suggestions for improvements and amendments to future editions should be sent to the Secretary of the British Tunnelling Society at the Institution of Civil Engineers, Great George Street, London SW1P 3AA.

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Contents

Foreword

v

01	General requirements	1
	101. General notes	3
	101.1. General	3
	101.2. Carbon management	4
	102. Definitions	6
	102.1. General	6
	103. References to Standards	7
	103.1. Standards and alternative standards	7
	103.2. Alternative materials and equipment	7
	103.3. Design with non-standardised materials	7
	104. Eurocodes and European and British Standards	8
	104.1. Eurocodes	8
	104.2. British, European and International Standards	8
	104.3. British Standards	12
	105. Other standards and documents	14
	105.1. Standards referred to in the text	14
	105.2. Documents referred to in the text	14
	106. General provisions	18
	107. Occupational health, safety and welfare	19
	107.1. General principles	19
	107.2. Statutory requirements	19
	107.3. Fundamental safety standards	19
	107.4. Employer's safety requirements	19
	107.5. Emergency drills	21
	107.6. Shift length	21
	107.7. Occupational health	21
	108. Quality Management and records	22
	108.1. Quality Management System	22
	108.2. Engineer's agreement	22
	108.3. Site records	22
	108.4. As-built records	22
	108.5. Project BIM model	23
	108.6. Ongoing asset management	23
	109. Competence	24
	109.1. General	24
	109.2. Job-related competence assessment scheme	24
	109.3. Health and safety competence	24
	109.4. Induction training	25
02	Materials	27
	201. General requirements	29
	201.1. General	29
	201.2. Samples	29
	201.3. Material use	29
	201.4. Material storage and handling	29

	201.5.	Inspection and testing	29
	201.6.	Risk reduction in material selection	29
	201.7.	Carbon reduction in material selection	29
202.	Concrete		30
	202.1.	General	30
	202.2.	Constituent materials – cement	30
	202.3.	Constituent materials – aggregates	31
	202.4.	Constituent materials – water	32
	202.5.	Constituent materials – admixtures	32
	202.6.	Constituent materials – fibres	32
	202.7.	Constituent materials – additions	32
	202.8.	Concrete mixes	33
	202.9.	Ready-mixed concrete	33
	202.10.	Concrete batching	34
	202.11.	Quality control	34
203.	Reinforcement		36
	203.1.	Steel bar reinforcement	36
	203.2.	Welded wire fabric	36
	203.3.	Fibre reinforcement	36
	203.4.	Non-metallic reinforcement	37
204.	Precast concrete linings		38
	204.1.	General	38
	204.2.	Manufacture of segments	38
	204.3.	Moulds	39
	204.4.	Tolerances for the manufacture of bolted segments	39
	204.5.	Tolerances for the manufacture of expanded segments	44
	204.6.	Opening sets	44
	204.7.	Marking of segments	44
	204.8.	Identification and traceability of segments	45
	204.9.	Quality management system for segment production and delivery	45
	204.10.	Joint packing	45
	204.11.	Gasket grooves	45
	204.12.	Concrete cover	46
	204.13.	Grout ports	46
	204.14.	Curing	46
	204.15.	Handling, stacking and transport	46
	204.16.	Segments reinforced with fibres	46
205.	Spheroidal graphite cast iron (SGI) linings		47
	205.1.	General	47
	205.2.	Testing	48
	205.3.	Production testing	48
	205.4.	Marking segments	50
	205.5.	Machining and drilling	50
	205.6.	Dimensions and tolerances	50
	205.7.	Segment weights	52

