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Agrément Certificate

95/3141

Product Sheet 1

MACCAFERRI EARTH RETENTION, SOIL REINFORCEMENT AND PROTECTION SYSTEMS

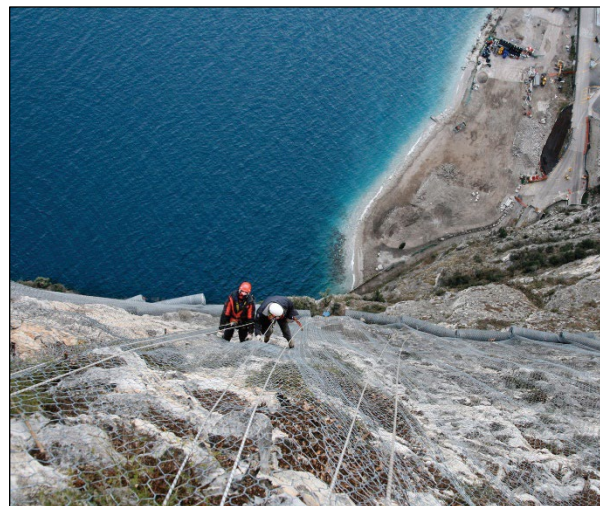
MACCAFERRI HEXAGONAL DOUBLE TWISTED MESH PRODUCTS FOR CIVIL AND ENVIRONMENTAL ENGINEERING APPLICATIONS

This Agrément Certificate Product Sheet ⁽¹⁾ relates to Maccaferri Hexagonal Double Twisted Mesh Products for Civil and Environmental Engineering Applications, comprising Gabions, Reno Mattresses, Cylindrical Gabions and mesh in rolls for civil engineering applications such as earth retention, soil reinforcement systems, river training works, slope stabilisation and erosion control in both temporary and long-term installations. This Certificate does not cover the use in any application of the mesh within the foundation zone of a building.

(1) Hereinafter referred to as 'Certificate'.

CERTIFICATION INCLUDES:

- factors relating to compliance with Building Regulations where applicable
- factors relating to additional non-regulatory information where applicable
- independently verified technical specification
- assessment criteria and technical investigations
- design considerations
- installation guidance
- regular surveillance of production
- formal three-yearly review.



KEY FACTORS ASSESSED

Structural performance — the products, when used correctly in a fully designed application, will have adequate strength to resist the anticipated loads and the designed long-term performance (see section 5).

Installation damage — the products, when used correctly in a fully designed application, will have adequate strength to resist the anticipated loads (see section 5).

Durability — when used in accordance with the requirements of this Certificate, the polymer-coated products may be considered to have a life expectancy in excess of 120⁽¹⁾ years (see section 8).

(1) Excludes the effects of adverse abrasion.

The BBA has awarded this Certificate to the company named above for the products described herein. These products have been assessed by the BBA as being fit for their intended use provided they are installed, used and maintained as set out in this Certificate.

On behalf of the British Board of Agrément

Date of Third issue: 7 July 2022

Originally certificated on 22 May 1995


Hardy Giesler
Chief Executive Officer

The BBA is a UKAS accredited certification body – Number 113.

The schedule of the current scope of accreditation for product certification is available in pdf format via the UKAS link on the BBA website at www.bbacerts.co.uk
Readers MUST check the validity and latest issue number of this Agrément Certificate by either referring to the BBA website or contacting the BBA directly.
Any photographs are for illustrative purposes only, do not constitute advice and should not be relied upon.

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Regulations

In the opinion of the BBA, the use of Maccaferri Hexagonal Double Twisted Mesh Products for Civil and Environmental Engineering Applications is not subject to the requirements of the national Building Regulations.

Construction (Design and Management) Regulations 2015

Construction (Design and Management) Regulations (Northern Ireland) 2016

Information in this Certificate may assist the client, designer (including Principal Designer) and contractor (including Principal Contractor) to address their obligations under these Regulations.

See sections: 3 *Delivery and site handling* (3.1 and 3.4) and 11 *Installation Procedure* (11.12) of this Certificate.

Additional Information

CE marking

The Certificate holder has taken the responsibility of CE marking the products in accordance with ETA 16/0758 and ETA 15/0219 and UKCA marking in accordance with UKTA 22_0019 and UKTA 22_0021.

Technical Specification

1 Description

1.1 Maccaferri Hexagonal Double Twisted Mesh Products for Civil and Environmental Engineering Applications comprise Gabions, Reno Mattresses, Cylindrical Gabions, mesh in rolls formed from metallic (a zinc or zinc-aluminium alloy), or metallic and polymer coated [PVC, PA6 or PoliMac⁽¹⁾], steel wire fabric, manufactured in a standard range of mesh/wire combinations (see Table 1). The products are held together using the links listed in this Certificate (see sections 1.11 and 1.12). The mesh is available in a variety of widths and lengths depending on product but is typically supplied in rolls of either 2 or 3 m width x 25 m length.

(1) PoliMac is a registered trademark.

Table 1 Standard mesh and wire sizes

Mesh designation	Mesh opening size M ⁽¹⁾ (mm)	Mesh	Diameter of wires (mm)		
			Edge and selvage	Mesh with PVC, PoliMac or PA6 (external)	Edge and selvage with PVC, PoliMac or PA6 (external)
6 x 8 ⁽²⁾	60 ⁽²⁾	2.0	2.4	3.0	3.4
		2.2	2.7	3.2	3.7
		2.4	3.0	3.4	4.0
		2.7	3.4	3.7 ⁽³⁾	4.4 ⁽³⁾
8 x 10 ⁽²⁾	80 ⁽²⁾	2.2	2.7	3.2	3.7
		2.4	3.0	3.4	4.0
		2.7	3.4	3.7	4.4
		3.0	3.9	4.0 ⁽³⁾	4.4 ⁽⁵⁾
		3.4	4.4	4.4 ⁽⁴⁾	4.4 ⁽⁶⁾
		3.9	4.9	—	—
10 x 12 ⁽²⁾	100 ⁽²⁾	2.7	3.4	3.7	4.4
		3.0	3.9	—	—

(1) See Figure 1.

(2) Values are also declared in ETA 16/0758 and ETA 15/0219 and UKTA 22_0019 and UKTA 22_0021.

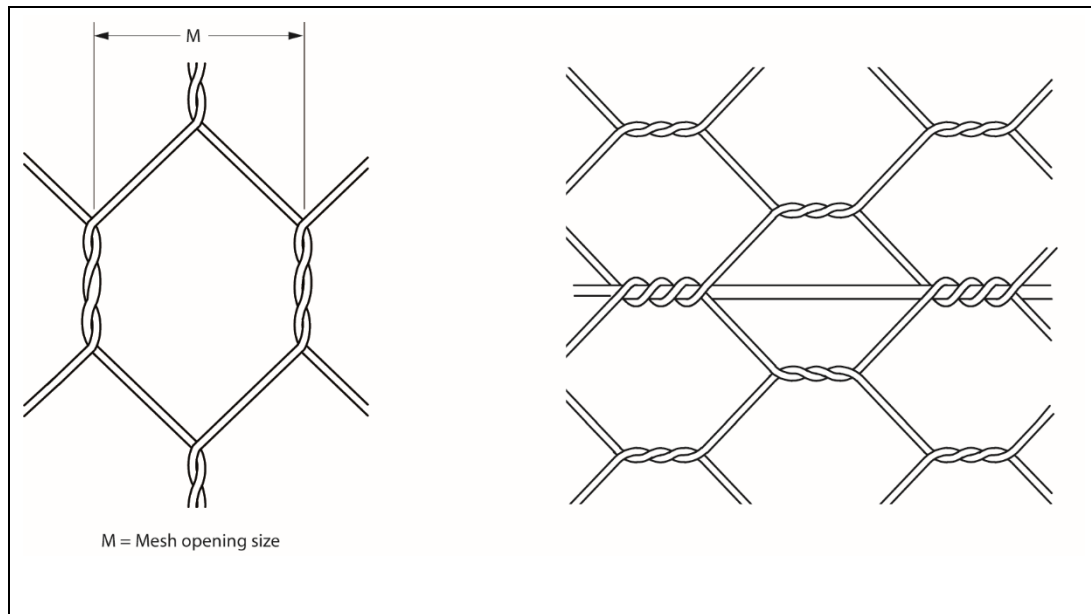
(3) For PoliMac and PA6 only.

