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BBA BRITISH BOARD OF AGRÉMENT
ASSESSMENT OF PRODUCTS FOR CONSTRUCTION

Designated by Government to issue European Technical Approvals

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Agrément Certificate No 95/3141
*Second issue**

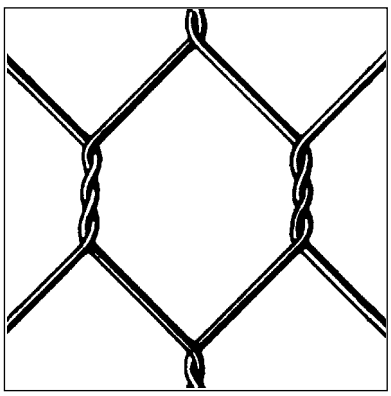
MACCAFERRI HEXAGONAL MESH FOR CIVIL ENGINEERING

Maille hexagonale — travaux publics
Sechseckige Masche — Hoch- und Tiefbau

Product

- *THIS CERTIFICATE RELATES TO THE USE OF MACCAFERRI HEXAGONAL DOUBLE TWISTED MESH IN CIVIL ENGINEERING.*
- *The mesh is manufactured from galvanized wire and PVC-U coated galvanized wire.*
- *The galvanized wire mesh is for use in non-aggresive conditions or for use in situations with a limited design life.*
- *The mesh is available in rolls and is used to fabricate gabions, soil reinforcement units, Reno Mattresses, etc.*
- *The mesh is manufactured or supplied by the Maccaferri Group and marketed by Maccaferri Ltd.*
- *This Certificate does not cover the use of the mesh for gabion walls within the foundation zone of a building.*

These Front Sheets must be read in conjunction with the accompanying Detail Sheets, which provide information specific to particular applications.



Building Regulations — Detail Sheet 1

1 The Building Regulations 1991 (as amended 1994) (England and Wales)

In the opinion of the British Board of Agrément, Maccaferri Hexagonal Mesh for Civil Engineering and its applications are not subject to these Regulations.

2 The Building Standards (Scotland) Regulations 1990 (as amended)

In the opinion of the BBA, Maccaferri Hexagonal Mesh for Civil Engineering and its applications are not controlled under these Regulations.

3 The Building Regulations (Northern Ireland) 1994

In the opinion of the BBA, Maccaferri Hexagonal Mesh for Civil Engineering and its applications are not controlled under these Regulations.

Conditions of Certification

4 Conditions

4.1 Where reference is made in this Certificate to any Act of Parliament, Regulation made thereunder, Statutory Instrument, Code of Practice, British Standard, manufacturer's instruction or similar publication, it shall be construed as reference to such publication in the form in which it is in force at the date of this Certificate.

4.2 The quality of materials and the method of manufacture have been examined and found satisfactory by the BBA and must be maintained to this standard during the period of validity of this Certificate. This Certificate will remain valid for an unlimited period provided:

(a) the specification of the product is unchanged; and

(b) the manufacturer continues to have the product checked by the BBA.

4.3 This Certificate will apply only to the product that is installed, used and maintained as set out in this Certificate.

4.4 In granting this Certificate, the BBA makes no representation as to:

(a) the presence or absence of patent or similar rights subsisting in the product; and

(b) the legal right of Maccaferri Ltd to market, install or maintain the product; and

(c) the nature of individual installations of the product, including methods and workmanship.

4.5 It should be noted that any recommendations relating to the safe use of this product which are contained or referred to in this Certificate are the minimum standards required to be met when the product is used. They do not purport in any way to restate the requirements of the Health & Safety at Work etc Act 1974, or of any other statutory or Common Law duties of care, or of any duty of care which exist at the date of this Certificate or in the future; nor is conformity with such recommendations to be taken as satisfying the requirements of the 1974 Act or of any present or future statutory or Common Law duties of care. In granting this Certificate, the BBA does not accept responsibility to any person or body for any loss or damage, including personal injury, arising as a direct or indirect result of the use of this product.

Health and Safety at Work Act

5 General

Provision must be made to ensure the works necessary to install the products comply with the relevant sections of the above Act.

Technical Specification

6 Description

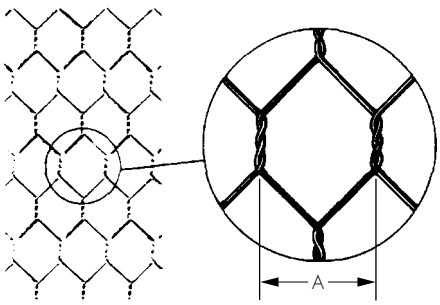
6.1 The double twist mesh is produced in a range of mesh/gauge combinations (see Table 1).

