SERIES 2500
SPECIAL STRUCTURES

Contents

SPECIAL STRUCTURES

2501 Corrugated Steel Buried Structures

General

1 Corrugated steel buried structures of clear span or internal diameter exceeding 900 mm shall comply with this Clause.

2 The Contractor shall design the corrugated steel buried structures listed in Appendix 1/10 in accordance with Standard BD 12, the design requirements given in Appendix 25/1 and the procedures given in Standard BD 2.

Earthworks

3 Earthworks shall comply with the 600 Series.

Steel Components

4 All helically wound systems and all bolted segmental systems to be incorporated in the Works shall have a current Type Approval Certificate. All the individual components and materials making up the system shall comply with the properties listed in the current Type Approval Certificate.

5 Helically wound systems shall additionally have a current British Board of Agrément Roads and Bridges Certificate.

6 The lockseams of helically wound systems shall be able to withstand tensile forces across the seam, according to steel sheet thickness, as tabulated below:

Nominal Sheet Thickness (mm)	Minimum Tensile Force across Seam (kN/m)
1.00	36
1.30	51
1.60	65
2.00	88
2.80	136
3.50	182
4.20	234

For intermediate sheet thicknesses, the minimum tensile force required may be determined by linear interpolation.

7 After forming, the depth of the corrugations shall be within a tolerance of ± 6% and the pitch of the corrugations within a tolerance of ± 4% of the nominal dimensions. Plates shall have a minimum lip of 45 mm beyond each end crest. Cut edges shall be free from notches, gouges, rust or burrs.

8 When all the plates of a bolted segmental structure have been assembled, the nuts shall be tightened by applying a torque within the range stated on the Type Approval Certificate. The tightening shall be repeated if necessary to achieve the required torque.

Bolts, nuts and washers (if provided) shall be of such a design that no damage is caused to metal coatings when the nuts are tightened as described above.

Hot Dip Galvanizing of Steel Components

9 All surfaces of steel components shall be hot dip galvanized in compliance with the standards listed in the appropriate Type Approval Certificate and British Board of Agrément Roads and Bridges Certificate. Plates for bolted segmental structures shall be galvanized after forming the corrugations and completing all necessary cutting, punching and drilling. Units in which the galvanized coating has been burned by welding or otherwise damaged in fabrication, transport, cutting or handling at site shall be made good in compliance with Clauses 1905 and 1906.

10 Bolts and nuts shall be hot dip galvanized in compliance with the standards listed in the appropriate Type Approval Certificate and British Board of Agrément Roads and Bridges Certificate.

Concrete Foundations of Arch Profile Structures

11 Concrete foundations shall be constructed as described in Appendix 25/1 with concrete complying with the 1700 Series.

Concrete Invert Pavings

12 Where described in Appendix 25/1, concrete invert pavings shall be constructed in compliance with that Appendix using Class 30/20 concrete complying with the 1700 Series.

13 Concrete invert pavings shall be reinforced with a steel fabric complying with the 1700 Series having mesh dimensions not greater than 150 mm x 300 mm

and a nominal wire size not less than 5 mm. All laps in the mesh shall be at least 150 mm. The steel fabric shall be securely fixed to the structure by means of fixings at the bolt positions. It shall extend to within a distance not greater than 100 mm, nor less than 40 mm inside the edges of the concrete on each side. A nominal cover of 45 mm shall be provided to all other faces, including that to the crest of the corrugations in the structural steel.

14 Concrete invert pavings shall be cast in lengths not exceeding 10 metres with the provision of a water bar between adjacent panels and the joints sealed with a joint sealant to Clause 2303..

15 At each end of the structure the concrete invert paving shall be either:

(i) terminated with a toe that returns at least 200 mm under the structural steel forming the structure. The steel fabric shall be folded under the lips of the structure to suit. The toe shall be detailed with a thickness of not less than that required for the paving, in Standard BD 12;

(ii) detailed to suit any headwall arrangement eg paving reinforcement lapped with headwall reinforcement.

16 All foreign matter, (but not any secondary proprietary protective coating unless indicated otherwise in the Type Approval Certificate or British Board of Agrément Roads and Bridges Certificate referred to in sub-Clauses 4 and 5 of this Clause) and free standing water shall be removed from the steel surfaces to be paved, before commencing work.

Proprietary Invert Pavings

17 Any proposed proprietary invert paving system shall have a current British Board of Agrément Roads and Bridges Certificate.

Proprietary Secondary Protective Coatings Applied Above Hot Dip Galvanized Coating

18 Any proposed proprietary protective coating system shall have a current British Board of Agrément Roads and Bridges Certificate.

