



# Recommended Specification...

## Segmental Reinforced Soil Retaining Wall Structures

### **SPECIFICATION – / FREESTONE ECO / FREESTONE ROCKFACE / GARDEN WALL BLOCKS Retaining Wall Systems**

#### **Australian Standards**

All components and installation shall comply with the Building Code Of Australia (BCA) and the relevant Australian Standards, including AS 4678 and the standards referred to therein.

#### **Safety And Protection Of Existing Structures**

All excavations shall be carried out in a safe manner in accordance with the relevant regulations, to prevent collapse that may endanger life or property.

In the absence regulations to the contrary, the following may applied

- where excavation is performed and remains open only in dry weather,
- where there is no significant ground water seepage,
- where the excavation remains open for no longer than two weeks,
- where the back slope of the natural ground does not exceed 1 vertical in 6 horizontal,
- where bedding planes do not slope towards the cut, and
- where there are no structures founded within a zone of influence defined by a line from the toe of the cut at 30 degrees for cohesionless material and 45 degrees for other material.

Natural material	Maximum height of cut M	Maximum permissible unpropped batter Vert : horiz
Stable rock, sandstone, firm shale etc where bedding planes do not slope towards the excavation	0 – 3.2	1 : 0.4
	Over 3.2	Seek advice of Engineer
Materials with both significant cohesion and friction in its undisturbed natural compacted state	0 – 2.6	1 : 0.8
	Over 2.6	Seek advice of Engineer
Cohesive soils, Eg clay, silts	0 – 2.0	1 : 1.2
	Over 2.0	Seek advice of Engineer
Cohesionless soils, Eg Loose gravel, sand	0 – 1.4	1 : 1.6
	Over 1.4	Seek advice Engineer

In all other cases, the advice of the Engineer shall be sought.

Adjacent structures must be founded either beyond or below the zone of influence. Where there is risk of global slip around a slip plane encompassing the proposed retaining wall or other structures, or where there is risk of inundation by ground water or surface water, retaining wall construction shall not proceed until remedial action has been carried out.

#### **Foundation Material and Bearing Pad**

The capacity of the foundation material to resist global slip and to support the horizontal and vertical loads, noted as an annexure to this specification, shall be determined by a qualified and experienced Geotechnical Engineer. This shall be assessed when the excavation has revealed the nature and extent of the foundation material.

The bearing pad having the following properties:

- Compacted density angle such that a conservative estimate of the mean is at least 18.6 kg/m<sup>3</sup>
- Effective internal friction angle such that a conservative estimate of the mean is at least 37°
- Effective cohesion such that a conservative estimate of the mean is at least 5 kPa

A well graded low plasticity crushed rock complying with the following specification is deemed satisfactory for this application.

Nominal Size	20 mm
AS Sieve	% Passing
26.5 mm	100
19.0 mm	95 -100
13.2 mm	78 - 92
9.5 mm	68 - 83
4.75 mm	44 - 64
2.36 mm	29 - 47
425 µm	12 - 20
75 µm	2 - 6
Liquid Limit not exceeding 20.	
Plasticity Index not exceeding 6.	
Los Angeles Abrasion Loss of 40% maximum.	
Californian Bearing Ratio (CBR) of 100% after soaking at 98% Modified Dry Density.	

**Preparation of the Foundation and Bearing Pad**

# Unless indicated otherwise on the drawings, the bearing pad dimensions shall be:

Minimum Bearing Pad Dimensions		
Application	Where the foundation material is adequate to provide sliding and bearing capacity	Where the foundation material is inadequate and must be removed and replaced by an enlarged bearing pad  Where H = total height of wall
Total width of bearing pad	750 mm	0.3 H
Depth of bearing pad below bottom block	150 mm	0.1 H
Distance the bearing pad extends in front of the wall face	200 mm	0.1 H

The bearing pad shall be compacted to a minimum thickness of 150 mm at a moisture content within 2% of Optimum Moisture Content (OMC). Compaction shall be by mechanical plate vibrator to a minimum of 95% of the standard proctor density.

Where there are significant variations of foundation material or compaction, soft spots or where there is ponding of ground water, the material shall be removed, replaced and compacted in layers not exceeding 150 mm at a moisture content within 2% of Optimum Moisture Content (OMC) to achieve 95% Standard Proctor density.

Trenches and footing excavations shall be dewatered and cleaned prior to placement of drainage material or footings such that no softened or loosened material remains. If necessary place and compact foundation material in layers not exceeding 150 mm to make up levels. The levels beneath the wall shall **not** be made up with bedding sand or other poorly graded granular material that may permit ground water to permeate under the base of the retaining wall, except where drainage material is specified and an adequate drainage system is designed.

The capacity of the foundation material to support the horizontal and vertical loads, noted as an annexure to this specification, shall be determined by a qualified and experienced Geotechnical Engineer or Civil Engineer. This shall be assessed when the excavation has revealed the nature and extent of the foundation material.

