1.MATERIALS SPECIFICATION

1.1 INTRODUCTION

The specification below applies to Gabions, Reno® Mattresses, Terramesh®, Rockfall Netting and to the materials from which these are manufactured.

For simplicity the word "gabion" is used. This may be changed for or have the words "Reno® mattress" and/or "Terramesh®" and/or Rockfall Netting added singularly or in combination as appropriate unless specifically stated otherwise. Likewise the words "Plastic Coated" relates to a UV stabilised plastic coating extruded over the zinc-coated wire.

1.2 GENERAL DESCRIPTION

1.2.1. Gabions

Gabions shall be "Maccaferri" type flexible woven wire mesh boxes of dimensions as specified in the Bill of Quantities and/or drawings and manufactured and certified to meet Quality Assurance Standards AS/NZS ISO 9002.

The boxes shall be divided by diaphragms into cells of length not greater than the width of the gabion, or otherwise as stated in the Bill of Quantities and/or drawings.

The woven wire mesh twists shall be orientated horizontally along the length of the gabion.

End panels of all Gabions shall be mechanically selvedged to the Gabion base. Diaphragms shall be connected to the base by a spiral wire passing in turn through each mesh opening of the base and each mesh opening of the diaphragm panel.

1.2.2. Mattresses

Mattresses shall be "Maccaferri Reno®" type flexible woven wire mesh boxes with dimensions 6.0 x 2.0m in plan or as specified in the Bill of Quantities and/or drawings and manufactured and certified to meet Quality Assurance Standards AS/NZS ISO 9002.

The boxes shall be divided into cells by diaphragms across the width of the unit and at not more than 1.0m centres or as specified in the Bill of Quantities and/or drawings.

Diaphragms shall be double sided and formed by factory folding of the base panel to create the diaphragm of the required height (i.e. 0.17m, 0.23m and 0.3m).

The rigidity of each diaphragm shall be fixed at the base by a minimum of four wire spirals generally placed equidistant along the length of the diaphragm. Wire used to manufacture the spirals shall be to the specification of the mattress supplied. Diaphragms for 0.5m thick mattresses shall be of single mesh type and connected to the base by a spiral wire passing in turn through each mesh opening of the base and each mesh opening of the diaphragm panel.

1.2.3 Terramesh® Gabions and Panels

Terramesh® Gabions shall be flexible woven wire Heavily Galvanised and Plastic Coated mesh boxes with integral panels of dimensions as specified in the Bill of Quantities and/or drawings and manufactured and certified to meet Quality Assurance Standards AS/NZS ISO 9002.

Terramesh® panels shall be "Maccaferri" type flexible woven wire mesh in 2m wide panels or 50m x 2m Rolls or as specified in the Bill of Quanties and/or drawings and manufactured and certified to meet Quality Assurance Standards AS/NZ ISO 9002.

The mesh twists shall be orientated perpendicular to the front face in the reinforcement panel.

Both units to comply with this specification and the manufacturer shall submit to the superintendent prior to approval of the units a fully documented design method for reinforced soil walls using the proposed materials supported by independent full scale test data detailing confirmed mesh strength and soil friction interaction.

1.2.4 Rockfall Netting

Rockfall Netting shall be "Maccaferri" type flexible woven wire mesh in 50m x 2m Rolls or as specified in the Bill of Quanties and/or drawings and manufactured and certified to meet Quality Assurance Standards AS/NZ ISO 9002.

The Manufacturer shall submit to the superintendent prior to approval of the Rockfall Netting detailed documentation and test results validating the use of the proposed materials for the intended purpose including details of approved fixing, pinning and cabling methodologies.

1.3 STEEL WIRE

1.3.1 General

All wire used in the fabrication of the gabions and in the wiring operations during construction shall be to AS 1391, viz having a tensile strength of not less than 38kg/sq.mm.