Table 1 General specification of hexagonal mesh

Manufacturer's reference[1]	Mesh opening size A[2] (mm)	Diameter of wires (mm)			
		Mesh	Edge and selvedge	Mesh with PVC-U	Edge and selvedge with PVC-U
Z10/2.7	100	2.7	3.4	—	—
Z10/3.0	100	3.0	3.9	—	—
P10/2.7	100	2.7	3.4	3.7	4.4
Z8/3.0	80	3.0	3.9	—	—
Z8/2.7	80	2.7	3.4	—	—
Z8/2.4	80	2.4	3.0	—	—
P8/2.7	80	2.7	3.4	3.7	4.4
P8/2.4	80	2.4	3.0	3.4	4.0
Z6/2.4	60	2.4	3.0	—	—
Z6/2.2	60	2.2	2.7	—	—
Z6/2.0	60	2.0	2.4	—	—
P6/2.2	60	2.2	2.7	3.2	3.7
P6/2.0	60	2.0	2.4	3.0	3.4
P6/2.4	60	2.4	3.0	3.4	4.0
Z5/2.0	50	2.0	2.4	—	—

(1) Z — galvanized wire zinc coated
P — PVC-U coated galvanized wire
2.7, 3.0, etc is the diameter of the galvanized wire for the mesh
(2) see Figure 1.

Figure 1 Details of hexagonal mesh



A = mesh opening size

6.2 The wire (see Table 2) used to manufacture the mesh is in accordance with BS 1052 : 1980(1986) with a tensile strength of between 380 Nmm^{-2} and 500 Nmm^{-2} and with a minimum elongation at failure of 12% at the time of drawing the wire. The wire is galvanized in accordance with BS 443 : 1982(1990) having the specified zinc coating.

Table 2 Detailed wire specification

Galvanized wire without PVC-U coating[1] nominal diameter	tolerance	Galvanized wire with PVC-U coating[2] nominal diameter	Minimum zinc coating
(mm)	(mm)	(mm)	(gm^{-2})
2.0	0.05	3.0	240
2.2	0.06	3.2	240
2.4	0.06	3.4	260
2.7	0.08	3.7	260
3.0	0.08	4.0	275
3.4	0.10	4.4	275
3.9	0.10	—	290

(1) Associated galvanized lacing wire diameter 2.2 mm supplied in 25 kg coils.

(2) Associated galvanized, PVC-U coated lacing wire diameter 3.2 mm with 2.2 mm core supplied in 25 kg coils.

7 Manufacture and quality control

7.1 Galvanized wire and PVC-U coated wire are manufactured by the Maccaferri Group or bought in to the specification defined by the Maccaferri Group. Certificates of conformity and/or mill certificates are supplied with each batch of bought-in wire.

7.2 The wire is woven into a hexagonal pattern mesh, with double-twist joints; larger diameter wire is introduced along the edge. When used to fabricate panels the mesh is cut to the required length, the selvedge wire positioned and mechanically fixed to the panel.

7.3 Factory production control includes checking the mill certificate with the agreed specification, visual and dimensional checks on the incoming wire coil, checks on the thickness of the zinc coating and thickness of the plastic coating as appropriate, and dimensional checks on the woven mesh.

Design Data

8 Durability

8.1 Under normal site exposure, the PVC-U coated wire mesh is not adversely affected, as verified by independent investigations of various installations up to 40 years old.

8.2 For non-PVC-U coated galvanized wire mesh the life expectancy of the mesh, if it is not subjected to accidental damage, can be estimated from the minimum zinc coating (see Tables 2 and 3). A life expectancy of between 6 and 60 years may be anticipated for galvanized wire mesh. There are existing structures up to 100 years old.

8.3 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.

Table 3 Expected deterioration of non-PVC-U coated galvanized wire mesh

Exposure	Loss of zinc coating (gm^{-2} per year)	Corrosion to 25% loss in strength after complete loss of zinc coating (years)	Example of environment
severe	100	3	marine
mild	10	40	inland rural

Note: The life expectancy of the non-PVC-U coated galvanized wire mesh will also be dependent on the type of product, the use of the product and the soil environment. See specific statements in the *Durability* section of the product Detail Sheets.