**Drainage System**

The drainage system shall consist of:

- A permeable wall facing system.
- A permeable drainage layer not less than 300 mm wide adjacent to the stem of the wall.
- A 100 mm slotted PVC agricultural pipe with geofabric sock, or equivalent system, draining to the storm water system

### **Drainage Pipe**

The drainage pipe shall be a 100 mm diameter slotted PVC agricultural pipe with geofabric sock.

### **Drainage Fill**

Drainage fill material shall be a nominal 10 mm GP (poorly graded gravel) complying with the following specification.

Sieve	Percent Passing
19.0 mm	100
13.2 mm	30 - 100
9.52 mm	0 - 100
6.70 mm	0 - 90
4.76 mm	0 - 70
2.36 mm	0 - 35
1.18 mm	0

### **Installing Drainage Fill**

Drainage fill shall be compacted:

- above and beside the drainage pipe to a minimum width of 300 mm behind the levelling fill
- behind the wall to a minimum width of 300 mm behind the wall to within 150 mm of the top

Compaction shall be by mechanical plate vibrator to a minimum of 95% of the standard proctor density. All drainage fill must be adequately drained by the drainage system.

### **Installing The Drainage System**

The drainage pipe shall be positioned in the drainage fill at a minimum uniform grade of 1 in 100 over a length not exceeding 15 metres. It shall be connected to the storm-water system at the lower end of each run and shall drain positively away from base of the retaining wall. The drainage pipe shall be brought to the surface at the upper end of each run to facilitate future flushing, capped and its position marked.

### **Geosynthetic Filter Fabric**

Geosynthetic filter fabrics shall be of a material which:

- is not hydrophobic
- permits water to pass freely
- does not permit fine material to enter the drainage layer
- has sufficient strength to resist tearing during the placing and back-filling operations
- has the following specified properties.

For use behind retaining walls which are retaining silt, fine sand or similar materials:

Minimum Grab Tensile Strength to AS 2001.2.3 600 N

Minimum Wide-strip Tensile Strength to AS 3706.2 8.0 kN/m

Minimum Trapezoidal Tear Test to AS 3706.3 200 N

Minimum CBR Burst Strength to AS 3706.4 1600 N

Maximum Pore Size  $O_{95}$  by dry sieving to AS 3706.7 200  $\mu\text{m}$  (woven fabric)

Minimum Permittivity to AS 3706.9  $1.3 \text{ sec}^{-1}$

Minimum Coefficient Of Permeability to AS 3706.9 0.003 m/sec

Minimum Flow Rate Under 100 mm Head AS 3706.9  $220 \text{ l/m}^2/\text{sec}$

### **Bulk Fill Material**

Bulk fill material shall be uniform and of maximum particle size 100 mm.

### **Installing Bulk Fill Material**

Bulk filling material shall be placed and in layers not exceeding 200 mm at a moisture content within 2% of Optimum Moisture Content (OMC) to achieve 85% Standard Proctor density.

### **Surface Sealing Material**

The material used to seal the surface of the fill shall be compacted clay.

### **Installation Of Surface Sealing Material And Catch Drain**

The whole of the disturbed fill surface shall be sealed and drained by compacting a layer of surface sealing material at least 150 mm thick and incorporating a 100 mm deep catch drain which drains to the site drainage system at a minimum slope of 1 in 100.

### **Concrete Facing Blocks**

Unless specified otherwise, concrete facing blocks shall be keyed retaining wall units, complying with AS 4455 and the following requirements:

- Dimensional category DW4

- General purpose salt attack resistance grade
- Minimum characteristic compressive strength of 15 MPa
- To a colour and texture agreed in writing before the supply takes place.

Broken or chipped units shall not be used. When it is necessary to cut units, they shall be cut with blade rather than broken.

### **Infill Material**

The infill material shall meet the following specification:

- Compacted density angle such that a conservative estimate of the mean is at least 18.6 kg/m<sup>3</sup>
- Effective internal friction angle such that a conservative estimate of the mean is at least 35°
- Effective cohesion such that a conservative estimate of the mean is at least 0 kPa
- GW (well-graded gravel) or SW (well-graded sand) These properties may not be achieved by the inclusion of cement or lime in site material.
- pH (for polyester geogrids) between 4 and 9
- Plasticity Index shall not exceed 12%.
- Liquid Limit shall not exceed 30%.
- Coefficient of uniformity =  $D_{60}/D_{10}$  shall exceed 5, where  $D_{60}$  and  $D_{10}$  are the equivalent sizes in millimetres as interpolated from the particle size distribution curve through which 60% and 10% of the material passes respectively.
- Grading within the following range:

Sieve	Percent Passing
26.0 mm	100
19.0 mm	40 - 100
13.2 mm	30 - 100
9.5 mm	25 - 100
6.70 mm	22 - 100
4.76 mm	18 - 100
2.36 mm	15 - 85
1.18 mm	12 - 70
600 microns	10 - 55
300 microns	6 - 40
150 microns	3 - 26
75 microns	0 - 15
2 microns	0

### **Geogrids**

The geogrids shall be of the type and index strength nominated in the schedule. Geogrids shall be a single length in the direction of design tension, not lapped, making provision for connection to the facing across the whole width of the facing and providing for the specified anchorage within the in designated anchorage zone. Geogrids shall cover the whole of the plan area behind the wall for the specified anchorage length and shall be lapped with adjacent sections in accordance with the manufacturer's instructions.