Additional Protective Coatings

19 Where described in Appendix 25/1, exposed galvanized steel surfaces shall be prepared and protected after erection in compliance with that Appendix. The additional protective coating may be factory or site applied and shall have a service life of at least six years in aggressive conditions.

2502 Reinforced Soil and Anchored Earth Structures

General

1 Reinforced soil or anchored earth structures shall comply with this Clause.

The Contractor shall design the reinforced soil or anchored earth structures listed in Appendix 1/10 in accordance with Standard BD 70 and the design requirements and procedures described in Appendix 25/2.

Earthworks

2 Earthworks for reinforced soil and anchored earth structures shall comply with the 600 Series.

Reinforcing Elements for Reinforced Soil and Anchor Elements for Anchored Earth

3 Carbon steel strip to be hot dip galvanized shall comply with BS EN 10025 either grade S235 JR or S355 JR or BS 1449 : Part 1, either quality KHR 34/20P or quality KHR 50/35P, each having a silicon content of not less than 0.25% and not more than 0.40%. The fabricated element shall be hot dip galvanized in compliance with Clause 1911 except that the average zinc coating weight for any individual test area shall be not less than 1000 g/m^2.

4 Stainless steel strip shall comply with:

(i) BS 1449 : Part 2 quality 316 S 31 or 316 S 33 except that the material shall be cold rolled to provide a 0.2% proof stress of not less than 400 N/mm^2 and the tensile strength shall be not less than 540 N/mm^2, or

(ii) BS 1449: Part 2 quality 316 S 31 CR temper rolled to a minimum 0.2% proof stress of 310 N/mm^2.

5 Proprietary reinforcing elements and systems using such elements shall have a current British Board of Agrément Roads and Bridges Certificate.

6 Anchor elements for anchored earth shall be made of cold worked steel reinforcing bar Type 2, Grade 460 complying with BS 4449 except that no bar shall contain a flash weld. Welding of steel reinforcement bars to form anchors shall comply with Clause 1717. The fabricated elements shall be hot dip galvanized in compliance with Clause 1911 except that the average zinc coating weight for any individual test area shall be not less than 1000 g/m^2.

7 Reinforcing and anchor elements shall be prefabricated and delivered to Site ready for installation into the Works. The elements shall be:

(i) Loaded, unloaded and handled in such a manner that:

(a) no permanent set or other structural damage is caused;

(b) the protective coating is not damaged.

(ii) Stored flat and clearly marked to identify items having different lengths and cross-sectional dimensions.

Fasteners

8 Bolts, screws and nuts complying with ISO 898, property classes A and B, shall comply with ISO 4014, 4017 and 4032, and shall be made from one of the following:

(i) Steel property class 8.8, complying with ISO 898 and hot dip galvanized in compliance with the 1900 Series.

(ii) Stainless steel quality 316 S 31 or 316 S 33 complying with BS 970 : Part 1 except that the 0.2% proof stress of the bolt shall be not less than 450 N/mm² and the tensile strength shall be not less than 700 N/mm².

9 Bolts, screws and nuts shall comply with one of the following:

(i) ISO 898, 4016, 4018 and 4034, hot dip galvanized in compliance with Clause 1911. The property class of the bolts and screws shall be not less than 4.6, while the property class of the nuts shall not be less than 4.0

(ii) stainless steel to BS 6105 grade A4-70.

10 Plain washers shall be of either Form A or Form E complying with BS 4320 and shall be made from one of the following:

(i) Cold rolled carbon steel strip CS4 complying with BS 1449 : Part 1 hot dip galvanized in compliance with Clause 1911.

(ii) Stainless steel strip quality 316 S 31 or 316 S 33 complying with BS 1449 : Part 2.

11 Dowels and rods shall be made from one of the following:

(i) Steel bar complying with BS 4449 grade 250, hot dip galvanized in compliance with Clause 1911.

(ii) Steel of grade S 355 JR complying with BS EN 10·025 hot dip galvanized in compliance with Clause 1911.

(iii) Stainless steel quality 316 S 31 or 316 S 33 complying with BS 970 : Part 1 except that the 0.2% proof stress shall be not less than 450 N/mm² and the tensile strength shall be not less than 700 N/mm².

Prefabricated and Precast Facing and Capping Units

12 Carbon steel strip or sheet to be hot dip galvanized shall comply with BS 1449 : Part 1, either quality KHR 34/20P or quality KHR 50/35P each having a silicon content of not less than 0.25% and not more than 0.40%. Following fabrication, the units shall be hot dip galvanized in compliance with Clause 1911 except that the average zinc coating weight for any individual test area shall be not less than 1000 g/m².