	205.8.	Grout holes	53
	205.9.	Grout plugs	53
	205.10.	Casting details	53
	205.11.	Corrosion protection	53
	205.12.	Damaged segments	54
	205.13.	Ring removal	54
206.		Structural steelwork and steel linings	55
	206.1.	General	55
	206.2.	Fatigue and dynamic loading	55
	206.3.	Connection design	55
	206.4.	Materials	55
	206.5.	Fabrication	55
	206.6.	Protective treatment	56
	206.7.	Steelwork erection	56
	206.8.	Bolt assemblies	57
	206.9.	Fabricated steel segments	57
	206.10.	Cold-formed pressed steel segments	57
207.		Jacking pipes	59
	207.1.	General	59
208.		Support arches and lattice girders	60
	208.1.	General	60
	208.2.	Arches/ribs	60
	208.3.	Lattice girders	61
209.		Spiles, dowels, rockbolts and forepoling boards	63
	209.1.	Spiles and canopy tubes	63
	209.2.	Rock dowels	63
	209.3.	Rockbolts	64
	209.4.	Rock anchors	64
	209.5.	Forepoling and lagging boards	65
210.		Sprayed concrete constituent materials	67
	210.1.	General	67
	210.2.	Cement	67
	210.3.	Pulverised fuel ash (PFA) and ground granulated blast furnace slag (GGBS)	67
	210.4.	Silica fume	67
	210.5.	Other binders and fillers	68
	210.6.	Aggregates	68
	210.7.	Water	68
	210.8.	Admixtures	68
	210.9.	Consistency	69
	210.10.	Strength and quality	70
	210.11.	Fibres	70
	210.12.	Regulating layer	71
211.		Sheet waterproofing membranes	72
	211.1.	Sheet waterproofing membrane systems	72
	211.2.	Materials – drainage and protection layer	72

	211.3.	Materials – fixing elements for sheet waterproofing membrane	74
	211.4.	Materials – sheet waterproofing membrane	74
	211.5.	Additional items – sheet waterproofing systems	75
	211.6.	Requirements for the waterproofing system substrate	75
212.		Sprayed-applied waterproofing membrane	76
	212.1.	General	76
	212.2.	Materials	76
	212.3.	Materials – health and safety during application	76
	212.4.	Selection of spray-applied membrane systems – from track record or appropriate trials	77
	212.5.	Quality Assurance and requirements during trials	78
	212.6.	Quality Assurance construction testing	80
213.		Gaskets	82
	213.1.	Compression gaskets – general	82
	213.2.	Compression gaskets – testing	83
	213.3.	Hydrophilic gaskets	84
	213.4.	Composite gaskets	85
	213.5.	Gaskets for pipe jack joints	85
214.		Cementitious grout	86
	214.1.	General	86
	214.2.	Special grouts	87
	214.3.	Mixing	89
	214.4.	Storage and delivery	89
215.		Packings	90
	215.1.	Packings for segmental linings	90
	215.2.	Packings for opening frames	90
	215.3.	Packings for jacking pipes	90
	215.4.	Packings for timber headings	90
	215.5.	Fixing for packers	90
216.		Grommets, bolts, dowels	91
	216.1.	Grommets	91
	216.2.	Bolts	91
	216.3.	Dowels	91
217.		Caulking and pointing	93
	217.1.	Caulking	93
	217.2.	Pointing	93
218.		Timber	94
	218.1.	General	94
219.		Grout for compensation grouting	95
	219.1.	General	95
	219.2.	Fluid cementitious grouts	95
	219.3.	Cementitious mortar pastes	95

	220. Maintenance – grouting to control seepage in existing tunnels	96
	220.1. General	96
	220.2. Cementitious grouts	96
	220.3. Mortar	96
	221. Reinjectable grout tubes and grouting	97
	221.1. General	97
	221.2. Reinjectable grouts	97
03	Methods	99
	301. Excavation for tunnels	101
	301.1. General	101
	301.2. Rock	103
	301.3. Soft ground	103
	302. Drilling	104
	302.1. General	104
	302.2. Blast hole drilling	104
	302.3. Probe hole drilling	104
	303. Temporary works	105
	303.1. General	105
	303.2. Design of temporary works	105
	303.3. Supervision	105
	304. Spiling, dowelling and rockbolting	107
	304.1. Spiling	107
	304.2. Rock dowelling	107
	304.3. Rockbolting	108
	304.4. Load testing	109
	304.5. Records	109
	305. Sprayed concrete	111
	305.1. General	111
	305.2. Proficiency	112
	305.3. Batching and mixing	113
	305.4. Application	113
	305.5. Curing	117
	305.6. Defects and repairs	117
	305.7. Reinforcement	117
	305.8. Tests for trial mixes	118
	305.9. Test panels and acceptance tests	118
	305.10. Production tests	120
	305.11. Acceptance	123
	305.12. Delivery, storage and handling	124
	306. Ground support with arches, ribs and lattice girders	125
	306.1. Steel arches/ribs and lattice girders	125
	307. Forepoling	126
	307.1. General	126