### **Adhesive**

The adhesive used to bond the capping units shall be a flexible two-part epoxy-based adhesive.

### **Installing Concrete Facing Units, Infill Material And Geogrids**

Concrete facing blocks shall be installed on the leveling pad or footing such that the resulting wall has a backward slope as specified on the drawings, but not less than 1 in 40. The units of successive courses shall be stacked in stretcher bond. In high walls that are curved in plan, it may be necessary to compensate for joint creep in the upper courses (the longitudinal translation of joints along the wall and the radius of curvature increases or decreases).

Geogrids shall be installed under tension applied by a system of stakes that shall remain in place until the geogrids are covered by at least 150 mm of infill material.

Infill material shall be placed, spread and compacted in a manner that eliminates wrinkles in the geogrid or movement of the facing units. Infill material shall be placed and compacted in layers equal to the height of the facing units, but not exceeding 200 mm in thickness, at a moisture content within 2% of Optimum Moisture Content (OMC) to achieve 95% Standard Proctor density. Infill material within 1.0 metre of the rear face of the retaining wall facing units shall be placed and compacted by at least three passes of a lightweight mechanical plate, tamper or roller at a moisture content within 2% of Optimum Moisture Content (OMC) to achieve 90% Standard Proctor density.

Tracked construction equipment shall not be operated directly on the geogrids, which shall have a minimum of 150 mm of soil cover. In order to avoid disruption of the geogrids, tracked construction equipment shall not be turned on the infill material. Rubber tyred equipment may be used on the geogrids provided it is operated in accordance with the geogrid manufacturer's instructions, without sudden braking and turning and at speed under 6 kilometres per hour.

At the end of each day's construction, the infill material shall be sloped such that any rainwater is directed away from the face of the retaining wall and to a temporary (or permanent) drainage system.

The top facing unit or capping unit shall be bonded to the facing units below using an adhesive.

Unless specified otherwise for reasons of aesthetics or by the client or architect, all construction shall be within the following tolerances:

Element	Vertical Position	Horizontal Position	Vertical Alignment	Horizontal Alignment
Soil surface	± 100 mm	-	-	-
Facings & wall structures	± 50 mm	± 50 mm	± 20 mm in 3.0 m	± 20 mm in 3.0 m
Footings & supports	± 50 mm	± 50 mm	± 20 mm in 3.0 m	± 20 mm in 3.0 m

### Inspections

The Contractor shall supply all required equipment and materials and perform all relevant tests. All new work shall remain open until it has been inspected, tested and approved by the Engineer. The following inspections shall be performed:

Item or Product	Inspection Required	Accept Criteria	Hold/Witness
Foundation			
Density	Sand replacement		Hold
Friction angle	Shear box		Hold
Cohesion	Shear box		Hold
Leveling pad			
Width	Spot check	+ 10%, - 2%	Hold
Depth	Spot check	+ 10%, - 2%	Hold
Density	Sand replacement		Hold
Friction angle	Shear box		Hold
Cohesion	Shear box		Hold
Masonry units			
Type	Spot check	As specified	Hold
Dimensions	Spot check	As specified	Witness
Strength	Spot check docket	As specified	Witness
Geogrids			
Type	Spot check markings	As specified	Hold
Strength grade	Spot check markings	As specified	Hold
Spacing	Spot check	As specified	Witness
Laps	Spot check	+,- 5%	Witness
Drainage system	Visual	As specified	Witness
Granular fill	Visual	As specified	Witness
Geofabric	Visual	As specified	Witness
Fill	Visual	As specified	Witness
Sealing and surface drains	Visual	Located to drg	Witness

**Basis of Design**

The retaining wall shall be constructed in accordance with the attached schedule and drawings.

The global stability, resistance to forward sliding and bearing capacity must be confirmed by the Geotechnical Engineer, from design data to be provided as part of the final design. These should be considered under all conditions of water levels.

Foundations must be designed and constructed for the combination of:

- factored vertical loads,  $P_V$ , spread over an effective bearing width,  $L_B$  (to give an ultimate bearing pressure,  $q_{ult}$ ), and
- coincident horizontal load,  $P_H$

Notes:

All loads are factored using the following formula  $1.25 G^C + 1.5 Q^C < 0.8G^R + (\Phi R)$ .