13 Stainless steel strip or sheet shall comply with BS 1449 : Part 2, quality 316 S 31 or 316 S 33.

14 Reinforced concrete shall comply with the 1700 Series.

15 Proprietary facing units and systems using such units shall have a current British Board of Agrément Roads and Bridges Certificate.

Metal Components - Material Compatibility

16 All metallic components buried in the soil, ie reinforcing elements, connections, facing lugs and facing units, shall be of electrolytically compatible material. Where this is not possible, effective insulation shall be provided between different materials.

2503 Reinforced Clay Brickwork Retaining Walls of Pocket-type and Grouted-Cavity Construction

Materials

1 Cement, aggregates, water and mortars for reinforced brickwork retaining wall structures shall comply with the relevant Clauses of the 2400 Series, except where different requirements are given in this Clause.

Masonry cement or high alumina cement shall not be used.

2 Only clay bricks to BS 3921 shall be used. When tested in accordance with BS 3921, clay bricks shall have:

(a) water absorption not greater than 7% by mass;

(b) an initial rate of suction not exceeding 1.5 kg/m²/min;

(c) a frost resistance designation of F, and low (L) salt content.

When requested, the Contractor shall provide results of the above tests. Only random sampling as described in BS 3921 shall be employed in selecting test samples.

Selection of bricks shall follow the recommendations contained in BS 5628 : Part 3 in respect of durability and other considerations. Second hand masonry units shall not be used.

3 Unless otherwise described in Appendix 25/3, concrete shall be a designed mix and shall be either ordinary structural concrete or special structural concrete. It shall comply with the requirements of the 1700 Series.

4 Reinforcement shall comply with Clauses of the 1700 and 2400 Series, except that all stainless steel shall be grade 316. Bed-joint reinforcement shall not exceed 6 mm diameter.

No bi-metallic contact is permitted.

5 Wall ties shall be as described in Appendix 25/3. Dove-tail wall ties shall not be used.

6 Damp proof courses shall be as described in Appendix 25/3.

Storage of Materials

7 The handling, storage and mixture of materials shall follow the recommendations of BS 5628 : Part 3.

8 Bricks shall be unloaded with due care to minimize damage, placed on site in different stacks according to strength and type and be marked clearly. They shall be stacked on prepared level areas avoiding ground contamination and be protected from rain or snow.

9 Cement, lime and lime/sand mix shall be stored off the ground in dry areas and used in the sequence of delivery. Different types of cements shall be stored separately and clearly identified. Lime and lime/sand mix shall be protected from drying out.

10 Reinforcement shall be stored on site in a safe manner and be free from loose rust, scale, dirt, paint, oil, grease or any other harmful material, prior to fixing.

Laying of Bricks

11 Brickwork shall be laid in accordance with Clause 2412. Jointing is preferable to pointing and shall be used unless there is a specific need for pointing. Joints shall be tooled as the work progresses to either a flush or bucket handle profile. Bricks shall not be used within 14 days of firing.

12 The maximum height of brickwork to be built in a day shall be limited to 1.0 m and 12 hours shall elapse before recommencing bricklaying.

13 Cutting of bricks shall be kept to a minimum. When cutting is necessary, cutting discs shall be used.

14 Where sleeves, chases or holes are required, they shall be provided during the erection of brickwork.

Mixing of Mortar

15 Mortar shall be mixed mechanically until its colour and consistency are uniform. The constituent material shall be accurately measured.

16 Where ready mixed mortars are specified, their use shall be in accordance with the manufacturer's instructions and Appendix A of BS 4721 : 1981 (AMD 5041, 1986).

17 Mortar shall be made in small quantities only as and when required. Mortar which has begun to set or which has been mixed for a period of more than one hour shall be discarded.

18 When additives or admixtures are specified in Appendix 25/3, their use shall strictly follow the manufacturer's instructions and shall be demonstrated in the trial panel.

19 Mortars shall be tested in accordance with Appendix A of BS 5628 : Part 1 : 1992.

Concrete - General

20 Batching and mixing of concrete shall comply with Clause 1706.

21 Concrete compliance shall be in accordance with Clauses 1701 and 1707.

22 Transporting, placing, compacting and finishing of concrete shall be in accordance with Clauses 1708 and 1710. The rate of placing of concrete with respect to the rate of brickwork construction shall be as required by Appendix 25/3. The placing and compaction of concrete shall not disrupt either the masonry or the reinforcement.

Cold Weather Working

23 Cold weather working shall be in accordance with Clauses 1709 and 2414.

Hot Weather Working

24 During hot weather, the Contractor shall ensure that the constituent materials of mortar and concrete are sufficiently cool to prevent stiffening before placement in their final position. Cement shall not be allowed to come into contact with water at a temperature greater than 60°C.