308.	Explosives	127
308.1.	General	127
308.2.	Blasting vibrations and air-overpressure	129
309.	Groundwater	130
309.1.	General	130
309.2.	Contamination	131
310.	Probing ahead	132
310.1.	General	132
311.	Break-outs from shafts and tunnels	133
311.1.	General	133
312.	Installation of sheet waterproofing membranes	134
312.1.	Surface preparation	134
312.2.	Geotextile fleece layer	134
312.3.	Waterproofing membrane	135
312.4.	Construction joints: geotextile fleece	136
312.5.	Construction joints: sheet waterproofing membrane	136
312.6.	Quality Assurance and control – field trials	136
312.7.	Quality Assurance and control – construction testing	137
312.8.	Defective membrane	138
312.9.	Secondary lining concrete works	138
313.	Installation of sprayed-applied waterproofing membrane	139
313.1.	Substrate preparation	139
313.2.	Application	140
313.3.	Equipment	140
313.4.	Construction joints	140
313.5.	Defective membrane	140
313.6.	Secondary lining construction	140
313.7.	Storage	141
314.	Tunnel boring machines (TBMs) and shields	142
314.1.	General	142
314.2.	Machine characteristics	143
314.3.	Guidance	145
314.4.	Fire protection	146
314.5.	Contractor's submission	147
314.6.	Quality inspection and testing	148
314.7.	Personnel and training	149
314.8.	Design	149
315.	Slurry and earth pressure balance machines	151
315.1.	General	151
315.2.	Machine characteristics	151
315.3.	Annular grouting	152
315.4.	Spoil removal	152
315.5.	Instrumentation	152

316.	Open-faced tunnel boring machines	154
316.1.	General	154
316.2.	Unshielded tunnelling machines	154
316.3.	Shielded tunnelling machines	154
317.	Hand shields and mechanised open shields	155
317.1.	General	155
317.2.	Cutter boom machines	155
317.3.	Backhoe machines	155
318.	Tunnelling machines and shield operation	156
318.1.	General	156
318.2.	Excavation	156
319.	Pipe jacking	157
319.1.	General	157
319.2.	Thrust and reception pits	157
319.3.	Operation	157
319.4.	Packing and sealing	158
319.5.	Monitoring and instrumentation	158
319.6.	Tolerances	159
319.7.	Microtunnelling	159
320.	Jacked box tunnelling	160
320.1.	General	160
320.2.	Design principles	160
320.3.	Site investigation	161
320.4.	Tunnelling shield	161
320.5.	Jacking system	161
320.6.	Anti-drag systems	161
320.7.	Prediction of ground movements	162
320.8.	Design	162
320.9.	Construction	162
320.10.	Tunnelling operations	163
321.	Construction of segmental tunnel lining	164
321.1.	General	164
321.2.	Erection of bolted/dowelled lining	164
321.3.	Tapered segmental lining	165
321.4.	Grouting of bolted/dowelled lining	165
321.5.	Erection of expanded lining	165
321.6.	Packing	165
321.7.	Defective work	166
322.	Segment gaskets	167
322.1.	General	167
323.	Grouting	168
323.1.	Cavity grouting of segmental lining	168
323.2.	Primary grouting	168
323.3.	Secondary grouting	169
323.4.	Cavity grouting of in situ lining	169
324.	Pointing and caulking	171
324.1.	Pointing	171
324.2.	Caulking	171