Bibliography

BS 443 : 1982(1990) *Specification for testing zinc coatings on steel wire and for quality requirements*

BS 1052 : 1980(1986) *Specification for mild steel wire for general engineering purposes*

BBA BRITISH BOARD OF AGRÉMENT
ASSESSMENT OF PRODUCTS FOR CONSTRUCTION

In the opinion of the British Board of Agrément, Maccaferri Hexagonal Mesh for Civil Enginering is fit for its intended use provided it is installed, used and maintained as set out in this Certificate. Certificate No 95/3141 is accordingly awarded to Maccaferri Ltd.

On behalf of the British Board of Agrément

Date of Second issue: 30th June 1995 Director

**Original Certificate issued 22nd May 1995 to River and Sea Gabions Ltd. This amended version issued to include change of name and address of Certificate holder.*

Existing installations

M62, Junction 31 Eastbound

River Bann, Coleraine, Northern Ireland

British Board of Agrément
P O Box No 195, Bucknalls Lane
Garston, Watford, Herts WD2 7NG
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For technical or additional information, tel: 01923 670844.
For information about Agrément Certificate validity and scope, tel:
Hotline: 01923 662900

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BBA BRITISH BOARD OF AGRÉMENT
ASSESSMENT OF PRODUCTS FOR CONSTRUCTION

Maccaferri Ltd

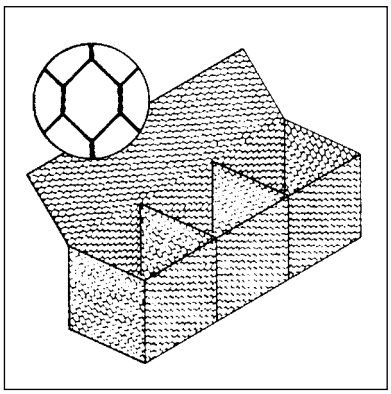
MACCAFERRI GABIONS AND RENO MATTRESSES

Certificate No 95/3141

DETAIL SHEET 2

*Second issue**

Product



- *THIS DETAIL SHEET RELATES TO MACCAFERRI HEXAGONAL MESH GABIONS AND RENO MATTRESSES FOR EARTH RETENTION, SOIL REINFORCEMENT SYSTEMS, RIVER TRAINING AND EROSION CONTROL PURPOSES.*
- *The system is based on box gabions or Reno Mattresses formed from hexagonal mesh of galvanized wire or PVC coated galvanized wire and is for use in both temporary and long-term installation.*
- *Construction of the system is usually carried out by civil engineering or building contractors.*

This Detail Sheet must be read in conjunction with the Front Sheets, which give the product's position regarding the Building Regulations, the hexagonal mesh details, and the Conditions of Certification.

Technical Specification

1 Description

1.1 Maccaferri Gabions and Reno Mattresses are cages formed from hexagonal galvanized wire mesh with or without a PVC-U coating.

1.2 The gabions and mattresses are available in a large range of standard sizes as defined in Tables 1 and 2. Non-standard sizes are available to special order for specific design requirements.

1.3 Details of the wire used for the range of standard mesh/wire combinations and the associated lacing wire required for on-site fabrication are given in the Front Sheets. Other sizes and mesh/wire combinations may be manufactured to order.

1.4 The Maccaferri Gun reference SC-50 is a mechanical device for crimping stainless steel or galvanized steel Flex-C rings to the PVC-U coated or galvanized steel mesh, respectively. The stainless steel rings reference 11SS40 are manufactured from 3.05 mm diameter stainless steel to ASTM A313 type 302 class I. Galvanized steel rings reference 11GS40 are manufactured from 3.05 mm diameter high tensile wire coated with 280 gm^{-2} of zinc to ASTM A90 and A76E class II.

Table 1 Standard sizes of gabions

Size (metres)	Code				
	Z8/2.4(1)	Z8/2.7(1)	Z8/3.0	P8/2.4(1)	P8/2.7(1)
1.0 × 1.0 × 1.0	–	✓(2)	–	–	✓(2)
1.5 × 1.0 × 1.0	✓(2)	✓(2)	✓(2)	✓(2)	✓(2)
2.0 × 1.0 × 1.0	✓(2)	✓(2)	✓(2)	✓(2)	✓(2)
3.0 × 1.0 × 1.0	–	✓(2)	–	✓(2)	✓(2)
4.0 × 1.0 × 1.0	✓(2)	✓(2)	–	✓(2)	✓(2)
1.5 × 1.0 × 0.5	–	✓(2)	–	–	✓(2)
2.0 × 1.0 × 0.5	✓(2)	✓(2)	✓(2)	✓(2)	✓(2)
3.0 × 1.0 × 0.5	–	✓(2)	–	✓(2)	✓(2)
4.0 × 1.0 × 0.5	–	–	–	–	✓(2)
2.0 × 1.0 × 0.3	–	✓(2)	–	–	✓(2)

(1) Mesh available in 25 metres × 2 metres rolls for these codes.