1.3.2 Zinc Coating

All wire used in the fabrication of the gabions and in the wiring operations during construction shall be heavily galvanised and exceed AS 1650, the minimum mass of the zinc coating shall be according to the figures shown in the table below:

Diameter of Wire mm	Weight of Coating g/sq.m
3.40	275
3.00	275
2.70	260
Diameter of Wire mm	**Weight of Coating g/sq.m**
2.40	260
2.20	240
2.00	240

The adhesion of the zinc coating to the wire should be such that when the wire is wrapped six times round a mandrel of four times the diameter of the wire, it should not flake or crack to such an extent that any zinc can be removed by rubbing with the bare fingers.

1.3.3 Plastic Coating

Where stated in the Bill of Quantities and/or drawings, the heavily galvanised gabions shall also be plastic coated and fabricated from plastic coated wire to the following specifications:-

All wire used in the fabrication of Plastic coated gabions and in the wiring operations during construction shall have extruded onto it (after coating it with zinc in accordance with the foregoing specification) a coating of polymer, otherwise referred to as "plastic coating". The coating shall be 0.5mm average thickness and nowhere shall be less than 0.40mm thickness. The plastic coating shall be grey in colour.

It shall be capable of resisting deleterious effects of natural weather exposure, immersion in salt water and not show any material difference in its initial characteristics which are:

(a) Specific Gravity

Shall be 1.30 to 1.35 in accordance with ASTM D 792-91.

(b) Durometer Hardness

Shall be 50 to 60 shore D, in accordance with ASTM D 2240-91 (ISO 868-1985).

(c) Volatile Loss

Shall be less than 5% after 24hrs at 105°C, according to ASTM D2287-92
Residual Ashes shall be less than 2%, according to ASTM D2124-62T

(d) Tensile Strength

Shall not be less than 210kg/sq.cm in accordance with ASTM D 412-92

(e) Elongation

Shall not be less than 200% and not greater than 280% in accordance with ASTM D 412-92.

(f) Modulus of Elasticity at 100% of Elongation

Shall not be less than 190kg/sq.cm in accordance with ASTM D 412-87.

(g) Resistance of Abrasion

The loss in volume shall be less than 0.30 cm^3 according to ASTM D1242-56(75), test method

(h) Creeping Corrosion

Maximum penetration of corrosion of the wire core from a square cut end shall not be greater than 25mm when the specimen has been immersed for 2000 hours in a 50% solution of HCL (Hydrochloric Acid 12 BE).

Testing

Variation of the initial characteristics may be allowed, as specified hereunder, when the specimen is submitted to the following tests:

(a) Salt Spray

According to ASTM B 117-90.
Period of test = 3000 hours.

(b) Exposure to Ultraviolet Light

According to ASTM D 1499-92 and ASTM G 23(93) apparatus type E.
- Period of test = 3000 hours at 63°C.

(c) Exposure at High Temperature

According to ASTM D 1203-89, (ISO 176-1976) and ASTM D 2287-(92)E2.
- Period of test = 24 hours at 105°C.

After the above tests have been performed, the plastic coating shall exhibit the following properties:-

(a) Appearance

The vinyl coating shall not crack, blister or split and shall not show any marked change in colour.

(b) Specific Gravity

Shall not show change greater than 6% of its initial value.

(c) Durometer Hardness

Shall not show change greater than 10% of its initial value.

(d) Tensile Strength

Shall not show change greater than 25% of its initial value.

(e) Elongation

Shall not show change greater than 25% of its initial value.

(f) Modulus Elasticity

Shall not show change greater than 25% of its initial value

(g) Resistance to Abrasion

Shall not show change greater than 10% of its initial value.

1.4 MESH

The mesh shall be hexagonal mechanically woven mesh wherein the joins are formed by twisting each pair of wires through three half turns (commonly called Double Twist).

For gabions the wire diameter, (wire core diameter in the case of plastic coated gabions) shall be 2.7mm. The nominal size of the mesh for gabions shall be 80 x 100mm. The dimension 80mm being taken from centre to centre of the twisted joins. Mesh twists direction shall be orientated horizontally along the length of the unit to facilitate the erection process.