Protection of New Work

25 Protection of newly laid brickwork shall be in accordance with Clause 2415.

26 In addition, during freezing conditions, brickwork shall be covered with an insulating layer followed by a waterproofing material. Covers shall be held clear of the brickwork and be well secured.

27 Side protection shall be provided in exposed site conditions.

Weatherproofing, Backfill and Drainage

28 The retaining face of the wall shall be flush-jointed and tooled and shall be subsequently painted with a waterproofing material in accordance with Clauses 2001, 2004 and 2006.

29 Backfilling shall be in accordance with Clause 610. Before commencing backfilling, a period of 14 days or longer if required by Appendix 25/3 shall elapse after the completion of the wall.

30 Permeable backing to the retaining wall shall be in accordance with Clause 513.

31 When used, weep-holes shall not be allowed to drain freely across footways or carriageways.

Trial Panel

32 The Contractor shall construct a trial panel of pocket type or grouted-cavity reinforced brickwork retaining wall of dimensions specified in Appendix 25/3 prior to commencement of permanent work. The trial panel shall be used to demonstrate the colour of mortar, workability of mortar, formation of pockets and infilling of concrete. Where required in Appendix 25/3, the panel shall be dismantled in such a manner that the effectiveness of each element can be examined.

33 Where required in Appendix 25/3, the Contractor shall construct additional panels to comply with the appearance requirements of BS 3921.

2504 Environmental Barriers

General

1 Environmental barriers shall consist of materials and be erected to standards described in the following sub-Clauses.

2 Where an environmental barrier is erected on ground or any other surface which follows the longitudinal profile of the adjacent road or on existing ground or earthwork environmental bund which has a gradient of not greater than 1 in 50 along the line of the barrier, the top of the barrier shall follow a flowing vertical alignment. Where the earthwork environmental bund or original ground has a slope exceeding 1 in 50, the top of the barrier may be stepped, where permitted in Appendix 25/4. The minimum height of the barrier and the maximum step increments where steps are permitted, shall be as specified in Appendix 25/4. Where necessary the ground shall be excavated or filled and compacted in compliance with the appropriate Clauses in the 600 Series. Any excavation required shall not affect the minimum height of the barrier as shown in Appendix 25/4. The gravel board or bottom edge of the barrier shall be buried to a depth of at least 50 mm.

3 Where the environmental barrier is combined with an open box safety fence, the safety fence shall comply with the 400 Series.

4 Where the environmental barrier is erected on an earthwork environmental bund, the bund shall comply with Clause 619.

Tolerances

5 Tolerances shall be as follows:

(i) An environmental barrier shall be erected along a line or smooth curve as indicated on the contract drawings within a tolerance of ± 75 mm normal to the plane of the barrier; in addition, the horizontal deviation from the required positions at adjacent panels or posts shall not vary by more than ± 15 mm.

(ii) The top edge of the barrier shall be at the specified height above the road surface, existing ground or finished ground level of the earthwork environmental bund within a tolerance of ± 50 mm and the deviation from the required levels at adjacent panels or posts shall not vary by more than ± 15 mm.

(iii) Barriers shall be vertical unless otherwise stated in Appendix 25/4.

Timber

6 Timber shall comply with Clause 304. Non-structural timber shall be acceptable if it complies with HCD Drawing Number H37 and H38. For checking compliance, the rejection numbers shall be 3, 4, 6, 8, 11 and 15 respectively instead of 4, 6, 8, 11, 15 and 22.

7 Timber surfaces shall be sawn unless otherwise stated in Appendix 25/4.

8 Timber within panels shall not be butt jointed. The thickness of panel boards shall be sufficient to ensure the specified acoustic requirements and their width shall not be more than 150 mm measured at 28% moisture content. Exposed ends of vertical boards shall be protected against weathering by a top or capping rail.

Fittings

9 Fittings shall comply with Clause 305 unless otherwise stated in Appendix 25/4. Nails in timber preserved with copper/chromium/arsenic (CCA) treatment shall be austenitic stainless steel grade 302 or 304.

Concrete

10 Reinforced concrete components shall comply with the requirements of Appendix A of BS 1722: Part 3: 1986.

Combination of Timber and Concrete

11 Timber cladding used to screen concrete panel barriers shall comply with BS 1722 : Part 6 and Clause 304.

Steel

12 Steel posts and environmental barrier members shall comply with the requirements in the 1800 Series and shall be:

(i) hot dip galvanized to comply with Clause 1911, and either be:

(a) painted with the following paint system to comply with the 1900 Series,
1 coat of 'T' wash
2 coats of zinc phosphate epoxy ester
2 coats of MIO m/phenolic or phenolic
to achieve a minimum total dry film thickness of 200 microns, or

(b) plastic coated to comply with Clause 2604;

(ii) improved atmospheric corrosion resistant steel complying with Clauses 1801 and 1803.