(4) For PA6 only.

(5) For PA6 and PoliMac only, selvage wire 3.4 mm.

(6) For PA6 only, selvage wire 3.4 mm.

Figure 1 Details of hexagonal mesh regular (left) and reinforced (right)



1.2 The base metal of the hexagonal netting is steel wire and complies with BS EN 10218-1 : 2012 and BS EN 10218-2 : 2012. The steel wire has a minimum tensile strength in the range of 350 to 550 N·mm⁻², with a minimum elongation at rupture of 8%, and is drawn from rods complying with BS EN ISO 16120-1 : 2017 and BS EN ISO 16120-2 : 2017. The wire is coated with zinc or zinc-aluminium alloy in accordance with BS EN 10244-2 : 2011. The metallic coating is Class A⁽¹⁾ for non-polymer coated or PVC and PoliMac⁽²⁾ coated wire, and Class E⁽³⁾ for PA6⁽⁴⁾ coated wire.

- (1) Class A coating as defined in BS EN 10244-2 : 2011, Table 2, relates to the highest coating thickness
- (2) Maccaferri PoliMac is an environmentally safe extruded polymer specifically developed with an additional masterbatch, to provide increased resistance to abrasion and to mechanical damage, an improved performance in cold and hot temperatures, and a better performance to UV radiation. The properties of the Polimac coating are in accordance with BS EN 10245-1 : 2011.
- (3) Class E coating as defined in BS EN 10244-2 : 2011, Table 2, for which the corrosion resistance must be at least equivalent to that from zinc coating according to Class B defined in BS EN 10244-2 : 2011, Table 1.
- (4) Maccaferri PA6 is an environmentally safe, extruded polyamide coating applied to galvanized mild steel wire to provide increased resistance to mechanical damage, low friction coefficients, long term strength and elasticity, improved adhesion to wire, low liquid penetration during corrosion process, and improved performance in cold temperatures.

Table 2 Specification details of available wire coatings

Galvanized wire without polymer coating ⁽¹⁾		Galvanized wire with PVC, PA6 or PoliMac coating ⁽²⁾	Minimum Zn or Zn-Al coating Class A ⁽³⁾	Minimum Zn-Al coating for PA6 coated wire Class E ⁽³⁾
Nominal diameter (mm)	Tolerance (mm)	Nominal diameter (external) (mm)	(g·m ⁻²)	(g·m ⁻²)
2.0	± 0.05	3.0	215	60
2.2	± 0.06	3.2	230	60
2.4	± 0.06	3.4	230	60
2.7	± 0.06	3.7	245	60
3.0	± 0.07	4.0	255	60
3.4	± 0.07	4.4	265	60
3.9	± 0.07	4.9	275	60

- (1) Associated galvanized lacing wire diameter 2.2 mm supplied in 25 kg coils.
- (2) Associated galvanized PVC, PA6 or PoliMac coated lacing wire diameter 3.2 mm, with 2.2 mm core, supplied in 25 kg coils.
- (3) To BS EN 10244-2 : 2011, Table 2.

Notes:

- Mesh specification is typically described using a 'Mesh Code' to denote wire coating, mesh opening size and wire diameter, eg P8/2.7 describes a mesh with PVC coating, mesh designation 8 x 10, 2.7 mm wire diameter, and PMC8/2.7 describes a mesh with Polimac coating, mesh designation 8 x 10, 2.7 mm wire diameter.

1.3 Maccaferri Gabions and Reno Mattresses are cages formed from hexagonal double twisted wire mesh, galvanized (a zinc or zinc-aluminium alloy) and with or without an additional polymer (PVC, PoliMac or PA6) coating.

1.4 Maccaferri Gabions and Reno Mattresses are available in a large range of standard sizes as defined in Tables 3 and 4. Non-standard sizes are available for specific design requirements. Reno Mattresses consist of a separate base and a lid. Reno Mattress bases are fabricated from a single panel of mesh, with sides, ends and diaphragms formed by folding during manufacture. Mattresses may alternatively be manufactured with separate diaphragms. The lid is formed either by a panel of mesh for each base or by longer panels cut from a roll of mesh and used to cover several adjacent mattresses.

Table 3 Standard⁽¹⁾ sizes of gabions

Length (m)	Width (m)	Height (m)
1	1	0.5 or 1
1.5	1	0.5 or 1
2	1 or 2	0.5 or 1
3	1 or 2	0.5 or 1
4	1 or 2	0.5 or 1
5	1 or 2	0.5 or 1
6	1 or 2	0.5 or 1

(1) Non-standard sizes are available to special order for specific design requirements. Also, for 2 m width units could have separate lid.

Table 4 Standard⁽¹⁾ sizes of Reno Mattresses

Length (m)	Width (m)	Height (m)
3	2 or 3	0.17, 0.23, 0.30 or 0.50
4	2 or 3	0.17, 0.23, 0.30 or 0.50
5	2 or 3	0.17, 0.23, 0.30 or 0.50
6	2 or 3	0.17, 0.23, 0.30 or 0.50

(1) Non-standard sizes are available to special order for specific design requirements.

1.5 Cylindrical Gabions are fabricated from 2 or 3 m wide mesh panels to create a cylindrical element of 0.65 or 0.95 m diameter respectively, of lengths to suit sizes for the application (see Table 5).

Table 5 Standard sizes of Cylindrical Gabions

Width of mesh panel (m)	Nominal diameter (m)
2.0	0.65
3.0	0.95

Note: Generally used at lengths of less than 2 m.

1.6 Details of the wire used for the range of standard mesh/wire combinations, and the associated lacing wire required for on-site fabrication, are described in section 1.2 and Table 2. The mesh in rolls can be reinforced by the insertion of steel wire ropes into the DT Mesh during manufacture to produce higher strength versions of the mesh for rockfall protection and slope stabilization applications. See section 2.6 for more details. Other sizes and mesh/wire combinations may be manufactured to order.

1.7 Mesh sizes, tolerances and end-use applicability are as described in BS EN 10223-3 : 2013, Table 2.

1.8 Items used with the products to form Maccaferri Gabions, Reno Mattresses, Reno Mattress Plus, mesh in rolls and Cylindrical Gabion systems, but outside the scope of this Certificate, include:

- gabion filling material
- backfill material.
- Maccaferri Pneumatic Fastening Tool

1.9 Additional items for use with the products include single wire ropes (see Table 6).

Table 6 Steel Rope Types

Steel rope type	Nominal diameter (mm)	Nominal diameter including polymer coating (external)	Rope construction ⁽²⁾⁽³⁾
Zn-Al Galvanized ⁽¹⁾	8	-	6 x 7 WC or 6 x 19 WC
Zn-Al Galvanized with PVC, PA6 or PoliMac coating	6	8	6 x 7 WC or 6 x 19 WC

(1) Zn-5%Al coated to Class A in accordance with BS EN 10264-2 : 2021.

