

SPECIFICATION FOR REINFORCED SOIL WALL

1.0 EXTENT OF WORK

The work shall consist of Reinforced Soil walls built in accordance with this specification and in conformity with the lines, levels and details shown on the plans or as amended by the Superintending Officer. The design of the reinforced soil wall shall be designed using the general principles of British Standard BS8006: 1994 Code of Practice for Strengthened/Reinforced Soils and other Fills.

2.0 MATERIALS

2.1 Concrete Facing Panels

This section defines the manufacture of the concrete panels which form the facing of Reinforced Soil structures with moderate exposure conditions.

2.1.1 Concrete Quality & Strength

Panels shall be made of vibrated concrete, produced in a concrete mixing plant of approved standard.

Concrete shall have a minimum characteristic compressive strength at 28 days (f_{cu}) of 30MPa.

Minimum cement content shall be 325 kg/m³.

Maximum free water/cement ratio shall be 0.55.

Unless notified otherwise, at least two test cubes shall be made per production cycle and tested at 28 days.

For sea walls or structures in adverse environments, thicker panels with higher cement content shall be specifically designed for its intended use and as per the relevant design codes.

2.1.2 Cast-In-Elements

a. Tie-Connections

Tie-connections are supplied pre-bent and hot dip galvanized to a minimum thickness of 70 μ m for metal tie.

Tie-connections shall be securely bolted (or clamped) in the position shown on the drawings when pouring concrete.

b. Dowels

The dowels shall be rigid plastic bar with tolerances of (+0mm, -2mm). The dowel shall be cut in such manner as to neither bend nor distort the dowel ends.

c. Tube

The tube shall be rigid plastic with tolerances of (+2mm, -2mm).

d. Reinforcement

Where required for particular applications, reinforcement shall be placed in accordance with the project drawings.

e. Lifting Anchors

The lifting anchors shall not be displaced from its correct position and alignment when pouring concrete.

2.1.3 Appearance

The exterior face of the panels shall be uniform and must not show significant variations from one panel to the other. Panels should be free of honeycombs, chippings, stains or cracks on the face.

Cement, aggregate and release agent of the same type and from the same source shall be used throughout the project. The curing cycle shall be maintained consistently throughout the project.

2.1.4 Casting

Panels shall be cast face down on a flat area, the exterior face being at the bottom of the mould and the tie-connection upward.

2.1.5 Tolerances

All dimensions, unless otherwise noted, shall be within +/- 5mm except the following:-

- a. The height of panels shall be within +/- 3mm
- b. The difference between the lengths of the diagonals shall not exceed 10mm.
- c. Twist or warp shall not exceed 5mm.
- d. Tie-connection's plate separation shall be 9mm (+/- 1mm).
- e. Dowel straightness shall be within 2mm.
- f. Length of reinforcing strips shall be within +/- 100mm.

2.1.6 Moulds

The panel dimensions shown on the drawings shall be controlled. The moulds as supplied will produce panels within the tolerances specified above.

2.1.7 Handling

Panels shall be handled so as to avoid chipping or cracking of the concrete.

Panels shall be stored in such manner to prevent staining of the front face.

Panels shall be stacked clear of the ground in such a manner as to ensure that:-

- a. not more than 6 panels are in any one stack.
- b. tie strips do not impinge on the face of the panel above or below.
- c. Support points are one above the other through the stack.

2.2 Joint Filler (for concrete panels)

Filler for the vertical joints & horizontal joints shall be flexible open cell polyurethane foam strips of 40mm square cross section with density not less than 20 kg/m³.

For the horizontal joints the filler shall be

Either (i) resin bonded cork filler board conforming to American Standard for Testing and Material **ASTM D 1752**

Or (ii) rubber pad with shore hardness 85mm, +0mm, -5mm.

2.3 Steel Facing

Steel facing panels shall be cold formed sections of specified profile and thickness generally complying with AS 3679.

Facing panels shall be cut to length and holed in the specified locations and shall include joint cover strips as specified.

2.4 Reinforcement Bars

Steel reinforcement bars shall be made of mild steel bars or high yield bars generally in accordance with the composition and property requirements of MS 146 and BS 4449 with minimum tensile strength of 250MN/m² of 460MN/m² respectively. Steel bars of other properties/grade may be used subject to Engineer's approval. The steel reinforcement shall be hot dipped galvanised with zinc with a minimum thickness of 85µm.

Reinforcement strips shall be cut to length and holed in the specified locations. Reinforcement shall be inspected to ensure that it is free from defects that may impair its strength or durability.

No plastic material shall be used as reinforcement for permanent structures.