For Reno® Mattresses (170, 230 or 300mm deep) the wire diameter (wire core diameter in the case of plastic coated mattresses) shall be 2.0mm. For mattresses the nominal mesh size shall be 60 x 80 mm. The dimension 60mm being taken from centre to centre of the twisted join.

For mattresses 500mm deep the core wire diameter (core wire diameter in the case of Plastic coated mattresses) shall be 2.4mm or as stated in the Bill of Quantities. The nominal mesh size shall be 60 x 80mm with the 60mm dimension being taken from centre to centre of the twist joins.

For Terramesh® the wire core diameter shall be 2.7mm and the nominal mesh size shall be 80x100mm and shall always be made from Heavily Galvanised and plastic coated wire.

For Rockfall Netting the wire diameter (wire core diameter in the case of Plastic Coated wire) shall be 2.7mm. The nominal mesh size shall be 80 x 100mm.

1.5 SELVEDGES

All cut edges and side edges of the mesh forming the gabions, Reno® mattress, and Terramesh® and Rockfall Netting shall be mechanically selvedged to develop the full strength of the mesh and to prevent ravelling. The line wire used within the selvedge perpendicular to the mesh direction shall have a diameter not less than 20% greater than the wire used to form the body mesh. Diaphragm panels for gabions to be selvedged on sides and top edge only.

1.6 BINDING AND CONNECTING WIRE

Binding and connecting wire must be supplied with the gabions to perform all the wiring operations to be carried out in construction of the gabion work. The diameter of the wire (wire core in the case of plastic coated gabions) shall be 2.2mm.

Lacing Tool

As an alternative and/or in combination with hand lacing using binding wire, the use of a mechanical (pneumatic) lacing tool and rings may be permitted.

Rings shall be either Zn/AL for galvanised units or stainless steel for Plastic Coated units.

1.7 TOLERANCES

WIRE A tolerance on the diameter of all wire in the above clause of 2.5% shall be permitted (BS 1052-80); consequently the weight of the gabions is subject to a tolerance of ± 5%.

MESH A tolerance of +16%-4% on the nominal size of the mesh shall be permitted. The tolerance being applicable to the distance between the axis of twists only.

GABIONS A tolerance of ± 5% on the width and the height of the gabion and a tolerance of + 3% on the length shall be permitted

A tolerance of ± 10% on the length of the compartments shall be permitted

1.8 TESTING

The contractor shall supply detailed documentation and independent full-scale test results, which validate the use of the proposed materials for the intended purpose and design methodology used. These test results shall include but not be limited to; - mesh tensile and burst strengths, mechanical bend and shear tests, hydraulic shear stress etc.

2. SPECIFICATION FOR ASSEMBLY AND ERECTION OF GABIONS

2.1 SCOPE

This specification details the requirements from the assembly stage through to the final wiring of the completed gabion product.

The contractor shall provide to the superintendent, for his approval, full details and specifications of the gabion he proposes to use in this contract including test data from a TELARC or other registered laboratory or Audited Quality Assurance Certificates to AS/NZS ISO9002. Only those products so approved by the superintendent shall be allowed to be incorporated in the works.

Installation of the gabions shall only be undertaken by specialist installers, approved by the manufacturer and highly experienced in this work. The contractor shall provide to the superintendent for his approval, full details of the specialist installers experience in this type of work, and the installers fully documented Quality Assurance System to ISO9001 (1994).

If during the course of the work the superintendent determines that the specialist installer is not sufficiently skilled or experienced in the installation of the gabions/mattresses, approval for the use of that specialist installer may be revoked. The contactor shall then obtain approval to use another specialist installer. Any delay or expenses so incurred shall be the contractor's responsibility.

2.2 ASSEMBLY

2.2.1

Prior to assembly, the gabion material shall be opened out flat on the ground and stretched to remove all kinks and bends.

2.2.2

The gabion boxes shall be assembled individually, by raising the sides, ends and diaphragms, ensuring that all creases are in the correct position and that the tops of all four sides and the diaphragms are even.

2.2.3

The four corner edges of the Gabion boxes shall be laced first, followed by the edges of internal diaphragms to the sides.