	324.3.	Lead caulking	171
	324.4.	Cementitious cord caulking	171
325.		In situ concrete linings other than sprayed concrete	172
	325.1.	General	172
	325.2.	Temperature monitoring of concrete	172
	325.3.	Transport of concrete	173
	325.4.	Concrete placing equipment	173
	325.5.	Placing concrete	173
	325.6.	Compaction	174
	325.7.	Curing and protection	174
	325.8.	Construction joints	175
	325.9.	Defective work	175
	325.10.	Formwork	175
	325.11.	Concrete finishes	176
	325.12.	Fixing bar and mesh reinforcement	178
	325.13.	Inspection of completed structure	179
326.		Shafts	180
	326.1.	General	180
	326.2.	Safety	180
	326.3.	Temporary shafts	180
	326.4.	Construction	180
327.		Timber headings	182
	327.1.	General	182
328.		Tolerances for tunnels, shafts and underground works	183
	328.1.	All tunnels and shafts	183
	328.2.	Segmental lined tunnels and shafts	183
	328.3.	Sprayed concrete lined tunnels and shafts	184
329.		Control process of underground works	185
	329.1.	General	185
	329.2.	Tunnel Management Plan	186
	329.3.	Monitoring of tunnel excavation	187
	329.4.	Ground movement monitoring	188
	329.5.	Tunnel and shaft linings	189
	329.6.	Daily Review Meeting (DRM)	189
	329.7.	Assurance through monitoring	190
	329.8.	RESS/PTS – Required Excavation and Support Sheet or Permit to Tunnel Sheet	192
	329.9.	Contingency measures and emergency procedures	192
330.		Survey and setting out	194
	330.1.	Datum for the Works	194
	330.2.	Survey benchmarks	194
04		Ground stabilisation processes	195
	401.	Compressed air working	197
	401.1.	General	197

	401.2.	Submission of information	197
	401.3.	Initial pressurisation	197
	401.4.	Minimisation of leakage	197
	401.5.	Changes in working conditions	197
	401.6.	Submission of daily records	198
	401.7.	Exposure records	198
	401.8.	Depressurisation of working chamber	198
	401.9.	Settlement	198
	401.10.	Emergency procedures	198
	401.11.	Storage of materials	198
	401.12.	Burning and welding	199
402.		Grouting for ground stabilisation and groundwater control	200
	402.1.	General	200
	402.2.	Contractor's proposals	200
	402.3.	Drilling	201
	402.4.	Plant	201
	402.5.	Disposal of waste	201
	402.6.	Records	201
403.		Ground freezing	203
	403.1.	General	203
	403.2.	Process	203
	403.3.	Methods	203
	403.4.	Precautions	204
	403.5.	Method statement	204
	403.6.	Freeze pipes	204
	403.7.	Plant	204
	403.8.	Monitoring and records	205
404.		Dewatering	206
	404.1.	General	206
	404.2.	Contractor's proposals	206
	404.3.	Drilling and jetting	207
	404.4.	Plant	207
	404.5.	Operations	207
	404.6.	Monitoring and records	207
405.		Compensation grouting	208
	405.1.	General	208
	405.2.	Execution	208
	405.3.	Monitoring	208
	405.4.	Assessment	208
05		Working environment	209
	501.	Temporary electrical installations	211
		501.1. General	211
	502.	Ventilation during construction	212
		502.1. General	212
		502.2. Ventilation systems	212
		502.3. Monitoring	213

	502.4.	Start-up ventilation	213
	502.5.	Checking and inspection	214
	502.6.	Ventilation failure	214
	502.7.	Ventilation after breakthrough	214
503.		Lighting	215
	503.1.	General	215
504.		Noise and vibration	216
	504.1.	General	216
	504.2.	Temporary fencings and barriers	216
	504.3.	Plant and equipment	217
	504.4.	Transport restrictions	217
	504.5.	Noise and vibration monitoring	217
	504.6.	Noise and vibration levels	217
505.		Access and egress	219
	505.1.	General	219
	505.2.	Designated access routes	219
	505.3.	Maintenance of routes	219
	505.4.	Access for others	219
	505.5.	Traffic safety and management	220
	505.6.	Signing and signalling	220
	505.7.	Temporary lighting	221
	505.8.	Survey and reinstatement	221
	505.9.	Access within Works	221
506.		Atmospheric testing	223
	506.1.	General	223
	506.2.	Temperature	223
507.		Disposal of spoil and water	224
	507.1.	Spoil waste programme	224
	507.2.	Disposal of solid waste spoil	224
	507.3.	Monitoring spoil removal	224
	507.4.	Liquid waste disposal	224
508.		Leakage	225
	508.1.	General	225
	508.2.	Leakage criteria and classes of tunnel	226
	508.3.	Leakage tests	227
		Index	229