2.5 Anchor Blocks

The anchor blocks shall be cast with the same concrete strength and quality as stated in the Drawings. The dimensions of the blocks shall not be less than those shown in the drawings.

2.6 Bolts & Nuts

Bolts and nuts shall be strength **Grade 8.8 to BS 3692** or equivalent, metric size **M 12** with hot dip galvanized or equivalent protective coating. The galvanization shall comply to **ISO 1460 & 1461**. Threading or machining process shall be carried out prior to galvanisation. In addition to galvanisation, the connections are further coated with anti-corrosion tar epoxy.

2.7 Selected Backfill

The backfill used in the Reinforced Soil block shall be a selected granular material. It should be free from organic or other deleterious material, conforming to the physical, chemical and electrochemical limits as defined in the following sections.

2.7.1 Physical

Angle of Friction for Selected Backfill

The angle of internal friction of a saturated soil specimen by shear box test should not be less than 36 degrees. The Engineer reserves the right to specify other types of test. The numbers of specimens to be tested shall be as directed by the Engineer.

Grain Size Distribution

The physical criteria shall be deemed to be satisfied (and the measurement of friction angle shall not be required) where the percentage (by weight) of the material less than 75 μm size is less than 15% or the percentage (by weight) of the material less than 15 μm size is less than 10%.

Materials which include a percentage (by weight) of material less than 15 μm size between 10% and 20% shall be acceptable provided the criteria of friction is satisfied.

Materials which include a percentage (by weight) of material less than 15 μm greater than 20% shall not be acceptable.

No aggregates shall be larger than 250mm.

For structures in **WATER**, coarser and well drained material with not more than 5% by weight of material finer than 75 μm should be used, unless otherwise specified in the drawing.

2.7.2 Chemical

PH Value

The pH value of the material shall be in the range of 5 to 10. For pH value within the range of 4.5 to 5.0 the resistivity shall be greater than 5000 ohm-cm.

Soluble Salts

Where the resistivity of the material (see 2.7.3) is in the range of 1000 to 5000 ohm-cm or the material is of industrial origin, the concentration of chloride (Cl^-) and sulphate (SO_4^{2-}) shall be checked and shall not exceed the following limits:

	Land Structure	Structure close to river (soft water)
Cl^- (mg/kg)	200	100
SO_4^{2-} (mg/kg)	1000	500

Sulphides

Where the origin of the material raises the possibility of the presence of sulphide, the concentration of the sulphide shall be checked and shall not exceed 300 mg/kg for structures outside water and 100 mg/kg for structures in soft water.

2.7.3 Electrochemical

Resistivity

The resistivity of the backfill material shall be determined on a saturated specimen after one hour of soil-water contact at 25 degree centigrade.

The resistivity of the backfill material shall be greater than the following limits:

	Land Structure	Structure close to river (soft water)
Resistivity (ohm-cm)	1000	3000

3.0 CONSTRUCTION

3.1 Excavation & Foundation

Excavation for the base of the wall shall be in accordance with the limits designated on the drawings. The bearing capacity of the soil shall be determined by carrying out adequate subsurface investigation tests. Should the bearing capacity of the soil is found to be insufficient, the Engineer will propose soil replacement or other treatment methods. When concrete panels are specified, a mass concrete (Grade 20) levelling pad shall be cast accurately to line and level as detailed on the drawings. The levelling pad shall be cast at least 12 hours before placement of wall panels.

3.2 Wall Erection – Concrete Panels

Concrete panels shall be placed vertically with the aid of a light crane and lifting beam. Panels are lifted using the erection inserts cast into the top edge. Panels shall be placed in successive horizontal lifts in the sequence indicated on the drawings. As fill is placed, the panels shall be held vertically by temporary timber wedges in the external joint at the junction of the two adjacent panels and by clamps at the staggered joint between the panels. External bracing is also required for the initial row of panels. During each stage of the erection each panel shall be checked for alignment and level by using the spacer bars and plumb bob.

3.3 Wall Erection – Steel Facing

Steel facing elements are placed manually in successive horizontal lifts as indicated in the drawings. Backfill shall be maintained not more than two facing elements (0.67 m) below the top of the wall. Temporary wooden wedges shall be placed at 1.5m centres between external facing joints and driven in to maintain verticality during backfilling. Batter boards shall be used for the first 5 lifts to maintain verticality. Timber wedges shall be maintained for at least 4 joints below the level of fill placement.

3.4 Backfill and Compaction

Backfill shall follow closely behind the wall facing panel erection. At each level of reinforcement, backfill shall be roughly levelled before placing and bolting reinforcement strips. The maximum loose thickness of each fill layer shall be 375mm or less as may be required to meet the specified density for the particular project.