Brickwork

13 Brickwork shall comply with the 2400 Series.

Other Materials

14 Other materials, or combination of materials, shall comply with Appendix 25/4.

Design

15 Where required, the Contractor shall design the environmental barriers listed in Appendix 1/10 in accordance with the design specification and procedures in Appendix 25/4. In addition, if required in Appendix 25/4 he shall design foundations, posts and/or other supports. The Contractor shall submit his design to the Overseeing Organisation for aesthetic approval. The Contractor shall also take account of the following:

(i) The Contractor shall when required in Appendix 25/4, erect 2 sample panels of barrier not less than 6 weeks before starting construction. One section shall show the horizontal elevation, the other a sloping elevation. Spacing of barrier posts shall be as described in Appendix 25/4. When Appendix 25/4 requires a safety fence to be attached to the environmental barrier, the safety fence shall be supplied and fixed to the sample panels of the environmental barrier. The sample panels shall be used as the standard which must be maintained throughout the Contract.

(ii) The Contractor shall provide working drawings of the design and details of fabrication.

(iii) The Contractor shall supply the Overseeing Organisation with the following:

(a) Design calculations.

(b) Details of materials and components used in the barrier.

(c) Details of gates and methods of fixing where applicable.

(d) Details of fixing to adjoining structures and parapets where applicable.

(iv) Fixings shall be fitted so that bolts either do not protrude on the traffic side, or only do so with a coach bolt head, a cup square head, or with a dome headed nut.

(v) Fixings and fastenings used shall be designed to prevent wilful damage. The design and materials used shall also enable damaged components to be replaced.

(vi) Stepping of panels shall only be permitted as specified in Appendix 25/4 to be compatible with aesthetic requirements.

(vii) The design shall be such that movement due to change in moisture content, thermal effects or weathering will not reduce the acoustic attenuation of the barrier.

(viii) All joints shall be sufficiently masked by cover strips or rebated to ensure acoustic integrity.

(ix) The design shall ensure that all members of the barrier can drain freely and do not allow water to stand on their surfaces or within joints.

(x) Where access gates are required in Appendix 25/4, their design shall be such that they blend unobtrusively into the barrier. They shall open away from the nearest carriageway and leave no gap when closed. The gates shall be self-closing by the provision of a heavy duty spring and be secured as described in Appendix 25/4. In barriers up to and including 2.00 m high the top edge of the gate shall be at the specified height of the barrier. Gates in barriers over 2.00 m high shall be 2.00 m high and provided with a header panel to align with the top of the barrier. Where a gate is not to be provided, but a gap is to be left for access as described in Appendix 25/4, a length of barrier shall be erected behind the gap or an overlap provided sufficient to maintain the acoustic properties of the barrier.

(xi) When timber is used in the barrier the following shall apply:

(a) One or two gravel boards not less than 150 mm deep shall be provided having a total thickness of not less than 50 mm. Concrete gravel boards or edging will be acceptable.

(b) Fixings shall be such as to allow timber movement due to change in moisture content to be accommodated without inducing splitting.

Testing of Acoustic Performance

16 Where required in Appendix 25/4 the complete form of construction proposed for an environment barrier shall have been tested at a laboratory approved by UKAS for acoustic testing in accordance with BS EN 1793.

Insulation Requirements

17 The overall performance characteristic DL_R determined in accordance with BS EN 1793 Part 2 shall meet the requirements stated in Appendix 25/4.

Absorption Requirements

18 The performance characteristic DL_α determined in accordance with BS EN 1793 Part 1 shall meet the requirements stated in Appendix 25/4.

Post Foundation Test

19 (i) Where stated in Appendix 25/4 the Contractor shall provide test equipment and carry out loading tests on post foundations as described in Appendix 25/4. The results shall be available at least one week prior to installation of the relevant length of fence, unless otherwise stated in Appendix 25/4.

(ii) The Contractor shall install foundations for testing after completion of the finished ground.

(iii) On completion of loading tests the Contractor shall remove the test posts and foundations and make good the finished ground, unless the posts and foundations have not exhibited failure and can be incorporated into the Permanent Works.

(iv) The Contractor shall establish and maintain appropriate traffic safety and management measures complying with Clause 117 during installation, loading and removal of the test posts and foundations.