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1. General requirements

101. General notes

101.1. General

1. This Specification is a model document intended to serve as a basis for materials and workmanship quality requirements for all tunnel projects, including adits and shafts, in conjunction with the specification component of the Institution of Civil Engineers Specification for Piling and Embedded Retaining Walls, and the scope can be extended to include cut-and-cover tunnels and similar underground structures.
2. This Specification is written in modular form. It is intended that the whole document be incorporated into documents by reference, and additional, substituted or deleted clauses particular to the Project be included in a Particular Specification. References are made to the Particular Specification at various points in the text for the user to insert project-specific requirements. Where the Particular Specification is in conflict with the general text of the Specification, the Particular Specification shall take precedence.
3. The Specification indicates minimum standards of materials and workmanship, and is written so that the parties to the Contract are as free as possible to agree on methods of carrying out the work.
4. Any clauses relating to work or materials not required in the project are deemed not to apply.
5. Whenever possible, reference has been made to other industry standards and accepted quasi-standards. Except in this chapter and where specific to the text, references to Acts of Parliament and Statutory Instruments have not been made, as compliance with legislation is a statutory requirement.
6. This Specification reflects tunnelling practice as undertaken by UK clients, contractors and designers, but has been written to allow it to be used also in an international context with the minimum of modification.
7. This Specification has been written so that it may be used with a range of procurement methods and Conditions of Contract. The title 'Engineer' has been used throughout this Specification as the accountable party who is empowered to make decisions on design and technical matters and variations, but this title will vary between procurement methods and Conditions of Contract. The Contract Documents or Particular Specification should set out the roles and responsibilities for the particular project.
8. The title 'Designer' has been used where it is essential that supervision or specific input is provided that fully understands the design basis. The 'Designer' may be employed by the Employer or the Contractor depending on the particular project and procurement method.

9. Assessment of payment and sharing of financial risk have been specifically excluded from this Specification, this being deemed to be the province of other Contract Documents.
10. This Specification is written to be used in conjunction with other Specifications where several disciplines are involved in the works. The Particular Specification should establish the order of precedence where more than one Specification is referenced.
11. This Specification has been written on the basis that details of the Contractor's methods and temporary works will be submitted to the Engineer for agreement. The Particular Specification should clarify the requirements for the Engineer's agreement to methods and temporary works for the particular project, including timescales for review. Where the Engineer's agreement to methods and temporary works is not required, this shall be stated in the Particular Specification.
12. The planning and implementation of the works shall comply with the current version of the International Tunnel Insurance Group *A Code of Practice for Risk Management of Tunnel Works* 2006 (being revised).
13. The Contractor shall be the *user* in terms of BS EN 16191 and shall be responsible for providing all information on *intended use* required by that standard.
14. In this specification 'Employer' means the entity commissioning and paying for the tunnel works.

101.2. Carbon management

1. The Designer and the Contractor shall manage and minimise whole life carbon across the delivery of the Contract, in line with the principles of the BSI Publicly Available Specification (PAS) 2080 *Carbon Management in Infrastructure*.

Note: Due to the rapid development cycle of carbon management it is recommended to review the requirements of Clause 101.2 and associated clauses and confirm their applicability in the Particular Specification.

2. The PAS 2080 carbon management hierarchy shall be applied for the management process as per Clause 101.2.1 to identify whole life carbon solutions for the asset and its components. In applying the carbon reduction hierarchy, all value chain members shall demonstrate they have considered the following
 - (a) avoid: ensure the outcomes of the project/programme of work are aligned with the net zero transition and evaluate the basic need of an asset/network
 - (b) switch: assess alternative solutions/options to reduce whole life emissions through alternative materials, technologies for operational carbon reduction, among

others, while satisfying the whole life performance requirements

- (c) improve: identify solutions and techniques that improve the use of resources and design life of an asset/network, including applying circular economy principles to assess materials/products in terms of reuse and recycling potential after end of life as well as flexibility in being repurposed.
3. The Designer and Contractor shall identify carbon reduction opportunities at the earliest stage of the project or programme of work to enable the greatest carbon savings to be achieved. The baseline against which savings are measured shall be agreed in the Contract.
 4. The definition of the goal and scope of greenhouse gas (GHG) quantification shall capture the elements listed in PAS 2080 Section 7.1.1 and shall be agreed with the Engineer.
 5. Carbon management shall be captured in the Quality Management System as per Clause 108 of this specification.
 6. For the use of non-standardised materials please refer to Clause 103.3 of this specification.