During backfill placement, trucks and heavy vehicles shall be kept back 1.5m from the rear face of the wall and crawler tracks shall not be directly in contact with the reinforcement. The

backfill within 1.5m behind the wall shall be compacted with hand-operated compacting machine with weight not greater than 1 ton.

The compaction operation in a Reinforced Soil structure has essentially an objective to prevent excessive ultimate settlement of the backfill material. The backfill shall be compacted to not less than 95% standard proctor density or higher as may be required by the Superintending Officer for the specific use of the wall and the minimum bulk density after compaction should not be less than 1800 kg/m³.

In general, 15 – 25 passes by a 8 ton vibratory roller may sufficiently compact the granular backfill to the reinforced soil wall specification of 95% standard proctor density.

3.5 Tolerance

Reinforced soil wall is a flexible structure and may withstand substantial horizontal and vertical movements. Such movements should be estimated and agreed by the parties concerned before construction, taking into consideration the serviceability requirements of the structure and the tolerance of the associated works to such movements.

A differential settlement of up to one percent along the wall can be tolerated. Local variation of up to 30 mm or more measured by a 4.5m straight edge along the wall face may be allowed if the aesthetic appearance of the wall is not adversely affected.

3.6 Drainage

3.6.1 Subsoil Pipe

The subsoil pipe, when indicated on drawing, shall be with minimum diameter of 100mm. The perforated pipe wrapped round with geotextile cloth or equivalent of PVC pipe with 4 nos. 10mm diameter concentric holes staggered at 150mm spacing longitudinally or as directed by the Project Engineer. Laying of the subsoil pipe shall be in accordance with the levels shown in the drawings.

3.6.2 Temporary Drainage

During construction of Reinforced Soil structures, temporary drainage shall be constructed to divert any surface run-off away from the structures.

At the end of each day any surplus backfill behind the structure shall be level-off at a gentle slope so that any surface run-off can flow into the temporary drainage.

3.7 Walls on Soft Foundation

A specific erection procedure is to be worked out and agreed upon by the Main Contractor and the Superintending Officer. In general, the erection rate may be regulated in accordance with soil conditions. Instrumentation to monitor the behaviour of the foundation soils during construction may also be required.

4.0 MEASUREMENT

4.1 Concrete Facing Panels

The unit of measurement for supply of all materials for the wall including concrete facing panels, reinforcing and tie strips, fasteners, joint fillers and incidentals shall be in square metre of the wall.

4.2 Steel Facing

The unit of measurement for the supply of all materials for the wall including steel facing panels, reinforcing strips, fasteners, joint covers and incidentals shall be in square metre of the wall.

4.3 Wall Erection

The unit of measurement for wall erection shall be in square metres. The quantity to be paid for shall be the actual quantity erected in place at the site. Payment shall include compensation for all labour and materials required to prepare the wall foundation, put in place the reinforcing strips and erecting the panel elements to the lines and grade shown on the plans.

4.4 Levelling Pads

The unit of measurement for the concrete levelling pad shall be the length in linear metre completed in place and accepted, measured along the line and grade of the levelling pad.

4.5 Backfill

The unit of measurement for selected granular backfill shall be compacted volume in cubic metres.

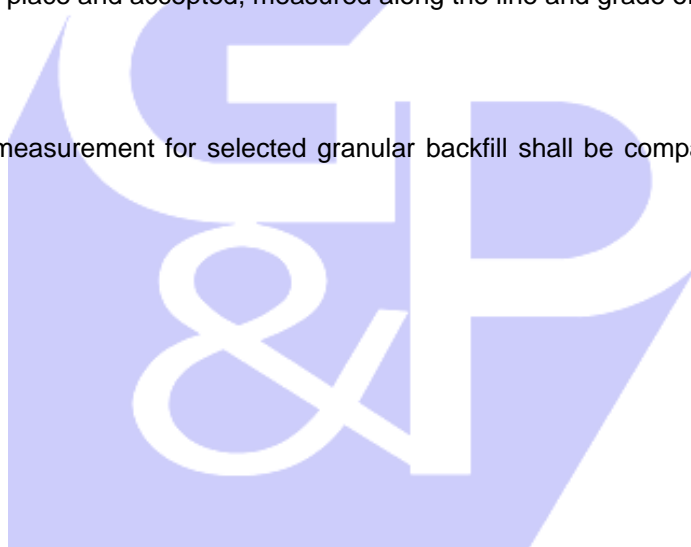


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