

# Master Specification

## Part ST-RE-C1

### Reinforced Soil Structures

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**Government of South Australia**  
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# ST-RE-C1 Reinforced Soil Structures

## 1 General

- a) This Master Specification Part sets out the requirements for the supply of materials and the construction of Reinforced Soil Structures consisting of composite systems of compacted select backfill and reinforcing material with precast concrete wall facing. This includes:
  - i) the documentation requirements set out in section 2;
  - ii) the material requirements, as set out in section 3;
  - iii) the construction requirements, as set out in section 4;
  - iv) monitoring requirements, as set out in section 5;
  - v) the requirements for test procedures, as set out in section 6;
  - vi) the Hold Point and Witness Point requirements, as set out in section 7; and
  - vii) the verification requirements and records, as set out in section 8.
- b) Reinforced Soil Structures must comply with the Reference Documents, including:
  - i) AS 1289 Methods of testing soils for engineering purposes;
  - ii) AS 1554 Structural steel welding;
  - iii) AS 5100 Bridge design;
  - iv) AS/NZS 3678 Structural steel - Hot-rolled plates, floorplates and slabs;
  - v) AS/NZS 3679 Structural steel;
  - vi) AS/NZS 4671 Steel for the reinforcement of concrete; and
  - vii) AS/NZS 4680 Hot dip galvanized (zinc) coatings on fabricated ferrous articles.

## 2 Documentation

### 2.1 Construction Documentation

In addition to the requirements of PC-CN3 “Construction Management”, the Construction Documentation must include:

- a) a sampling and test plan for materials that demonstrates compliance with the design;
- b) the nominated reinforcing products used for the fabrication of reinforcing strips and grids, and their connections, in accordance with section 3.4a); and
- c) a methodology for lifting wall facing panels in accordance with section 4.3a).

### 2.2 Quality Management Records

In addition to the requirements of PC-QA1 “Quality Management Requirements” or PC-QA2 “Quality Management Requirements for Major Projects” (as applicable), the Quality Management Records must include:

- a) backfill conformity test results, including type and source of fill, in accordance with section 3.7a);
- b) details of the final position of the top and bottom of each wall facing panel in accordance with section 4.3b);
- c) the compaction testing results of fill material in accordance with section 4.4d);

- d) evidence of the inspection of the condition of reinforcement and connections in accordance with section 4.4i); and
- e) the verification requirements required by Table ST-RE-C1 8-1.

## 3 Materials

### 3.1 General

Materials must comply with any specific requirements of the proprietary systems adopted.

### 3.2 Wall facings

- a) Wall facing panels must be of incremental height, precast reinforced concrete, manufactured in accordance with Master Specification Parts ST-SC-C1 to C7 and have a minimum concrete grade of S32.
- b) Steel reinforcement must be a minimum of  $450 \text{ mm}^2 / \text{m}$  in each of 2 directions at right angles to each other and located at mid depth of the panel thickness.
- c) Wall facing panels must be positively interconnected to prevent relative displacement normal to the wall face.

### 3.3 Joint fillers

- a) Joint fillers between wall facing panels must be incorporated into the Works and composed of durable inert material resistant to attack from the soil material and the atmosphere.
- b) Joint fillers must be provided to:
  - i) allow for joint rotation without spalling of concrete edges; and
  - ii) prevent loss of fines from the backfill material and staining of the panel faces.

### 3.4 Soil reinforcing

- a) Reinforcing strips and grids, and their connections, which are attached to the wall facing panels and embedded in the fill, must be fabricated from reinforcing products nominated as part of the Construction Documentation.
- b) Steel reinforcing must comply with AS/NZS 3679 "Structural steel", with a minimum base metal thickness of 5 mm and hot dip galvanized after fabrication in accordance with AS/NZS 4680 "Hot-dip galvanized (zinc) coatings on fabricated ferrous articles", with a minimum average coating thickness equivalent to  $600 \text{ g} / \text{m}^2$ .
- c) Steel mesh must comply with AS/NZS 4671 "Steel for the reinforcement of concrete", and hot dip galvanized after fabrication with zinc in accordance with AS/NZS 4680 "Hot-dip galvanized (zinc) coatings on fabricated ferrous articles", with a minimum average coating thickness equivalent to  $600 \text{ g} / \text{m}^2$ .
- d) Synthetic material must comply with a British Board of Agrément (BBA) certificate and demonstrated by testing in a NATA accredited laboratory to satisfy the requirements of this Master Specification Part.