(2) Tensile strength of rope is 1770 N·mm² in accordance with BS EN 12385-4 : 2008.

(3) In accordance with BS EN 12385-2 : 2008 and BS EN 12385-4 : 2008.

1.10 The Maccaferri Pneumatic Fastening Tool is a mechanical device for crimping stainless steel or galvanized steel Flex-C rings to the polymer-coated mesh or the galvanized steel mesh, respectively. Stainless steel rings are manufactured from 3 mm diameter stainless steel wire with a minimum tensile strength of 1550 MPa. Galvanized steel rings are manufactured from 3 mm diameter steel wire with a minimum tensile strength of 1720 MPa, and coated with 255 g·m⁻² of Zn or Zn/Al. The pull-apart strength of the lacing rings is a minimum of 2.0 kN.

1.11 DT Links are a device for connecting and installing rolls of mesh when used in rockfall protection and surface slope protection works. They connect two adjacent wires, each with a maximum diameter (including polymer coating) of 4.4 mm. DT Links are made from minimum 3.6 mm diameter stainless steel wire with a minimum tensile strength of 1550 MPa. The pull-apart strength of DT Links is a minimum of 3.0 kN. DT Links are to be used only with rolled mesh based products and are not designed for use in gabions, mattresses and sack gabions.

1.12 HR Links are a device for connecting and installing rolls of mesh with integral steel ropes. They connect two adjacent steel ropes, each with a maximum diameter of 8 mm (including polymer coating if present). Galvanized HR Links are made from minimum 4.0 mm diameter Zn-Al galvanized high tensile carbon steel wire with a minimum tensile strength of 1720 Mpa. Stainless steel HR Links are made from minimum 4.0 mm diameter stainless steel wire with a minimum tensile strength of 1550 Mpa. The pull-apart strength of HR Links is 4 (+/-10%) kN.

2 Manufacture

2.1 The products are manufactured from galvanized steel wire, with or without polymer coating, which is either manufactured by the Certificate holder or bought in to the Certificate holder's specification. Certificates of conformity and/or mill certificates are supplied with each batch of bought-in wire.

2.2 The wire is woven into a hexagonal pattern mesh with double-twist joints; cut ends are mechanically selvaged with a wire of greater diameter than that used for the mesh (see Table 1). When used to fabricate panels the mesh is cut to the required length and the selvage wire is positioned and mechanically fixed to the panel (see section 11, Figure 3a).

2.3 Gabion end panels and diaphragms are selvaged along their upper edges in a similar manner to that described in section 2.2. Gabions and mattress units can also be produced using different wire diameters in specific areas of the mesh in order to create stronger sides or a stronger face, known as strong face gabions.

2.4 Reno Mattress bases are fabricated from a single panel of mesh, with sides, ends and diaphragms formed by folding during manufacture.

2.5 Cylindrical Gabions consist of a single mesh panel made of double twisted wire mesh, with steel reinforcing wires inserted during the manufacturing process to allow for faster closing during installation.

2.6 Rolls of mesh are selvaged along their longitudinal edges. Rolls of mesh can also be reinforced with steel ropes integrated into the mesh during the manufacturing process. The steel reinforcing ropes can be inserted either longitudinally (known as Steelgrid), or both longitudinally and transversely (known as MacArmour). The Certificate holder can advise further on the appropriate solution, to optimise the performance of the products.

2.7 As part of the assessment and ongoing surveillance of product quality, the BBA has:

- agreed with the manufacturer the quality control procedures and product testing to be undertaken
- assessed and agreed the quality control operated over batches of incoming materials
- monitored the production process and verified that it is in accordance with the documented process
- evaluated the process for management of nonconformities
- checked that equipment has been properly tested and calibrated
- undertaken to carry out the above measures on a regular basis through a surveillance process, to verify that the specifications and quality control operated by the manufacturer are being maintained.

2.8 The management system of Maccaferri Ltd has been assessed and registered as meeting the requirements of BS EN ISO 9001 : 2015 by CERTICOM/Slovak Republic (Certificate CM5620718/1). The management system of Maccaferri Ltd has also been certified by SGS UK for geotechnical design and supplying of retaining structures, erosion protection works, highway and bio-engineering systems (Certificate GB01/52789).

3 Delivery and site handling

3.1 The gabion and mattress units are flat packed and delivered to site in bundles weighing up to 800 kg depending on unit size and mesh specification. Rolls of mesh typically weigh up to 130 kg (depending on size).

3.2 The products may be stored indoors or outdoors but must be away from site traffic, to avoid risk of accidental damage, and should remain packaged until required.

3.3 A label, bearing the BBA logo incorporating the number of this Certificate, manufacturer's name, batch number and product code, is attached to each bundle.

3.4 All product bundles and rolls of mesh must be handled with care to avoid damage to coatings, and require suitable mechanical plant for lifting. Individual units may be manually lifted. The weights of individual units vary between approximately 10 and 243 kg depending on the specification and dimensions of the product. An assessment must be made about the appropriate number of people required to lift the units to satisfy manual lifting limits.

Assessment and Technical Investigations

The following is a summary of the assessment and technical investigations carried out on Maccaferri Hexagonal Double Twisted Mesh Products for Civil and Environmental Engineering Applications.

Design Considerations

4 Use

4.1 The design of structures using the products should be carried out by a suitably qualified engineer in accordance with BS EN 1997-1 : 2004, BS 8002 : 2015, BS 6031 : 2015, BS 8006-1 : 2010 and BS 8006-2 : 2011.

4.2 The magnitude and distribution of the earth pressures and earth resistance should be calculated in accordance with current design practices and available guidelines.

4.3 As with other earth-retaining structures it is necessary to ensure by design that a suitable factor of safety is achieved against the following potential modes of failure:

- overall stability
- overturning
- shearing pressure
- sliding
- internal stability.

4.4 Watercourse linings, weirs and/or other hydraulic or erosion protection structures may require special consideration in regard to scour, uplift, wave action, seepage etc.

4.5 The mesh specification should be chosen to achieve the required design life (see section 8).

Design of structures using Maccaferri Gabions

4.6 The design of gabion structures should be based on the principle of mass gravity earth-retaining walls. Additional allowances may be made to account for the effect of the wire mesh.

4.7 The density of filled gabions depends on both the granulometric curve of the filling stones and the installation procedures: generally it should be taken as 60 to 70% of the density of the solid material. A higher value may be appropriate in certain circumstances, but this will be the responsibility of the consulting engineer who must ensure that the design value is achieved on site.

4.8 The stone infill of the gabions is normally sized between 100 and 200 mm and will depend on the mesh size; the lower limiting size being controlled by the dimensions of the mesh. The fill must be of hard, durable stone as quarried or naturally occurring rounded stone.

4.9 Gabion walls can be constructed with a minimum radius of curvature of 25 metres on plan without modification of the gabion structure.

Design of structures using Reno Mattresses and Reno Mattress Plus

4.10 The design of Reno Mattress structures should be based on the principles of hydraulic engineering and, where applicable, mass gravity earth-retaining structures.

4.11 The density of filled Reno Mattresses should be taken as 60% of the density of the solid material. A higher value may be appropriate in certain circumstances, but this will be the responsibility of the consulting engineer, who must ensure that the design value is achieved on site.

