TECHNICAL NOTE

Global Synthetics
LEADERS IN GEOSYNTHETICS

Gabion Baskets & Rock Mattresses

Supply & Installation Technical Specifications

General

This Specification covers the supply of the gabion baskets, the rock filling to these, the preparation of the base for the walls and the placement, filling and tying of the baskets. It defines the quality of both materials and workmanship for the finished wall.

The specification below applies to Gabions & Rock Mattresses 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 "rock mattress" 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 Galfan coated wire.

Abbreviations

The abbreviations listed below, when used in this Specification, shall have the following meanings.

NZS	New Zealand Standard
AS	Australian Standard
BS	British Standard
ASTM	American Society for Testing of Materials
EN	European Normalisation
ISO	International Standards Organisation

Codes and Standards

ASTM A975-11(2021)	Standard Specification for Double Twisted Hexagonal Mesh gabions and Revetment mattresses
AS 1391-2007	Tensile Testing – Metallic Materials.
AS/NZS 4534-2006	Zinc and Zinc Aluminium Coatings on steel wire.
AS 1141-2015	Methods for Sampling and Testing Aggregates.
ASTM B 750-16	Standard Specifications for Galfan (Zinc 5% Aluminium Mischmetal) Alloy in Ingot Form for Hot Dip Coatings.
ASTM D412-15a	Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension
ASTM D1242-95a	Standard for Resistance of Plastic Materials to Abrasion
EN 10223-3:2013	Steel wire and wire products for fences. Part 3: wire netting for engineering purposes.
EN 10244-2:2023	Steel wire and wire products-non ferrous coatings on steel wire. Part 2 zinc or zinc alloy coatings.
EN 10245-2:2011	Steel wire and wire products-organic coatings on steel wire. Part 2 PVC finished wire.
ISO 527-2:2019	Determination of tensile properties -- Part 2: Test conditions for moulding and extrusion plastics.
ISO 868:2003	Plastics and ebonite- Determination of indentation hardness by means of a Durometer (Shore Hardness).
ISO 1183-1: 2019	Plastics- Methods for determining the density of non cellular plastics. Part 1 Immersion method, liquid pyknometer method and titration method.
REFERENCE DOC.	Link Gabion and Mattresses Design Booklet. Issue 2009

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Materials

GABIONS

Gabions shall be "Link" 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 Standard ISO 9001.

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.

ROCK MATTRESSES

Mattresses shall be "Link" 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 Standard ISO 9001.

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 manufactured from single mesh panels selvedged on all sides panel to create the diaphragm of the required height (i.e. 0.17m, 0.23m and 0.3m and 0.5m).

The rigidity of each diaphragm shall be assured by positively factory connecting the diaphragm to the base panel.

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.

Wire used to manufacture the spirals shall be to the specification of the mattress supplied.

SHIPPING

Baskets shall be shipped flat but complete with central vertical division, ends and lid. Note that the baskets that will be approved for the project are those available from Global Synthetics Pty Ltd

Steel Wire For Gabions & Rock Mattresses

All wire used in the fabrication of the gabions and in the wiring operations during construction shall be to EN 10233-3 and shall have a tensile strength of between 350 -500 N/mm^2.

GALFAN COATING

All wire used in the fabrication of the gabions and rock mattresses and in the wiring operations during construction shall be GALFAN coated and shall comply with the requirements of EN 10244-2. Coating type to comply with ASTM B750-16 and shall include rare earth mischmetals (MM). See Table 1.

Diameter of Wire mm	Weight of Coating gm/m^2
3.40	265
3.00	255
2.70	245
Diameter of Wire mm	**Weight of Coating gm/m^2**
2.40	230
2.20	230
2.00	215

The adhesion of the Galfan 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 coating can be removed by rubbing with the bare fingers.

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PLASTIC COATING

Where stated in the Bill of Quantities and/or drawings, the Galfan 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 Galfan coating 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. The plastic coating shall be in accordance with the specification following and shall additionally comply with EN 10245-2:2011.

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 ≤ 1.5g/m3 on accordance with ISO 1183-1:2019

(b) Durometer Hardness
Shall be ≥ 38 (Shore D) in accordance with ISO 868:2003

(c) Tensile Strength
Shall be ≥ 17 MPa in accordance with ISO 527-2:2019

(d) Elongation
Shall be ≥ 200% in accordance with ISO 527-2:2019

(e) Modulus of Elasticity at 100% of Elongation
Shall not be less than 190kg/cm2 in accordance with ASTM D 412-15a.

(f) Resistance to Abrasion
The loss in volume shall be less than 0.30 cm3 according to ASTM D1242-95a, test method

MESH FOR GABIONS & ROCK MATTRESSES

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 rock 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 joins.