### 3.5 Connections

- a) Materials connecting the wall facing panels with the reinforcing elements must be electrolytically compatible to ensure that corrosion will not be promoted through the use of dissimilar metals.
- b) All materials forming connections must be adequately protected for the in-situ conditions, consistent with the protection provided for adjacent components and for the Design Life of the structure.

### 3.6 Handling transportation and storage

- a) Handling transportation and storage of prefabricated structure components must not cause any damage or deterioration.
- b) Synthetic reinforcement elements susceptible to UV degradation and chemical attack must be protected.

### 3.7 Backfill

- a) Select backfill must be in accordance with section 8 and have a particle size distribution, shear strength and coefficient of friction value to ensure the design parameters are achieved. The Contractor must submit the conformity test results, including type and source of fill as part of the Quality Management Records, which will constitute a **Hold Point**. The backfill must not be used or installed until this Hold Point has been released.
- b) Pulverised fuel ash must not be used as select backfill.

## 4 Construction

### 4.1 Foundations

The Contractor must obtain acceptance from the Principal of the completed foundation, which will constitute a **Hold Point**. The placement of the levelling pads must not commence until this Hold Point has been released.

### 4.2 Levelling pads

- a) Levelling pads must be cast from Grade N20 concrete to the lines, levels and dimensions shown on the Design Drawings, within the tolerances in accordance with Table ST-RE-C1 4-1.
- b) Levelling pads must be cured for a minimum of 24 hours before placement of wall facing panels.

**Table ST-RE-C1 4-1 Levelling pads tolerances**

Name	Tolerance
Plan dimension	-5 mm to +0 mm
Thickness	-10 mm to +0 mm
Reduced level of top surface of footing	-5 mm to +5 mm
Maximum variation of top surface from a 3 m straight edge	-5 mm to +5 mm

### 4.3 Panel erection

- a) Wall facing panels must only be handled and lifted by a lifting device or other method specified in the Construction Documentation. Each wall facing panel must be supported immediately after erection and until the abutting fill material has been placed and compacted. Wall facing panels must be erected without disturbance, damage or distortion of reinforcing strips or panels.
- b) The Contractor must set out an offset line in front of and parallel to each Reinforced Soil Structure wall levelling pad. On completion of each row of wall facing panels and before commencing the next row, the Quality Management Records must include the details of the final position of the top and bottom of each wall facing panel.

### 4.4 Placement of filling

- a) Fill must be placed on to the reinforcing strips so that the toe of the fill heap is approximately 1.5 m from the wall facing panels. The material must be pushed parallel to the panels and



spread toward the panels and toward the free end of the strips. Fill placement must follow the erection of each run of wall facing panels.

- b) At each reinforcing strip level, fill must be compacted before placing and bolting strips. At the end of each days' operations, the Contractor must shape the top of fill to direct rainwater run off away from the wall face.
- c) Fill must be placed in horizontal layers of uniform thickness between 100 mm and 200 mm compacted thickness ensuring that that the properties comply with those specified in section 8.
- d) The location of tests required by section 8 must be selected by the Contractor for each Work Lot on a stratified random basis. The results of these tests must be submitted as part of the Quality Management Records, within 2 Business Days of each test, which will constitute a **Witness Point**.
- e) The minimum frequency of compaction testing must be the greater of:
  - i) 6 tests per 500 mm thickness of fill placed, and
  - ii) 6 tests per 50 m<sup>3</sup>.
- f) Heavy earthmoving and compaction equipment (in excess of 2 t gross vehicle mass) must be kept at least 1.5 m away from the back of the wall facing panels.
- g) Tracked machines and vehicles must not be operated on top of reinforcing elements until the elements are covered by at least 150 mm of fill material.
- h) Sheepsfoot rollers must not be used for compaction of fill material.
- i) The Contractor must inspect the condition of reinforcement and connections and document these inspections prior to placing the next layer of fill material. Evidence of the inspection must be provided as part of the Quality Management Records.

## 4.5 Tolerances

- a) The finished wall facing panels must comply with the tolerances in Table ST-RE-C1 4-2.
- b) No later than 5 Business Days after the completion of the wall construction, the Contractor must, as part of the Quality Management Records, include a survey certificate in accordance with PC-SI1 "Site Surveys", demonstrating that the wall facing panels comply with the tolerances specified in this Master Specification Part.