102. Definitions

102.1. General

1. Where definitions are not provided within the specification, they shall generally be those contained in BS 6100.
2. Definitions of tunnelling terms are contained in BS 6100-3: Section 6 (2007).
3. For terms not defined in BS 6100, reference shall be made to the ITA 'Glossary of tunnelling terminology' (<https://tunnel.ita-aites.org/en/component/seoglossary/1-main-glossary>).
4. 'Mechanised tunnelling' refers to tunnels excavated by some form of tunnel boring machine.
5. 'Conventional tunnelling' refers to tunnels excavated by means other than tunnel boring machine – for example, drill and blast in rock.
6. 'Permanent works' are works, the purpose of which extends beyond completion of construction and/or are left in place beyond the completion of construction.
7. 'Temporary works' are works, the purpose of which does not extend beyond completion of construction.
8. 'Carbon' is the short-hand colloquial term used for GHGs, typically the six covered by the Kyoto Protocol – carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF₆).

103. References to Standards

103.1. Standards and alternative standards

Materials, equipment and methods shall comply with the Standards and Codes of Practice indicated in the text. Where references in this specification are dated, the dated version of that document shall be used. Where references are undated, then the versions current at the date for submission of tenders shall be used.

For BS EN 16191 and BS EN 12110, the version used shall be that current when the declaration of conformity is made by the manufacturer.

The Contractor may propose the adoption of alternative standards and shall provide explanations with any proposals. The use of such standards shall be subject to the agreement of the Engineer.

103.2. Alternative materials and equipment

The Contractor may propose alternative materials or equipment to those specified provided either

- (a) they are of at least equal quality and performance or
- (b) they are of like quality and performance and comply with approved alternative standards.

If alternative materials or equipment are proposed, the Contractor shall submit comprehensive details including technical descriptions, drawings and specifications to demonstrate that the alternative complies with either requirement of this Clause. The adoption of such alternative materials or equipment shall be subject to the agreement of the Engineer.

103.3. Design with non-standardised materials

Where proposed alternative materials are not standardised, or are used within the context of a design standard not specifically developed for use with these alternative materials, the design shall be undertaken as 'Design assisted by testing' to BS EN 1990:2002 +A1:2005 Annex D.

104. Eurocodes and European and British Standards

104.1. Eurocodes

The following design standards (Eurocodes) are relevant and are referred to in the text

BS EN 1990	Basis of structural design (Eurocode 0)
BS EN 1991	Actions on structures (Eurocode 1)
BS EN 1992	Design of concrete structures (Eurocode 2)
BS EN 1993	Design of steel structures (Eurocode 3)
BS EN 1995	Design of timber structures (Eurocode 5)
BS EN 1997	Geotechnical design (Eurocode 7)
BS EN 1998	Design of structures for earthquake resistance (Eurocode 8)

104.2. British, European and International Standards

The British designated version of the following European standards dual (BS EN) or dual triple numbered European and International standards (BS EN ISO) and their UK National Annexes are relevant and are referred to in the text

BS EN ISO 62	Plastics. Determination of water absorption
BS EN 196-1	Methods of testing cement. Determination of strength
BS EN 196-2	Methods of testing cement. Chemical analysis of cement
BS EN 197-1	Cement. Composition, specifications and conformity criteria for common cements
BS EN 206	Concrete. Specification, performance, production and conformity
BS EN 295-7	Vitrified clay pipe systems for drains and sewers – Requirements for pipes and joints for pipe jacking
BS EN 335	Durability of wood and wood-based products. Use classes: definitions, application to solid wood and wood-based products
BS EN 338	Structural timber. Strength classes
BS EN 450-1	Fly ash for concrete. Definition, specifications and conformity criteria
BS EN 471	High-visibility clothing
BS EN 480	Admixtures for concrete, mortar and grout. Test methods
BS EN ISO 527-3	Plastics. Determination of tensile properties. Test conditions for films and sheets
BS EN 681-1	Elastomeric seals. Material requirements for pipe joint seals used in water and drainage applications – Vulcanized rubber
BS EN 681-2	Elastomeric seals. Material requirements for pipe joint seals used in water and drainage applications. Thermoplastic elastomers