For mattresses 500mm deep the core wire diameter (core wire diameter in the case of Plastic coated mattresses) shall be 2.7mm or as stated in the Bill of Quantities. The nominal mesh size shall be 80 x 10mm with the 80mm dimension being taken from centre to centre of the twisted joins.

SELVEDGES

All cut edges and side edges of the mesh forming the gabions and rock mattresses shall be mechanically selvedged to develop the full strength of the mesh and to prevent raveling. 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.

BINDING & 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 wire shall be supplied 5% by mass of gabion units supplied and 5% by mass of rock mattress units supplied.

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 Galfan coated for Galfan units or stainless steel for Plastic Coated units and shall meet the published specifications of Global Synthetics P/L for such product.

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Each ring shall have the following characteristics

Diameter:	3mm
Tensile Strength:	1530-1745 Mpa
Stainless Steel Grade:	Type 302 when used with plastic coated product.
Galfan Coated:	Galfan rings when used with Galfan product.
Dimension:	The dimensions of the C shaped ring when open shall be 44mm externally and 19mm when closed with the Lacing Tool.

TOLERANCES

WIRE	A tolerance on the diameter of all wire in the above clause of 2.5% shall be permitted (EN 10223:2013); 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 and in accord with EN 10223:2013.
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.

TESTING

The Contractor shall supply detailed documentation and test results that confirm compliance to this specification. The results must be traceable to the mesh supplied for the Project. All mesh bundles shall be identified with the type and number of gabions/mattress. A system of colour coded markings shall also identify the type of gabions/mattress contained within the bundle. Each bundle shall be uniquely identified such that each bundle is fully traceable to factory manufacture and compliance testing carried out as part of the MQC process during manufacture.

ROCK FILLING TO GABIONS BASKETS & ROCK MATTRESSES

Rock for gabion construction shall be hard, durable and shall be of such a size as to pass through a 300 mm sieve but be retained on a 100mm sieve. Rock for rock mattress construction shall be of equal quality to that proposed under this specification with the maximum stone size limited to no more than 2/3rds the depth of mattress proposed (0.5m rock mattress shall be interpreted as a gabion for requirements of rock fill size) and a minimum size of 75mm.

For both gabion and mattress rock, there will be an allowance of up to 5% oversize material and no more than 3% undersize material.

The rock shape is preferred to be generally cubical in shape. River run rock (or crushed river rock) is generally acceptable however the supplier shall submit a sample to the site for approval by the Engineer before full deliveries are undertaken to site.

In general the rock shall comply with the following TABLE 2

TABLE 2 - ROCK QUALITY

Los Angeles Value B Grading (AS1141)	< 20%
Wet / Dry Strength- Standard Fraction (AS 1141)	
Dry Strength	≥ 200kN
Wet strength	≥100 kN
Wet / Dry strength	≥ 50%

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Specification For The Assembly & Erection Of Gabions

GENERAL

This specification details the requirements from the assembly stage through to the final wiring of the completed gabion product. 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 Engineer for his approval, full details of the specialist installers experience in this type of work.

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

ASSEMBLY

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

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

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 using Galfan clips (or Stainless Steel for plastic specification units) may be used. Spacing of clips shall be to the gabion manufacturer's recommendations but shall generally be in accord with spacing requirements detailed by ASTM A975-11 (2021) Table 2.

ERECTION

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.

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 'Assembly'.

STRETCHING

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

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.

FILLING

Mechanical filling of the gabion baskets is allowed but care must be taken during such filling operations, that no permanent damage or distortion of the gabion basket occurs.

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

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 bulge's, depressions and voids.

Internal bracing wires shall be provided on the exposed faces at the rate of 4 per m2 at 330mm centres to prevent distortion of the gabion units during filling and in the completed structure for 1m high baskets. For 0.5m gabion baskets it is permissible to provide internal bracing at 250mm centres vertically and 330mm centres horizontally.

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 per m2 of face for 1m high gabions. For 0.5m high gabions internal bracing shall be supplied at the rate 2 per 0.5m2 of face.

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

Factory formed bracing wires available from Global Synthetics may be used as an alternative to the internal bracing wires with placement required at the same frequency as described above.

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

FINAL LACING

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.

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 on page 5 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.

Specification For The Assembly & Erection Of Rock Mattresses

GENERAL

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

Installation of the rock mattresses shall only be undertaken by specialist installers, approved by the manufacturer and highly experienced in this work. The Contractor shall provide to the Engineer for his approval, full details of the specialist installers experience in this type of work.

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

ASSEMBLY

To assemble the rock mattress the 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.