**Table ST-RE-C1 4-2 Tolerances**

Property	Acceptance limits
Departure from plan position detail in the Design Documentation at base of wall facing panels	±15 mm
Relative displacement of adjoining smooth wall face panels measured normal to the face of the wall face panels	±15 mm
Local deviation of the wall face panels measured at any location with a 3 m straight edge	±15 mm
Overall vertical tolerance of the exposed wall face panels	<5 mm/m of wall height
Reduced levels on the wall facing panels	±20 mm
Variation in exposed gap width between wall face panels	<5 mm/m length

## 5 Monitoring

- a) The Contractor must implement a monitoring program for Reinforced Soil Structures to ensure that the performance criteria in the Contract Documents are being met for the period between completion of the Reinforced Soil Structure and the later of:
  - i) the expiry of the relevant Defects Liability Period; and
  - ii) 5 years after completion of the relevant Reinforced Soil Structure.
- b) For the period specified in section 5a), both horizontal and vertical surface movement must be recorded:
  - i) every month, as a minimum, for the first 6 months after the Reinforced Soil Structure is completed;
  - ii) quarterly beyond the first 6 months after the Reinforced Soil Structure is completed; and
  - iii) at an agreed rate of monitoring beyond 2 years after the Reinforced Soil Structure is completed if it can be demonstrated to the satisfaction of the Principal that the performance criteria of this Master Specification Part and ST-RW-D1 “Design of Reinforced Soil Structures” are being met.
- c) The Contractor must monitor the backfill of Reinforced Soil Structures to ensure that the requirements of the Design Documentation, and the requirements of ST-RE-D1 “Design of Reinforced Soil Structures” have been achieved, including ensuring that at least 80% of the expected settlement occurs prior to the construction of the adjacent road pavements and associated structures and settlement does not exceed 10 mm.
- d) Monitoring points must be placed in accordance with the Design Documentation which at a minimum complies with the locations required by ST-RE-D1 “Design of Reinforced Soil Structures”.

## 6 Test procedures

The Contractor must use the test procedures in accordance with the Reference Documents, including the test procedures shown in Table ST-RE-C1 6-1 (available from: [https://dit.sa.gov.au/standards/test\\_procedures](https://dit.sa.gov.au/standards/test_procedures)) to verify conformance with the Contract Documents.

**Table ST-RE-C1 6-1 Test procedures**

Test procedure	Test
TP 061 Site Selection by Stratified Random Technique	Site selection by stratified random technique
TP 320 Compaction Control Test - Dry Density Ratio, Moisture Variation and Moisture Ratio	Dry density ratio
AS 1289 Methods of testing soils for engineering purposes	pH, resistivity, SO <sub>4</sub> content



## 7 Hold Points and Witness Points

- a) Table ST-RE-C1 7-1 details the review period or notification period, and type (documentation or construction quality) for each Hold Point referred to in this Master Specification Part.
- b) Table ST-RE-C1 7-2 details the review period or notification period, and type (documentation or construction quality) for each Witness Point referred to in this Master Specification Part.

**Table ST-RE-C1 7-1 Hold Points**

Section reference	Hold Point	Documentation or construction quality	Review period or notification period
3.7a)	Submission of backfill conformity test results, including type and source of fill	Documentation	5 Business Days review
4.1	Acceptance of foundation	Construction quality	48 hours notification

**Table ST-RE-C1 7-2 Witness Points**

Section reference	Witness Point	Documentation or construction quality	Review period or notification period
4.4d)	Submission of the compaction testing results of fill material	Documentation	5 Business Days review

## 8 Verification requirements and records

The Contractor must provide written verification as part of the Quality Management Records that the requirements listed in Table ST-RE-C1 8-1 have been complied with.