4.12 The stone infill of the Reno Mattresses is normally sized between 75 and 150 mm. The size will depend on the use of the product and the mesh size. In hydraulic structures the nominal size of the stone should be 1.5 times the mesh size. To ensure adequate protection to the underlying soil, the stone size and grading should be chosen to ensure more than one layer within the mattress depth. The fill must be of hard, durable stone as quarried or naturally occurring rounded stone.

4.13 Reno Mattresses can be constructed to form curved sections either by cutting and folding units or by overlapping adjacent mattresses.

Design of structures using Cylindrical Gabions

4.14 Each structure must be designed by a competent consulting engineer using the principles of mass gravity earth-retaining structures. Cylindrical Gabions are used mainly for emergency and river training works, where local conditions might require fast installation, or the presence of water prevents easy access to the site (eg underwater installations).

Design of structures using Maccaferri Hexagonal Double Twisted Mesh

4.15 Maccaferri Hexagonal double twisted mesh could also be used for erosion, slope stabilisation purposes and for use in both draped netting systems and stabilisation netting systems. The design should be based on current principles and/or BS 6031 : 2015, BS 8002 : 2015, BS EN 1997-1 : 2004, BS EN 8006-1 : 2010, BS EN 8006-2 : 2011 and CIRIA C775.

Soil reinforcement

4.16 BBA approval for this application is covered by HAPAS Certificate 16/H247.

5 Structural performance

5.1 When installed in accordance with the Certificate holder's *Installation Guidelines* and this Certificate, the products have adequate strength to resist all loads associated with handling, positioning and filling.

5.2 For soil reinforcement applications, the declared tensile strength of the wire mesh is determined according to the procedures of BS EN 10223-3 : 2013.

5.3 Maccaferri Gabions and Reno Mattresses are permeable and, in general, will not allow hydrostatic pressure to build up. Gabion earth-retaining structures are not normally designed to withstand hydrostatic pressure.

5.4 Where a cohesive material, eg clay, is retained, water movement may cause it to exude into the gabion structure and block the passage of water. To reduce the risk of a build-up of hydrostatic pressure in these conditions it may be necessary to provide additional granular layers behind the gabion structure to allow water to drain away.

5.5 Maccaferri Gabions and Reno Mattress cages have adequate strength to permit pre-filling and placing by crane when carried out in accordance with the Certificate holder's instructions.

5.6 For slope stabilisation applications, Maccaferri Hexagonal Double Twisted Mesh is also used with single wire ropes, which act to increase the strength of the stabilisation design (Steelgrid and MacArmour). The declared performance of the enhanced mesh is determined in accordance with the procedures of ETA 15/0219, ETA 16/0758, and UKTA 22_0019 and UKTA 22_0021 and BS EN 10223-3 : 2013. The Certificate holder could advise further on the appropriate solution, to optimise the performance of the products.

6 Practicability of installation

The products are designed to be installed by a competent general builder, or a contractor, experienced with these types of products, and can be installed under normal site conditions. Installation of mesh in rolls for slope stabilization applications requires specialist contractors familiar with roped access installations.

7 Maintenance and repair

Routine maintenance is not normally required; however, damaged exposed mesh can be repaired by securing additional or replacement mesh as necessary.

8 Durability

Maccaferri Hexagonal Double Twisted Mesh

8.1 Under normal site exposure, the PVC, PA6 or PoliMac coated wire mesh is not adversely affected, as verified by independent investigations of various installations up to 60 years old. The assumed working life of the products is in excess of 120 years, depending on the form of the galvanized coating (zinc or zinc-aluminium alloy), the presence of polymer coating (PVC, PoliMac or PA6), and the local environmental conditions, as given in BS EN 10223-3 : 2013, Table A.1.

8.2 An additional factor may be considered in the life expectancy calculation to account for vegetation growth, especially in locations that are not subject to sustained dry periods.

Maccaferri Gabions and Reno Mattresses

8.3 For a particular installation environment, the most appropriate Maccaferri mesh wire coating specification may be selected in accordance with BS EN 10223-3 : 2013, Annex A, to satisfy the required project design life.

8.4 The life of a gabion structure is dependent on the specification of the mesh, the durability of the stone and, in the longer term, the stability of the consolidated mass of the infill material and the conditions of exposure encountered during the structure's design life.

8.5 Polymer (PVC, PoliMac or PA6) coated, galvanized (zinc or zinc-aluminium alloys) steel wire will not be affected by the chemicals normally encountered in earth retaining structures.

8.6 Some local damage may occur to the polymer coating during installation and in exposed areas. Evidence from installations up to 60 years old indicates that such damage will remain local and not spread; thus, the integrity of the structure is not affected. Therefore, in accordance with BS EN 10223-3 : 2013, Table A.1, the polymer-coated mesh may be considered to have a life in excess of 120 years.

8.7 The zinc-aluminium alloy coating has better corrosion resistance than pure zinc and may be considered to give an increased design life compared to conventional zinc coated wire in the same exposure conditions.

8.8 When used in sea water, aggressive conditions (eg polluted environments), or where the anticipated exposure conditions are uncertain, polymer-coated mesh should be used to ensure an optimum design life.

8.9 The Certificate holder can advise on the life expectancy of products used in river erosion and coastal protection schemes and, if required, optimise the performance of the products.

9 Reuse and recyclability

The products are made from polymer-coated (PVC, PoliMac or PA6), galvanized (zinc or zinc-aluminium alloy) steel wire, which can be recycled.

Installation

10 General

Installation must be in accordance with this Certificate and the Certificate holder's installation instructions.

11 Procedure

In-situ filled gabions (see Figures 2 to 6)

11.1 Gabion flat-packed cages are opened and folded on a hard surface, pressing out any unwanted creases.

11.2 Front and rear sides, ends and diaphragms are lifted into position to form a box shape.

11.3 Top corners are secured with the thick selvedge wire (see Figure 3a). Vertical edges are joined together using the appropriate lacing wire, starting from the top, either in a continuous operation using alternate single and double twists or with rings applied using the Maccaferri Pneumatic Fastening Tool (see Figure 3b).

11.4 A number of empty gabions may be placed in position on a flat surface and secured together as described in section 11.3.

11.5 The gabions are filled with suitable stone to a level approximately 30 to 50 mm over full, to allow for settlement of the infill owing to self-weight of the gabions.

11.6 When considered necessary for aesthetic or other considerations, the gabions may be filled whilst under tension. Gabions are tensioned by applying a load, distributed over the full end panel of a row of gabions, to the first cell which has been anchored in position.

11.7 Gabions forming the exposed face of a structure should be filled to one-third height, braced from front to rear (see Figure 5), filled to two-thirds height and again braced. Filling may then be completed.

11.8 The mesh lid is folded down, stretched into position and secured to the front, sides and diaphragms.

11.9 It is essential that each gabion is properly secured to adjacent gabions above, below and on each side, using the lacing wire as described in section 11.3.