2.2.4

In all cases, lacing shall commence by twisting the end of the lacing wire tightly around the selvedge/s. It shall then pass round the two edges being joined using alternate single and double loops at 100mm intervals and be securely tied off at the bottom. The ends of all lacing wires shall be turned to the inside of the box on completion of each lacing operation. Each loop shall be pulled tight to prevent the joint opening during filling. Tightness of the lacing is essential.

As an alternative to the continuous lacing wire system for securing gabions, an approved mechanical system conforming to Section 1.6 using heavily galvanised clips (or Stainless Steel for plastic specification units) may be used. Spacing of clips shall be to the gabion manufacturers recommendations.

2.3 ERECTION

2.3.1

Only assembled boxes, or groups of boxes, shall be positioned in the structure. The side, or end, from which work is to proceed, shall be secured either to the completed work, or by rods or stakes driven into the ground at the corner. These stakes must be secure and reach at least to the top of the gabion box.

2.3.2

Further gabion boxes shall be positioned in the structure as required, each being securely laced to the preceding one along all common corners and diaphragms using the lacing technique described in 2.2.4.

2.4. STRETCHING

2.4.1

Final stretching of the gabion boxes shall be carried out using a pull-lift of at least one tonne capacity, firmly secured to the free end of the assembled gabion boxes.

2.4.2

Whilst under tension, the gabion boxes shall be securely laced along all edges (top, bottom and sides) and at diaphragm points, to all adjacent boxes.

2.5 FILLING

2.5.1

Filling shall be carried out whilst gabion boxes are under tension.

2.5.2

The front face and all other faces which will be exposed in the completed structure shall be "hand packed" with the stones placed so as to produce a neat face free from excessive bulges, depressions and voids.

2.5.3

Internal bracing wires shall be provided on the exposed faces at the rate of 4/cu.m at 330mm centres to prevent distortion of the gabion units during filling and in the completed structure.

These bracing wires shall be wrapped around two of the mesh wires and extend from front to back.

Additional bracing wires shall be provided on exposed ends at a rate of 4/sq.m of face.

2.5.4

Tension on the gabion boxes shall be released only when fully laced and sufficiently full to prevent the mesh from slackening.

2.5.5

All gabions shall be overfilled by 25mm using flat stone to allow for minor settlement and to provide a level surface for subsequent layers.

2.6 FINAL LACING

2.6.1

Closing and lacing down of lids shall proceed as soon as practicable after filling operations especially if exposed to the likelihood of storm or flood during construction.

2.6.2

Lids shall be stretched tight over the filling with suitably designed closing tools and laced down securely through each mesh along all edges, ends and diaphragms using the lacing method described in 2.2.4 before commencing work on the next layer of gabion. The ends of all tying and bracing wires shall be turned into the gabion box on completion of each lacing operation.

3. SPECIFICATION FOR ASSEMBLY AND ERECTION "TERRAMESH®" REINFORCED WALLS

3.1 SCOPE

This specification details the requirements from the assembly stage through to the final wiring of the completed Terramesh® Gabion Units.

The contractor shall provide to the superintendent, for his approval, full details and specifications of the gabion he proposes to use in this contract including test data from a TELARC or other registered laboratory or Audited Quality Assurance Certificates to AS/NZS ISO9002. Only those products so approved by the superintendent shall be allowed to be incorporated in the works.

Installation of the gabions shall only be undertaken by specialist installers, approved by the manufacturer and highly experienced in this work. The contractor shall provide to the superintendent for his approval, full details of the specialist installers experience in this type of work, and the installers fully documented Quality Assurance Systems to ISO9001 (1994).

If during the course of the work the superintendent determines that the specialist installer is not sufficiently skilled or experienced in the installation of the gabions/mattresses, approval for the use of that specialist installer may be revoked. The contactor shall then obtain approval to use another specialist installer. Any delay or expenses so incurred shall be the contractor's responsibility.

3.2 PREPARATION

3.2.1.