(2) Available in UK. Other sizes to special order.

Table 2 Standard sizes of Reno Mattresses and jumbo gabions

Size (metres)	Code				
	Z6/2.0(1)	Z8/3.0	P6/2.0(1)	P8/2.4(1)	P8/2.7(1)
3.0 × 2.0 × 0.5	–	–	–	–	✓(2)
6.0 × 2.0 × 0.5	–	–	–	–	✓(2)
3.0 × 2.0 × 0.3	✓(2)	–	–	✓(2)	–
6.0 × 2.0 × 0.3	✓(2)	–	–	✓(2)	–
3.0 × 2.0 × 0.23	✓(2)	–	✓(2)	–	–
6.0 × 2.0 × 0.23	✓(2)	–	✓(2)	–	–
3.0 × 2.0 × 0.17	✓(2)	–	✓(2)	–	–
6.0 × 2.0 × 0.17	✓(2)	–	✓(2)	–	–

(1) Mesh available in 25 metres × 2 metres rolls for these codes.

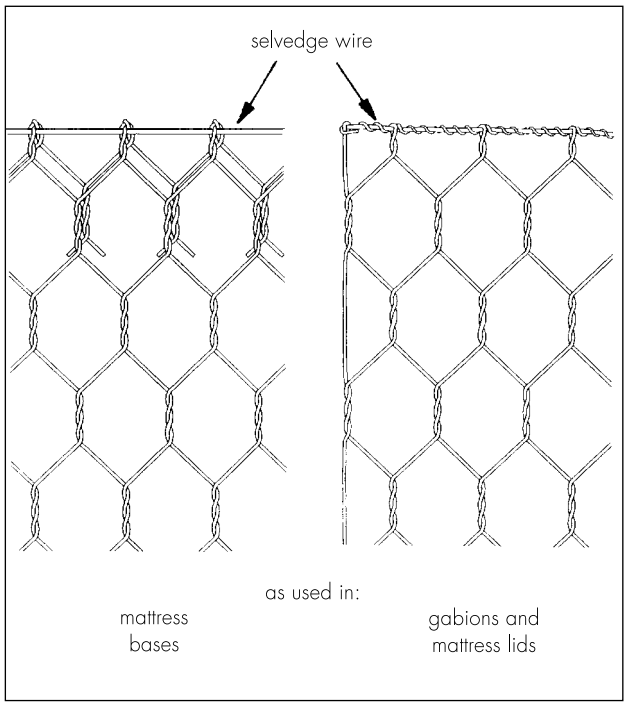
(2) Available in UK. Other sizes to special order.

2 Manufacture and quality control

2.1 Detail relevant to the manufacture of the hexagonal mesh is given in the Front Sheets.

2.2 During fabrication cut ends are mechanically selvedged with a wire of greater diameter than that used for the mesh wires (see Figure 1).

Figure 1 Selvedge detail



2.3 Box gabion end panels and diaphragms are selvedged along their upper edges in a similar manner to that described in section 2.2.

2.4 Reno Mattresses consist of a separate base and a lid. The lid is formed either by a panel of mesh for each base or by a roll of mesh used to cover several adjacent mattresses.

2.5 Reno Mattress bases are fabricated from a single panel of mesh having sides, ends and diaphragms formed by folding during manufacture (see Figure 8). The mattresses are folded and packed for delivery. Mattresses constructed from mesh to code P8/2.7 are manufactured with separate diaphragms.

3 Delivery, storage and site handling

3.1 The gabions and mattresses are delivered to site in bundles weighing up to 800 kg depending on unit size and mesh specification.

3.2 The products may be stored in the open, but away from site traffic to avoid the risk of accidental damage, and should remain packaged until required.

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

3.4 All bundles must be handled with care to avoid damage to coatings. Individual units may be manhandled.

Design Data

4 Maccaferri Gabions — general

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

4.2 The density of filled gabions should be generally 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.

4.3 The stone infill to the gabions is normally sized between 100 mm and 200 mm and is of hard, durable stone as quarried or naturally occurring rounded stone [see BS 5390 : 1976(1984), Section 3, paragraph 16].

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

5 Maccaferri Reno Mattresses — general

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

5.2 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.

5.3 The stone infill to the Reno Mattresses is normally sized between 75 mm 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 [see BS 5390 : 1976(1984), Section 3, paragraph 16].