Figure 2 Preparation of Gabion units

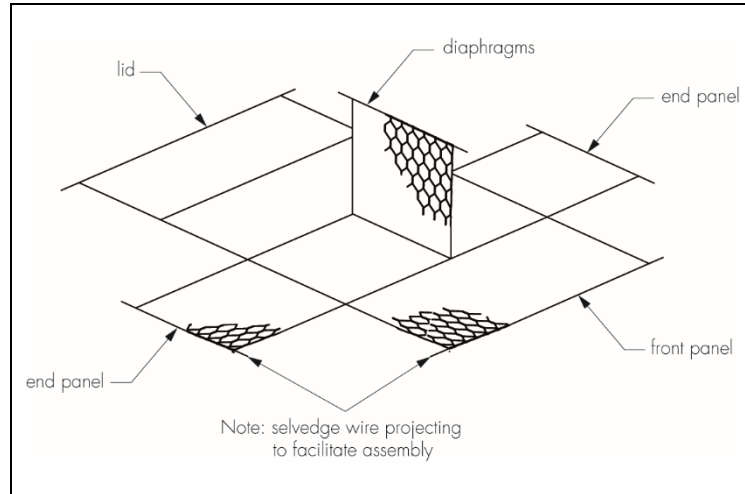


Figure 3 Typical selvedge and wiring pattern

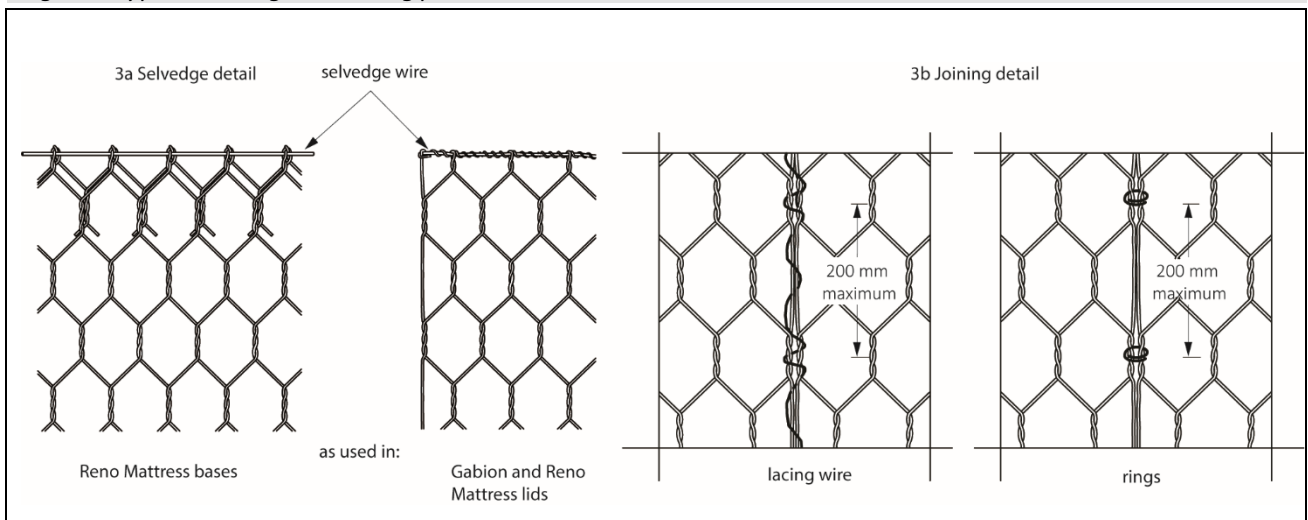
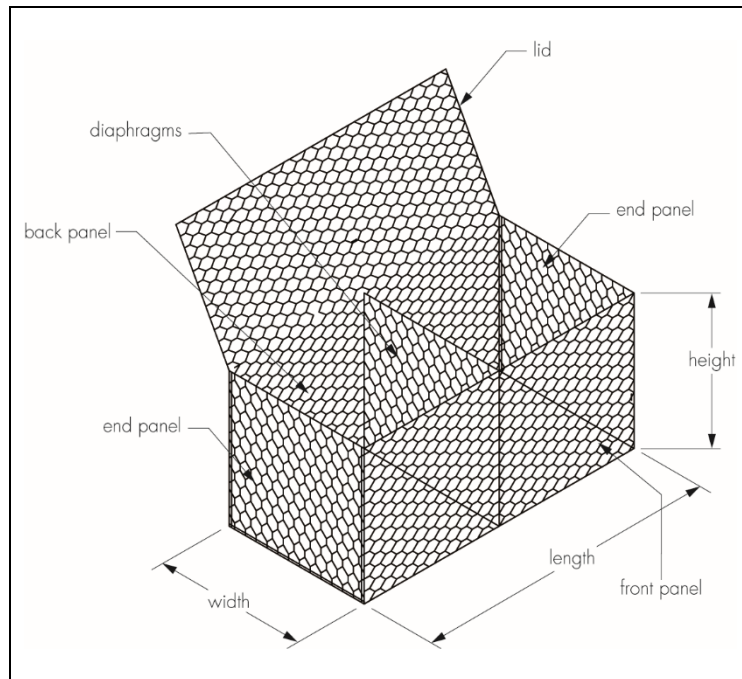


Figure 4 Forming Gabion unit⁽¹⁾



(1) Indicative figure for a typical gabion unit; units can be manufactured either with a vertically or horizontally oriented mesh in length direction.

Pre-filled Gabion units

11.10 Pre-filled Gabion units [traded under the name ReadyMac⁽¹⁾ or Cubiroc⁽¹⁾] are constructed as described in sections 11.1 to 11.3, 11.5, 11.7 and 11.8, but with double lacing loop throughout. It is advantageous to construct a slightly oversized frame within which the empty unit can be held, stretched taut during filling. For example, Cubiroc units are filled using a special frame combined with a shaking table to ensure that the stones are compacted by vibration. Cubiroc and ReadyMac pre-filled gabions require greater bracing than a gabion unit filled in-situ due to the additional face-stability required during lifting operations.

(1) ReadyMac and Cubiroc are registered trademarks.

11.11 During the filling operations, reinforcing steel bars or lifting straps are included to maintain the shape of the gabion during lifting.

11.12 Purpose-made lifting frames and slings must be used for lifting filled units, which weigh up to 1.8 tonnes per cubic metre.

Figure 5 Bracing gabions

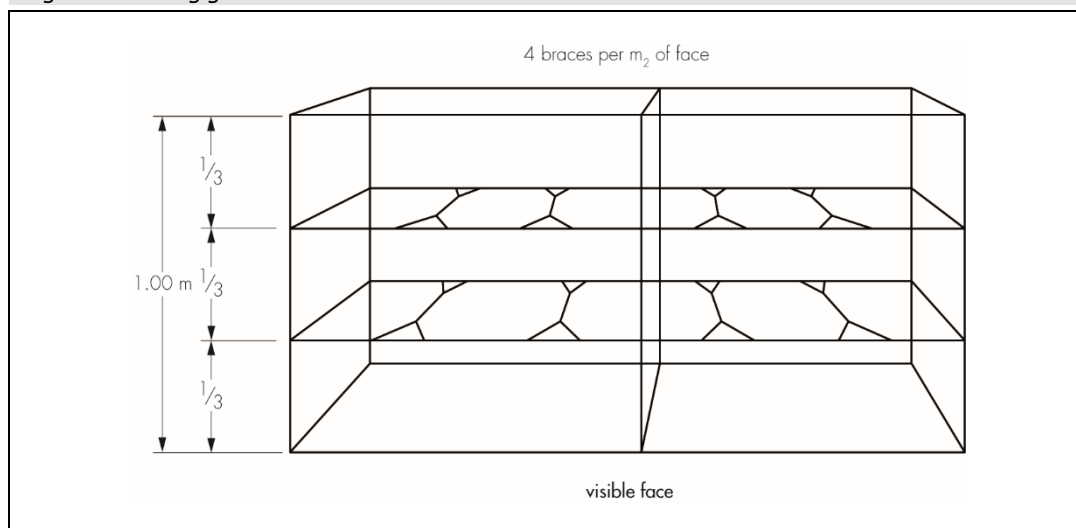
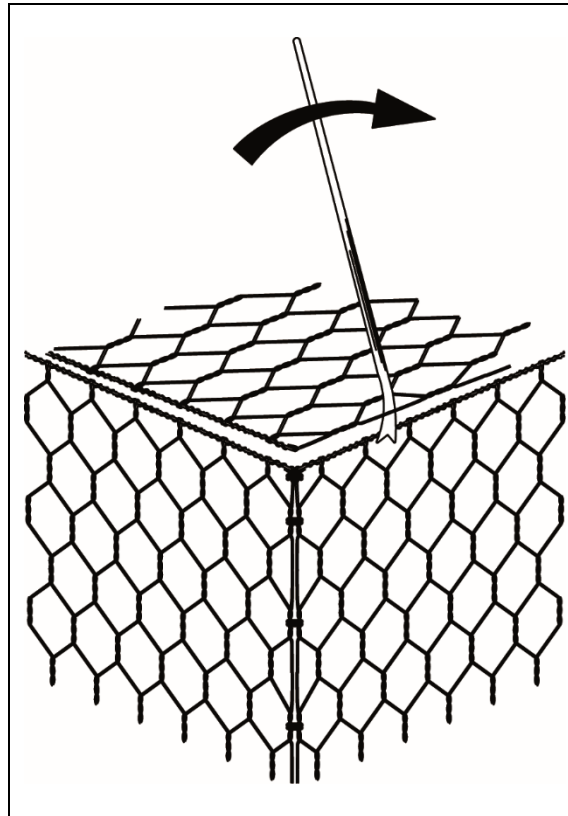