Mattress base units shall be assembled individually by raising the sides and diaphragms. Care must be taken to ensure that the diaphragms and sides are vertical and of the correct height as identified in the Bill of Quantities or on the drawings. The edges of the diaphragms shall be laced to the side panels. Lacing of side panels and diaphragms is achieved by straightening the spiral wire that attaches the base unit to the diaphragm unit and the excess wire thus formed to join in the approved lacing manner of alternate single and double loops.

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

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 manufacturer's recommendations. Spacing of clips shall be to the gabion manufacturer's recommendations but shall generally be in accord with spacing requirements detailed by ASTM A975-11 (2021) Table 2.

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 potential scour profiles.

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FILLING

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.

Filling materials shall be hand packed to ensure all diaphragm compartments are fully filled and to produce a neat and level top surface. Mattress units shall be overfilled by 25-50mm above to allow for subsequent settlement to prevent excessive stone movement under hydraulic conditions.

Where suitably sized filling materials cannot be obtained, the Engineer 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

FINAL LACING

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 previously ensuring that single and double loops are formed from a continuous length of lacing wire at alternate mesh openings. The ends of all tying wires shall be turned into the rock mattress on completion of all lacing operations.

Wall Construction

PREPARATION OF WALL BASE

At wall locations, excavate and prepare a base for the starting of the wall. This base shall be cut horizontal but, in sloping ground, the base may be cut into horizontal benches with 1000mm (or 500mm as appropriate to the gabions used) vertical height between each bench. The length of the horizontal benches shall be set out in multiples of 2000mm to suit the gabion basket length.

Slope the bench to the rear to maintain the wall face slope at an angle of 70 degrees from the horizontal or otherwise, as shown by the Drawings or Superintendent directions.

Compact the bench base (if required) before starting to construct wall and ensure that the design bearing capacity has been achieved. Bearing capacity shall be determined by a geotechnical engineer who shall confirm with the Contractor that the required bearing condition has been achieved. Such evidence shall be made available to the Superintendent when requested.

Changes Of Direction Of Wall

Where changes of direction are shown on the drawings, the set-out details shown on the drawings are to be followed.

Culvert Pipes

Where culvert pipes penetrate the wall, carefully lay baskets on either side of the pipe of such height to form a bridge. Pack the spaces between the baskets and the pipe with large stone (max. size 250mm) to prevent loss of earth fill.

Earth Filling

Earth filling shall be placed behind the wall when every second course is completed (i.e. 2000mm high) but the filling shall only extend for 1000mm high before the next layer of gabions is placed.

Compaction of the backfill immediately behind the wall shall be carried out by hand sized plate compactors, to the satisfaction of the Superintendent.

Drainage/ Geotextiles

Suitable drainage treatments where required, shall be installed as detailed by the Bill of Quantities and or drawings. Geotextile required to be installed behind gabion walls and under rock mattress shall be a nonwoven type and shall be equivalent to Profab AS801. The location and extent of such usage of geotextiles shall comply with the requirements ofsubsurface drainage requirements for the Project

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Arrangement & Order Of Work

It is expected that the bulk filling and compaction of the filling shall be completed in successive lifts at the same time as the construction of the gabion wall. Note that the wall is designed as a gravity wall and that excessive height of fill behind (and exerting forces on) the partly completed gabion wall may cause collapse. Each horizontal course must be completed before the next one starts and backfilling should proceed continuously to avoid too much height of unfilled space.

Dimensional Tolerances

The walls shall occupy true planes with a maximum deviation from straightness of 50mm in 3000 mm and a deviation from 70 degree vertical angle of no more than ± 2 degrees. Note that 70 degrees over a 1000mm height of gabion is equivalent to an offset of 360mm. Should an offset of gabions be used in the design then base preparation for such wall structures may be laid level with no slope (front to back) at foundation level.

About Us

Leaders in Geosynthetics

Global Synthetics is a 100% Australian-owned company, proud to offer a complete range of high-quality geosynthethic products backed by over 200 years of combined staff experience in the industry.

We have supplied products to some of the largest recent infrastructure works in Australia. Global Synthetics provides major benefits to any geotechnical engineering project with the right products and our technical expertise.

Global Synthetics products are used in the following applications:

- Pavement Stabilisation
- Ground Improvement
- Soil Reinforcement and Retaining Structures
- Water Management
- Drainage Systems & Hydraulic Works
- Landfills
- Coastal Erosion Structures

Get in Touch

AUSTRALIA

Website
globalsynthetics.com.au

Email
info@globalsynthetics.com.au

New South Wales
(02) 9725 4321

North Qld
(04) 5921 1692

Victoria/Tasmania
(03) 9791 1772

Queensland
(07) 3865 7000

South Australia
(08) 8384 8894

Western Australia
(08) 9459 4300

NEW ZEALAND

Website
globalsynthetics.co.nz

Email
info@globalsynthetics.co.nz

Auckland
0800 510 120

Christchurch
0800 510 120



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