**Table ST-RE-C1 8-1 Verification requirements**

Section reference	Subject	Property	Test procedure	Test frequency	Acceptance limits
3.2a)	Concrete properties	In accordance with Master Specification Parts ST-SC-C1 to C7	In accordance with Master Specification Parts ST-SC-C1 to C7	In accordance with Master Specification Parts ST-SC-C1 to C7	In accordance with Master Specification Parts ST-SC-C1 to C7
3.2b)	Steel soil reinforcing	In accordance with AS/NZS 3679 Structural steel, or AS/NZS 4671 Steel for the reinforcement of concrete	In accordance with AS/NZS 3679 Structural steel, or AS/NZS 4671 Steel for the reinforcement of concrete	In accordance with AS/NZS 3679 Structural steel, or AS/NZS 4671 Steel for the reinforcement of concrete	In accordance with AS/NZS 3679 Structural steel, or AS/NZS 4671 Steel for the reinforcement of concrete
3.4d)	Synthetic soil reinforcing	In accordance with the British Board of Agrément (BBA) certificate	In accordance with the British Board of Agrément (BBA) certificate	In accordance with the British Board of Agrément (BBA) certificate	In accordance with the British Board of Agrément (BBA) certificate
3.5	Select backfill	Gradings and soil consistency	In accordance with RD-EW-C1 "Earthworks", or ST-SP-C1 "Earthworks for Structures"	In accordance with RD-EW-C1 "Earthworks", or ST-SP-C1 "Earthworks for Structures"	In accordance with RD-EW-C1 "Earthworks", or ST-SP-C1 "Earthworks for Structures", and the Design Documentation
		Shear strength and coefficient of friction	In accordance with the Design Documentation	In accordance with the Design Documentation	In accordance with the Design Documentation
3.5	Select backfill in contact with steel when structure is not subject to inundation	pH	In accordance with AS 1289.4.3.1 Methods of testing soils for engineering purposes, Method 4.3.1: Soil chemical tests - Determination of the pH value of a soil - Electrometric method	1 test per 400 m <sup>3</sup>	between 5 to 10
		Resistivity	In accordance with AS 1289.4.4.1 Methods of testing soils for engineering purposes, Method 4.4.1: Soil chemical tests - Determination of the electrical resistivity of a soil - Method for fine granular materials	1 test per 400 m <sup>3</sup>	>5,000 (ohm.cm). If in range 1,000 to 5,000, it will be accepted if SO <sub>4</sub> is satisfactory.
		SO <sub>4</sub> content (only required if resistivity in range 1,000 to 5,000)	In accordance with AS 1289.4.2.1 Methods of testing soils for engineering purposes, Method 4.2.1: Soil chemical tests - Determination of the sulfate content of a natural soil and the sulfate content of the groundwater - Normal method	1 test per 400 m <sup>3</sup>	<1,000 (mg/kg)

Section reference	Subject	Property	Test procedure	Test frequency	Acceptance limits
3.5	Select backfill in contact with steel when structure is subject to inundation	pH	In accordance with AS 1289.4.3.1 Methods of testing soils for engineering purposes, Method 4.3.1: Soil chemical tests - Determination of the pH value of a soil - Electrometric method	1 test per 400 m <sup>3</sup>	between 5 to 10
		Resistivity	In accordance with AS 1289.4.4.1 Methods of testing soils for engineering purposes, Method 4.4.1: Soil chemical tests - Determination of the electrical resistivity of a soil - Method for fine granular materials	1 test per 400 m <sup>3</sup>	>3 000 (ohm.cm).
		SO4 content	In accordance with AS 1289.4.2.1 Methods of testing soils for engineering purposes, Method 4.2.1: Soil chemical tests - Determination of the sulfate content of a natural soil and the sulfate content of the groundwater - Normal method	1 test per 400 m <sup>3</sup>	<500 (mg/kg)
4	Wall construction	Backfill compaction	a) TP 320 Compaction Control Test - Dry Density Ratio, Moisture Variation and Moisture Ratio  b) AS 1289.5.8.1 Methods of testing soils for engineering purposes, Method 5.8.1: Soil compaction and density tests - Determination of field density and field moisture content of a soil using a nuclear surface moisture-Density gauge - Direct transmission mode	In accordance with section 4.4e)	a) Not less than 95%  b) In accordance with AS 1289.5.2.1 Methods of testing soils for engineering purposes, Method 5.2.1: Soil compaction and density tests - Determination of the dry density/moisture content relation of a soil using modified compactive effort  c) Moisture content range of ±2%
		Position of levelling pads	Survey certificate in accordance with PC-SI1 "Site Surveys"	In accordance with PC-SI1 "Site Surveys"	In accordance with section 4.2
		Panel position at completion of each row	Survey certificate in accordance with PC-SI1 "Site Surveys"	In accordance with PC-SI1 "Site Surveys"	In accordance with Table ST-RE-C1 4-2
		Panel position at completion of wall	Survey certificate in accordance with PC-SI1 "Site Surveys"	In accordance with PC-SI1 "Site Surveys"	In accordance with Table ST-RE-C1 4-2