Prior to assembly the Terramesh® Gabion and panel shall be opened out flat on the ground and stretched to remove all kinks and bends.

3.2.2.

The Terramesh® Gabion shall be assembled individually by raising the hinged back panel to the vertical, complete with two ends, and the box section completed by raising the front panel and lid ensuring that all creases are in the correct position and that tops of all four sides are even. The diaphragm panel should be located in a vertical plane centrally within the gabion.

3.2.3.

The four corner edges of the gabion shall be laced first followed by the edges of the internal diaphragm to the sides.

3.2.4.

In all cases, lacing shall commence by twisting the end of the lacing wire tightly around the selvedge/s. It shall then pass round the two edges being joined using alternate single and double loops at 100mm intervals and be securely tied off at the bottom. The ends of all lacing wires shall be turned to the inside of the box on completion of each lacing operation. Each loop shall be pulled tight to prevent the joint opening during filling.

As an alternative to the continuous lacing wire system for securing gabions, an approved mechanical system conforming to section 1.6 using heavily galvanised clips (or Stainless Steel for plastic specification units) may be used. Spacing of clips shall be to the gabion manufacturers recommendations.

3.3 ERECTION

3.3.1.

All erection stretching filling and lacing shall be in accordance with the specification for assembly and erection of plastic coated gabions clauses 2.3, 2.4, 2.5 and 2.6.

3.4 ANCHORAGE PANELS

The panel extends from the front face of the Terramesh® Gabion and the mesh is oriented so that the twists are at right angles to the face of the wall (ie. aligned to the line of maximum tension).

Panels are laced to the base of the Terramesh® gabion, front and back and in accordance with the specification for assembly and erection of Terramesh® Reinforced Walls clauses 3.2.4,

3.5 LACING

Adjacent panels shall be fixed longitudinally to provide security against upturning during placement of backfill.

All lacing wire shall be plastic coated as per clause 3.2.4.

3.6 GEOTEXTILE

Non-woven geotextile as specified shall be placed at the back of each gabion layer and extend 0.5m above the lower panel and 0.5m below the higher panel to prevent migration of fines from the select backfill.

A properly designed conventional gravel filter may be used if approved by the engineer.

3.7 SELECT BACKFILL

3.7.1

Select backfill shall be placed between each subsequent mesh panel layer to the full extent of the mesh reinforcement at each level.

The backfill shall be a well graded sand or fine gravelly sand and free draining and have the following minimum specification unless otherwise approved by the engineer:-

- not more than 15% by mass of total material to be finer than 75 micron sieve opening.
- maximum particle size to be limited to a maximum of 75mm.

- pH not less than 5.0.

3.7.2 Alternative Material (Testing)

Materials not satisfying the above size criteria may be accepted by the Engineer providing that the internal friction angle is determined by an appropriate test method for the given site conditions and that due regard to hydrostatic pore water and groundwater are given.

3.8 COMPACTION

The select backfill shall be compacted in lifts not exceeding 0.3m to 95% standard compaction (AS 1289 E1.1) unless otherwise specified on the drawings.

Care shall be taken to ensure heavy compaction equipment does not come into contact with the mesh panels or within 1.0m of the gabions.

Compaction adjacent to the gabions should be done using hand operated rollers or plate compactors.

4. SPECIFICATION FOR ASSEMBLY AND ERECTION OF RENO® MATTRESS

4.1 SCOPE

4.1.1

This specification details the requirements for the assembly stage through to the final wiring of the completed Reno® mattress.

The contractor shall provide to the superintendent, for his approval, full details and specifications of the mattress he proposes to use in this contract including test data from a TELARC or other registered laboratory or Audited Quality Assurance Accreditation Certificates to AS/NZS ISO9002. Only those products so approved by the superintendent shall be allowed to be incorporated in the works.

Installation of the mattress shall only be undertaken by specialist installers, highly experienced in this work. The contractor shall provide to the superintendent for his approval, full details of the specialist installers experience in this type of work and the installers fully documented Quality Assurance System to ISO9001 (1994).

