

SPECIAL STRUCTURES

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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 the NRA Addendum to BD 12, the design requirements given in Appendix 25/1 and the procedures given in NRA BD 2.

Earthworks

- 3 Earthworks shall comply with Series 600.

Steel Components

- 4 All helically wound systems and all bolted segmental systems, including the galvanizing of their plates, bolts and nuts, to be incorporated in the Works shall have a current NSAI Agrément Certificate, or equivalent.
- 5 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.

- 6 After forming, the depth of the corrugations shall be within a tolerance of $\pm 6\%$ and the pitch of the corrugations within a tolerance of $\pm 4\%$ 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.
- 7 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 by the designer/manufacturer. The tightening shall be repeated if necessary to achieve the required torque.

- 8 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 IS EN ISO 1461. Plates for bolted segmental structures shall be galvanized after forming the corrugations and completing all necessary cutting, punching and drilling. Units in which the metal coating has been burned by welding or otherwise damaged in fabrication, transport or handling at Site shall be made good in compliance with Series 1900.
- 10 Bolts and nuts shall be hot dip galvanized in compliance with IS EN ISO 1461.

Concrete Foundations of Arch Profile Structures

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

Concrete Invert Pavings

- 12 Where described in Appendix 25/1, concrete invert pavings shall be constructed in compliance with that Appendix using Class C25/30 concrete complying with Series 1700.
- 13 Concrete invert pavings shall be reinforced with a steel fabric complying with Series 1700 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 in accordance with Series 2300.
- 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 accordance with the NRA Addendum to BD 12.
- (ii) detailed to suit any headwall arrangement e.g. paving reinforcement lapped with headwall reinforcement.

16 All foreign matter 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 systems shall have a current NSAI Agrément Certificate, or equivalent.

Proprietary Secondary Protective Coatings Applied Above Hot Dip Galvanized Coating

18 Any proposed proprietary protective coating systems shall have a current NSAI Agrément Certificate, or equivalent.

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 the NRA Addendum to BD 70 and the design requirements and procedures described in Appendix 25/2.

Earthworks

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

Reinforcing Elements for Reinforced Soil and Anchor Elements for Anchored Earth

3 Carbon steel strip to be hot dip galvanized shall comply with IS EN 10025-1 and IS EN 10025-2 either grade S235 JR or S355 JR, each having a silicon content of not less than 0.25% and not more than 0.40%. The fabricated element shall be galvanized in compliance with Series 1900 except that the average zinc coating weight for any individual test area shall be not less than 1000 g/m².

4 Stainless steel strip shall comply with

- (i) IS EN 10029, IS EN 10048, IS EN 10051, IS EN ISO 9445 designation 1.4401 or 1.4436, except that the material shall be cold rolled to provide a 0.2% proof stress of not less than 400 N/mm² and the tensile strength shall be not less than 540 N/mm²;

or

- (ii) IS EN 10029, IS EN 10048, IS EN 10051, IS EN ISO 9445 designation 1.4401 CR temper rolled to a minimum 0.2% proof stress of 310 N/mm².

5 Proprietary reinforcing elements and systems using such elements shall have a current NSAI Agrément Certificate or equivalent.

6 Anchor elements for anchored earth shall be made of cold worked steel reinforcing bar conforming to IS EN 10080 and BS 4449 (Grade B500B) except that no bar shall contain a flash weld. Welding of steel reinforcement bars to form anchors shall comply with Series 1700. The fabricated elements shall be galvanized in compliance with Series 1900 except that the average zinc coating weight for any individual test area shall be not less than 1000 g/m².