Figure 6 Closing the lid on gabions



In-situ filled Reno Mattresses (see Figures 7 to 9)

11.13 Reno Mattress flat-packed cages are opened and folded on a hard surface, pressing out any unwanted creases.

11.14 Ends, side panels and diaphragms are lifted into position, and the ends and diaphragms are secured to the side panels using the method indicated in section 11.3.

11.15 The unit is placed in its final position and secured to adjacent mattresses, ensuring that diaphragms, ends and sides are taut.

11.16 Fill is placed into each compartment, working from the base of the slope upwards, until each cell is filled completely.

11.17 The lid is secured along each edge and diaphragm using lacing wire or rings as specified. The lid is made by a specific lid panel. Mesh in rolls could also be used as a lid, if and when required.

Reno Mattress Plus

11.18 Reno Mattress flat-packed cages are opened and folded on a hard surface, pressing out any unwanted creases.

11.19 Ends, side panels and diaphragms are lifted into position, and the ends and diaphragms are secured to the side panels using the method indicated in section 11.3.

11.20 For Reno Mattress Plus, additional X-Ties (see Figure 11) are added at this point. The vertical leg connections must be installed with inclined ties, to keep them in position during stone filling operation. The basal hook of the vertical leg must be placed upstream to ensure proper function.

11.21 The unit is placed in its final position and secured to adjacent mattresses, ensuring that diaphragms, ends and sides are taut.

11.22 Fill is placed into each compartment, working from the base of the slope upwards, until each cell is filled completely.

11.23 The lid is secured along each edge and diaphragm using lacing wire or rings as specified. The lid is made by a specific lid panel. Mesh in rolls could also be used as a lid, if and when required. The lid is then fixed down to the X-ties by the use of 2 C-Rings.

Pre-filled Reno Mattress

11.24 The Reno Mattress is assembled as described in section 11.14 but using double loop lacing throughout.

11.25 Additional support should be provided under the lid using reinforced steel bars, typically 20 mm diameter.

11.26 After filling, the unit must be properly secured along each edge and diaphragm, using lacing wire with double loops at every mesh.

11.27 Purpose-made lifting frames with suitable attachments must be used to enable the filled mattresses to be safely lifted and placed in position.