If during the course of the work the superintendent determines that the specialist installer is not sufficiently skilled or experienced in the installation of Reno® mattresses, approval given for the use of that specialist installer may be revoked. The contractor shall then obtain approval to use another specialist installer. Any delay and expense incurred shall be the contractor's responsibility.

4.2 ASSEMBLY

4.2.1.

To assemble the Reno® mattress base shall be opened out on the ground and all unnecessary creases removed. The lid is opened separately and all folds and creases should be removed.

4.2.2.

Mattresses shall be assembled individually by raising the sides and stamping the mesh to create the diaphragm folds. Care must be taken to ensure that the folded diaphragms and sides are vertical and of the correct height as identified in the Bill of Quantities.

4.2.3

The edges of the folded diaphragms shall be laced to the side panels using the lacing technique described in 3.2.4

The four corner edges of the mattress shall also be joined in this manner.

4.2.4

Shortening of the double diaphragm standard units to create smaller mattress lengths may be effected by cutting along the apex of any diaphragm fold ensuring a neat and integral end remains.

In all cases, lacing shall commence by twisting the end of the lacing wire around the selvedge/s. It shall then pass round the two edges being joined using alternative single and double loops at 100mm centres and be securely tied off at the bottom. Tightness of the mesh and wiring is essential.

As an alternative to the continuous lacing wire system for securing gabions, an approved mechanical system using heavily galvanised clips (or Stainless Steel for PVC specification units) may be used. Spacing of clips shall be to the gabion manufacturers recommendations.

4.3 ERECTION

Only assembled mattress or groups of mattresses shall be positioned in the structure, each mattress being securely laced to the surrounding ones along the perimeter. When the mattress is laid on a slope steeper than 1 in 1.5 it should be secured by hardwood stakes or star pickets driven into the ground just below the upper end panel, at 2m centres or as approved. It is essential that the mattress remain free to flex and accommodate any settlement or scour.

4.4 FILLING

4.4.1.

Mechanical filling equipment shall be used with the approval of the Engineer and providing adequate precautions are taken to protect the plastic coating from abrasion during filling operations.

4.4.2

Filling materials shall be hand packed to ensure all diaphragm compartments are fully filled and to produce a neat and level top surface.

4.4.3

Mattress units shall be overfilled by 25-50mm above to allow for subsequent settlement to prevent excessive stone movement under hydraulic conditions.

4.4.4

Where suitably sized filling materials cannot be obtained, the superintendent may approve insertion of a second mesh panel consisting of the same specifications as the mattress, below the top and front face of the mattress to contain the smaller sized rock filling within the mattress. The second woven wire mesh panel can be laced to the structure and off set by one half mesh.

4.5 FINAL LACING

4.5.1

Closing and lacing down of lids shall proceed as soon as practical after filling operations, immediately in the likelihood of storm flood during construction.

Lids shall be stretched tight over the filling with suitably designed closing tools and laced down securely through each mesh along all edges and diaphragms using the lacing technique described in 3.2.4. The ends of all tying wires shall be turned into the Reno® mattress on completion of all lacing operations.

5 ROCKFILL SPECIFICATION FOR GABIONS AND MATTRESS

5.1 GENERAL

Rockfill shall be dense, hard and durable Engineer. Recommended guidelines are given below.

5.2 LOS ANGELES VALUE ("B") GRADING - AS 1141.23

- not more than 20%.

5.3 AGGREGATE WET/DRY STRENGTH - AS 1141.21

Dry strength not less than 200kN
Wet strength not less than 100Kn
Wet/dry strength variation not greater than 50%.

5.4 SIZE

5.4.1

Gabion rock shall be 100-250mm with not more than 5% passing a 75mm aperture sieve opening.

5.4.2

Mattress rock shall be nominally (80mm to 0.66dmm) where d is the standard mattress depth (170, 230, 300mm).
For non-standard (deeper) mattress units the maximum rock size should not exceed 200mm.

5.4.3

In all cases not more than 10% of the material shall pass through a 75mm aperture sieve opening.