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 IS EN ISO 898-1, product grades A and B, shall

comply with IS EN ISO 4014, IS EN ISO 4017 and IS EN ISO 4032, and shall be made from one of the following:

- (i) Steel property class 8.8 complying with IS EN ISO 898-1 galvanized in compliance with Series 1900.
 - (ii) Stainless steel to IS EN 10088-1, designation 1.4401 or 1.4436 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) IS EN ISO 898-1 and IS EN ISO 4016, IS EN ISO 4018 and IS EN ISO 4034, and shall be galvanized in compliance with Series 1900. 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 IS EN ISO 3506-1 and IS EN ISO 3506-2 grade A4-70.
- 10 Plain washers shall be of either Form A or Form E complying with BS 4320 and shall be made from the following:
- (i) Cold rolled carbon steel strip CS4 complying with BS 1449: Part 1.1 hot dip galvanized in compliance with Series 1900.
 - (ii) Stainless steel strip designation 1.4401 or 1.4436 complying with IS EN 10029, IS EN 10048, IS EN 10051 and IS EN ISO 9445.
- 11 Dowels and rods shall be made from one of the following:
- (i) Steel bar conforming to IS EN 10080 and BS 4449 (Grade B500B), galvanized in compliance with Clause 1911.
 - (ii) Steel of grade S 355 JR complying with IS EN 10025 galvanized in compliance with Clause 1911.
 - (iii) Stainless steel to IS EN 10088-1, designation 1.4401 or 1.4436 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 galvanized shall comply with IS EN 10025-1 and IS EN 10025-2, either grade S235 JR or S355 JR, each having a silicon content of not less than

0.25% and not more than 0.40%. Following fabrication, the units shall be galvanized in compliance with Series 1900 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 IS EN 10029, IS EN 10048, IS EN 10051 and IS EN ISO 9445 designation 1.4401 or 1.4436.
- 14 Reinforced concrete shall comply with Series 1700.
- 15 Proprietary facing units and systems using such units shall have a current NSAI Agrément Certificate, or equivalent.

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 Series 2400, except where different requirements are given in this Clause.
- 2 Clay masonry units (bricks) shall be HD type Class B clay engineering bricks conforming to IS EN 771-1 and the following performance characteristics:
 - (i) The mean compressive strength of the bricks shall be not less than 40 N/mm² when tested in accordance with IS EN 772-1;
 - (ii) The water absorption of the bricks shall be not more than 7% by mass when tested in accordance with IS EN 772-7;
 - (iii) The freeze/thaw resistance category of the bricks shall be F2.
- 3 Unless otherwise described in Appendix 25/3, concrete shall be designed concrete. It shall comply with the requirements of Series 1700.
- 4 Reinforcement and all cutting, bending and fixing of reinforcement shall be in accordance with Series 1700.
- 5 Wall ties shall be as described in Appendix 25/3.
- 6 Damp proof courses shall be as described in Appendix 25/3.

Storage of Materials

- 7 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.
- 8 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.
- 9 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

- 10 Brickwork shall be laid in accordance with Series 2400.
- 11 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 IS EN 998-1 and IS EN 998-2.
- 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 used, the recommendations of the admixture manufacturer should be followed and they shall be demonstrated in the trial panel.

- 19 Mortars shall be tested in accordance with IS EN 1052-1.

Concrete – General

- 20 Batching, mixing, compliance, transporting, placing, compacting and finishing of concrete shall be in accordance with the requirements of Series 1700.
- 21 The rate of placing of concrete with respect to the rate of brickwork construction shall be as required by Appendix 25/3.

Cold Weather Working

- 22 Cold weather working shall be in accordance with the requirements of Series 1700 and 2400 as appropriate.

Hot Weather Working

- 23 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

- 24 Protection of newly laid brickwork shall be in accordance with Series 2400.
- 25 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.
- 26 Side protection shall be provided in exposed site conditions.

Weatherproofing, Backfill and Drainage

- 27 The retaining face of the wall shall be flush-jointed and tooled and shall be subsequently painted with a waterproofing material in accordance with Series 2000.
- 28 Backfilling shall be in accordance with Series 600. Before commencing backfilling, a period of 14 days or longer, if required by Appendix 25/3, shall elapse after the completion of the wall.
- 29 Permeable backing to the retaining wall shall be in accordance with Series 500.

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

Trial Panel

- 30** The Contractor shall construct a trial panel of pocket-type reinforced clay 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. When required in Appendix 25/3, the panel shall be dismantled in such a manner that the effectiveness of each element can be examined.