Figure 7 Preparation of Reno Mattresses

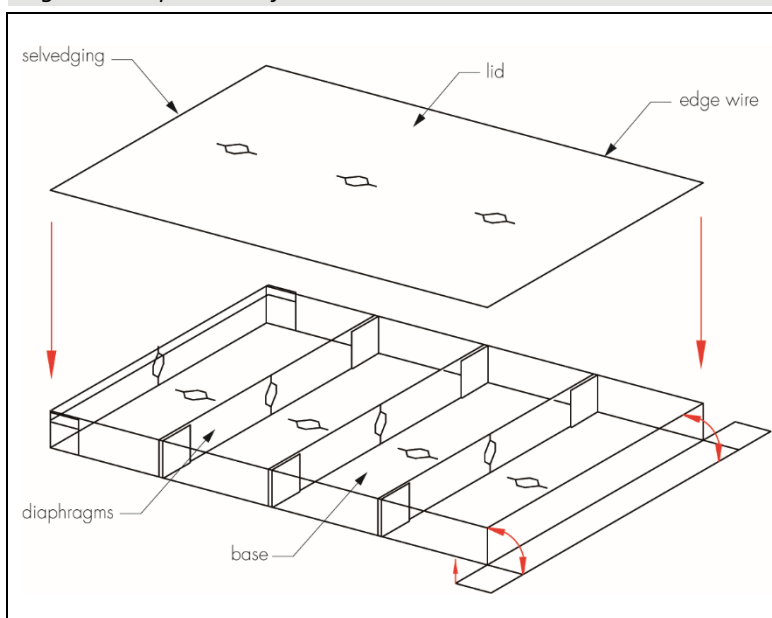


Figure 8 Forming the side/diaphragm junction

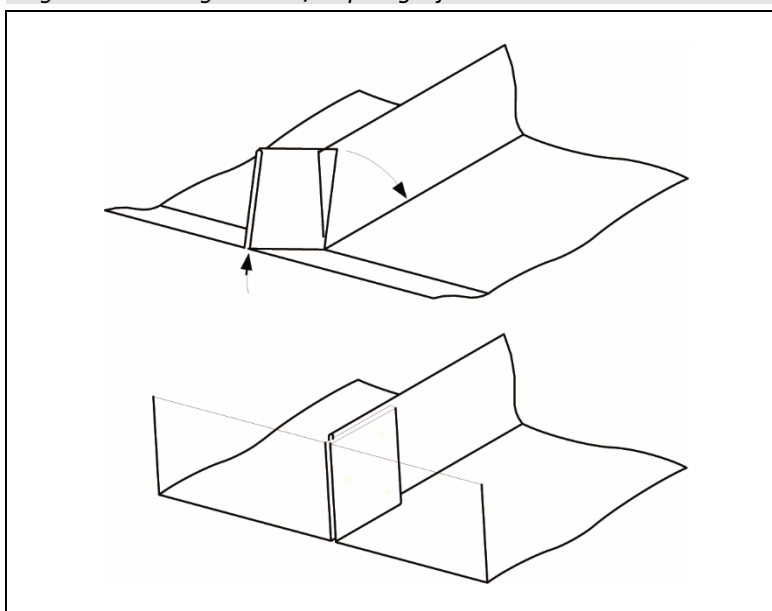


Figure 9 Reno Mattress installation procedure

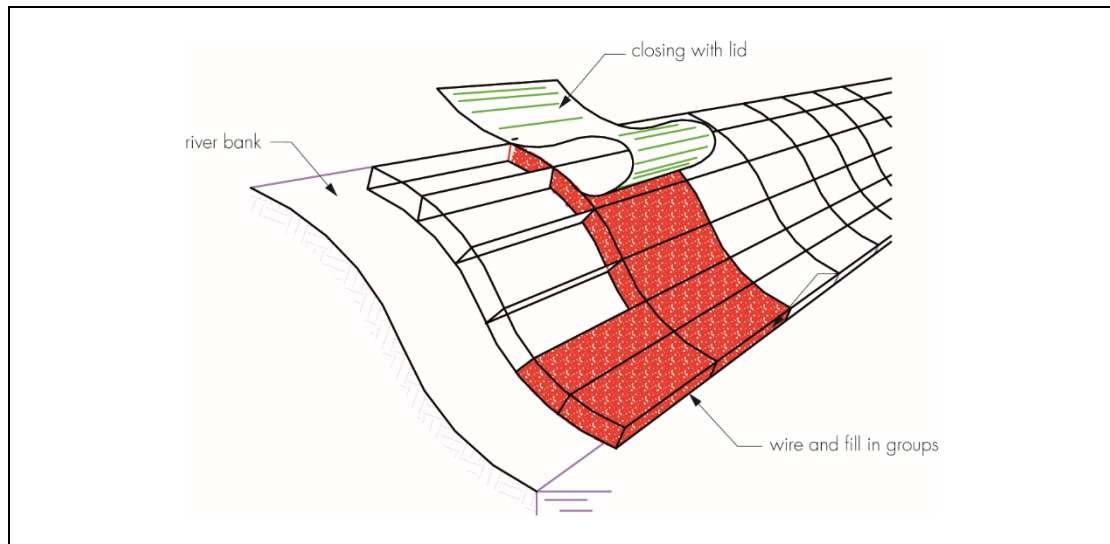


Figure 10 Reno Mattress Plus Arrangement

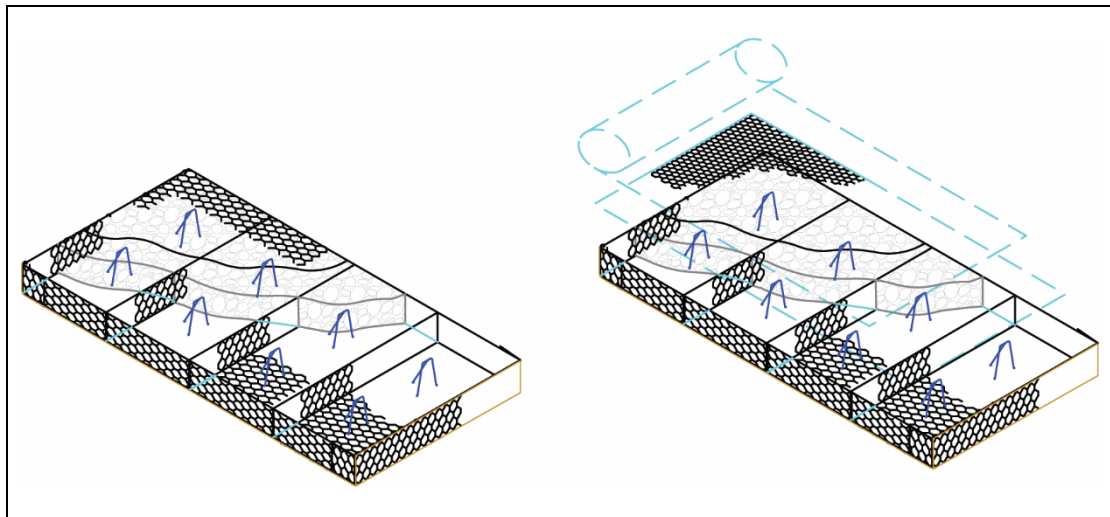
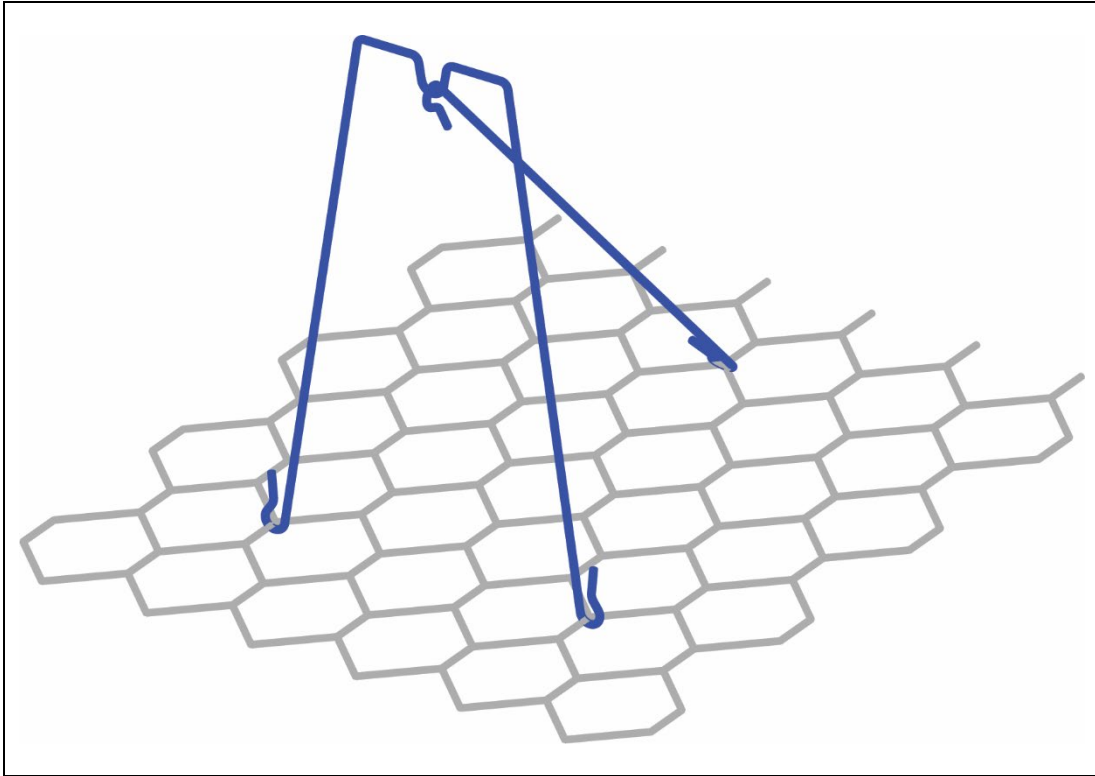


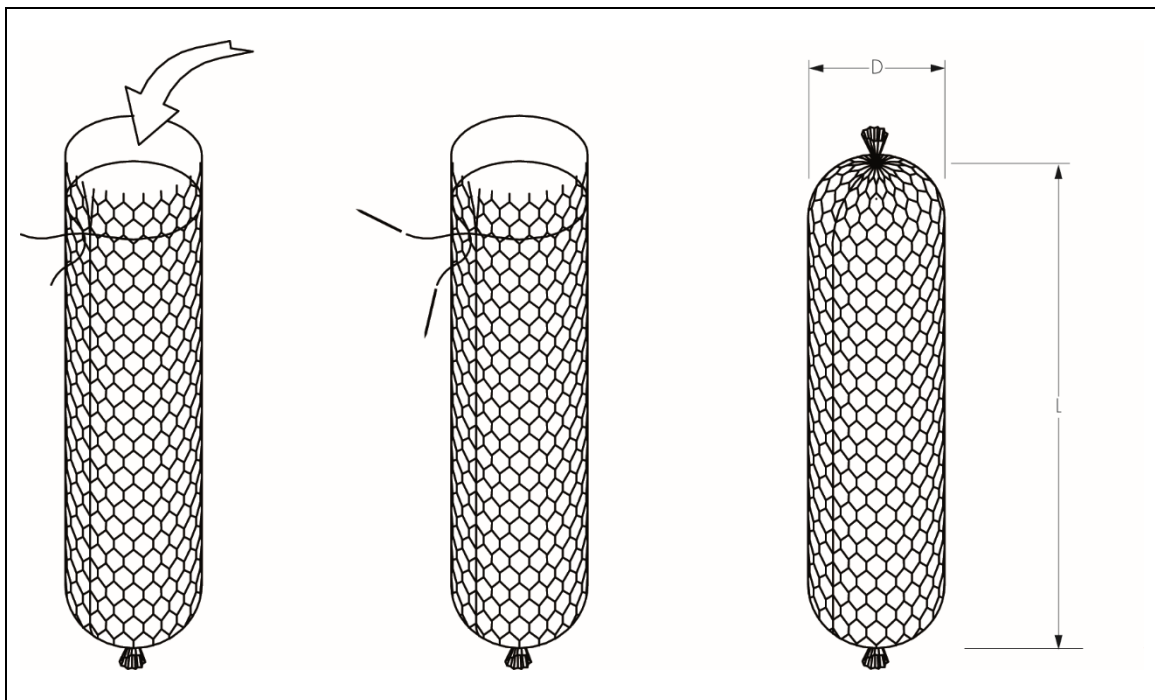
Figure 11 Reno Mattress Plus X Tie fixing detail



Cylindrical Gabions

11.28 Cylindrical Gabions are filled with appropriately sized stone fill (see section 4.8) at the project site. Filling operations can be carried out either from the side or from the open ends of the unit.

Figure 12 Cylindrical Gabion

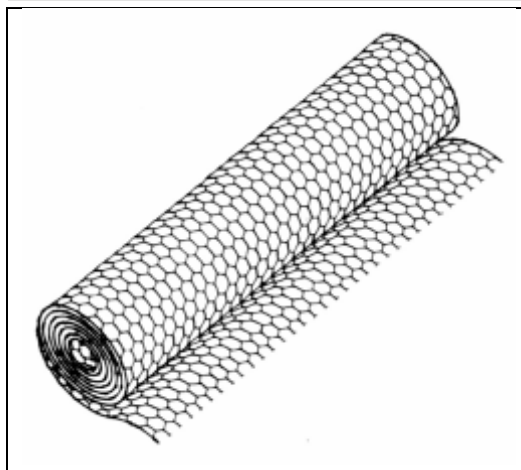


Maccaferri Hexagonal Double Twisted Mesh and reinforced meshes

11.29 Hexagonal double twisted mesh (basic, Steelgrid or MacArmour) is laid on or bolted to the soil or rock face as a slope stabilisation or erosion control measure. In erosion control applications, the mesh could be laid in conjunction

with a geosynthetic erosion mat (MacMat). Detailed installation information can be provided on request by Certificate holder.

Figure 13 Hexagonal double twisted mesh



Technical Investigations

12 Tests

12.1 An assessment of data was made to determine:

- dimensional accuracy
- tensile strength
- quality of galvanized coating
- the effect of tolerances
- strength of wire and wire mesh
- quality of materials
- quality of plastic coating
- ease of assembly
- design procedures
- strength of lifting frame
- durability
- effect of site damage
- equivalent performance of Zn or Zn/Al coated wire.

12.2 Dimensional checks were carried out on each type of mesh.

13 Investigations

13.1 The manufacturing process was evaluated, including the methods adopted for quality control, and details were obtained of the quality and composition of the materials used.

13.2 Site visits were carried out to assess the practicability, ease of handling and installation under various site conditions.

13.3 An assessment was made of data relating to site case-studies where the product has been in use for a number of years, to determine durability under various conditions.

Bibliography

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BS 8002 : 2015 *Code of practice for earth retaining structures*

BS EN 1997-1 : 2004 + A1 : 2013 *Eurocode 7 — Geotechnical design — General rules*

BS EN 8006-1 : 2010 + A1 : 2016 *Code of practice for strengthened/reinforced soils and other fills*

BS EN 8006-2:2011 + A1 : 2017 *Code of practice for strengthened/reinforced soils*

BS EN 10218-1 : 2012 *Steel wire and wire products — General — Test methods*

BS EN 10218-2 : 2012 *Steel wire and wire products — General — Wire dimensions and tolerances*

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BS EN 10244-2 : 2009 *Steel wire and wire products — Non-ferrous metallic coatings on steel wire — Zinc or zinc alloy coatings*

BS EN 10245-1 : 2011 *Steel wire and wire products — Organic coatings on steel wire — General rules*

BS EN 10264-2 : 2021 *Steel wire and wire products — Steel wire for ropes: Cold drawn non alloy steel wire for ropes for general applications*

BS EN ISO 9001 : 2015 *Quality management systems — Requirements*

BS EN ISO 16120-1 : 2017 *Non-alloy steel wire rod for conversion to wire — General requirements*

BS EN ISO 16120-2 : 2017 *Non-alloy steel wire rod for conversion to wire. Specific requirements for general purpose wire rod*

ETA 15/0219 *Officine Maccaferri S.p.A. Double twist wire mesh gabions and reno mattresses*

ETA 16/0758 *Officine Maccaferri S.p.A. Hexagonal double twisted wire meshes, and hexagonal double twisted wire meshes with inserted wire ropes*

UKTA 22_0019 *Officine Maccaferri S.p.A. Double twist wire mesh gabions and reno mattresses*

UKTA 22_0021 *Officine Maccaferri S.p.A. Hexagonal double twisted wire meshes, and hexagonal double twisted wire meshes with inserted wire ropes*

CIRIA C775 *Rock netting systems – design, installation and whole-life management*

14 Conditions

14.1 This Certificate:

- relates only to the product/system that is named and described on the front page
- is issued only to the company, firm, organisation or person named on the front page – no other company, firm, organisation or person may hold or claim that this Certificate has been issued to them
- is valid only within the UK
- has to be read, considered and used as a whole document – it may be misleading and will be incomplete to be selective
- is copyright of the BBA
- is subject to English Law.

14.2 Publications, documents, specifications, legislation, regulations, standards and the like referenced in this Certificate are those that were current and/or deemed relevant by the BBA at the date of issue or reissue of this Certificate.

14.3 This Certificate will remain valid for an unlimited period provided that the product/system and its manufacture and/or fabrication, including all related and relevant parts and processes thereof:

- are maintained at or above the levels which have been assessed and found to be satisfactory by the BBA
- continue to be checked as and when deemed appropriate by the BBA under arrangements that it will determine
- are reviewed by the BBA as and when it considers appropriate.

14.4 The BBA has used due skill, care and diligence in preparing this Certificate, but no warranty is provided.

14.5 In issuing this Certificate the BBA is not responsible and is excluded from any liability to any company, firm, organisation or person, for any matters arising directly or indirectly from:

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- actual installations of the product/system, including their nature, design, methods, performance, workmanship and maintenance
- any works and constructions in which the product/system is installed, including their nature, design, methods, performance, workmanship and maintenance
- any loss or damage, including personal injury, howsoever caused by the product/system, including its manufacture, supply, installation, use, maintenance and removal
- any claims by the manufacturer relating to CE marking.

14.6 Any information relating to the manufacture, supply, installation, use, maintenance and removal of this product/system which is contained or referred to in this Certificate is the minimum required to be met when the product/system is manufactured, supplied, installed, used, maintained and removed. It does not purport in any way to restate the requirements of the Health and Safety at Work etc. Act 1974, or of any other statutory, common law or other duty which may exist at the date of issue or reissue of this Certificate; nor is conformity with such information to be taken as satisfying the requirements of the 1974 Act or of any statutory, common law or other duty of care.