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

6 Design of Maccaferri Gabion and Reno Mattress structures

6.1 The design of gabion and Reno Mattress structures should be carried out by a suitably qualified engineer.

6.2 The magnitude and distribution of the earth pressures and earth resistance should be calculated in accordance with current design philosophy.

6.3 As in other earth retaining structures it is necessary to determine a suitable factor of safety against the principal modes of failure for the following parameters:

overall stability
overturning
shearing pressure
sliding
internal stability.

6.4 Watercourse linings, weirs and other hydraulic structures may require special consideration in regard to scour, uplift, wave action, seepage, etc.

6.5 The mesh specification should be chosen to achieve the required design life (see section 10).

7 Strength of Maccaferri Gabions and Reno Mattresses

7.1 If installed in accordance with this Certificate the mesh has adequate strength to resist all loads associated with handling, positioning and filling.

7.2 Gabions and mattresses are permeable and, in general, will not permit hydrostatic pressure to build up. Gabion earth retaining structures are not normally designed to withstand hydrostatic pressure.

7.3 Where cohesive materials, eg clay, etc, are 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.

7.4 Maccaferri Gabions and Reno Mattresses have adequate strength to permit pre-filling and placing by crane when carried out in accordance with the manufacturer's instructions.

8 Practicability of installation

The gabions and mattresses are installed easily under normal site conditions.

9 Maintenance and repair

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

10 Durability

10.1 The specification for a particular installation must be chosen to achieve the required design life.

10.2 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 in the conditions of exposure encountered during its design life.

10.3 PVC-U coated, galvanized steel wire will not be affected by the chemicals normally encountered in earth retaining structures.

10.4 Some local damage may occur to the PVC-U coating during installation and in exposed areas. Evidence from installations up to 40 years old indicates that such damage will remain local and not spread, affecting the integrity of the structure. Therefore, when used in dry land retaining walls, the PVC-U coated mesh may be considered to have a life expectancy of 120 years.

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

10.6 The life expectancy of the non-coated galvanized wire products may be estimated from the data given in the Front Sheets.

10.7 The life expectancy of products used in river erosion and coastal protection schemes will also be affected by the scouring effects of fast flowing water. Maccaferri Ltd can advise on the design of such installation to optimise the performance of the system.

Installation

11 General

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

12 Procedure

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

12.1 Gabions are opened and folded on a hard surface, pressing out any unwanted creases.

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

12.3 Top corners are secured with the thick selvedge wire. Edges are joined together, using the appropriate lacing wire, starting from the top course, either in a continuous operation using alternate single and double twists or with rings applied using the Maccaferri Gun reference SC-50.

12.4 A number of empty gabions may be placed in position on a flat surface and secured together as described in section 12.3.

12.5 The gabions are filled with suitable stone to a level approximately 50 mm to 75 mm overfull to allow for settlement of the infill due to self-weight.

12.6 When considered necessary for aesthetic or other considerations the gabion 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.

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

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

12.9 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 12.3.

Pre-filled gabions

12.10 Gabions are constructed as described in sections 12.1 to 12.3, 12.5, 12.7 and 12.8, but with double loops throughout. However, it is advantageous to construct a slightly oversize frame within which the empty unit can be stretched taut.

12.11 After filling the horizontal top edges are stiffened, if required, using reinforcing bars, typically 20 mm diameter, to maintain shape during lifting. Bars should be removed after placement.

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

Figure 2 Preparation of gabions

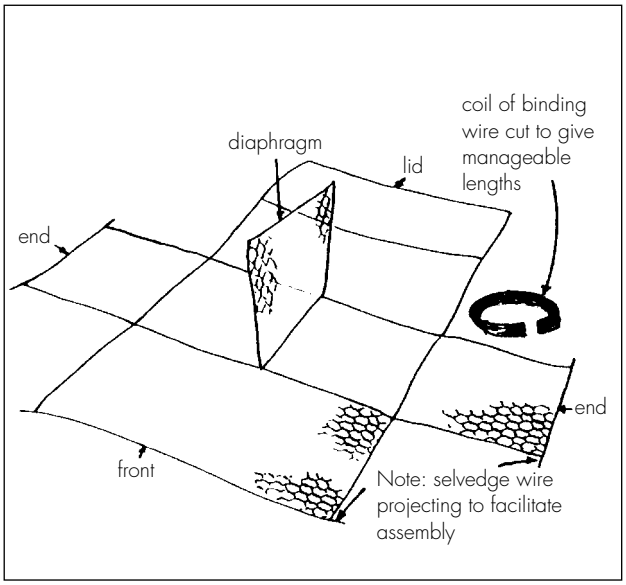


Figure 3 Wiring pattern

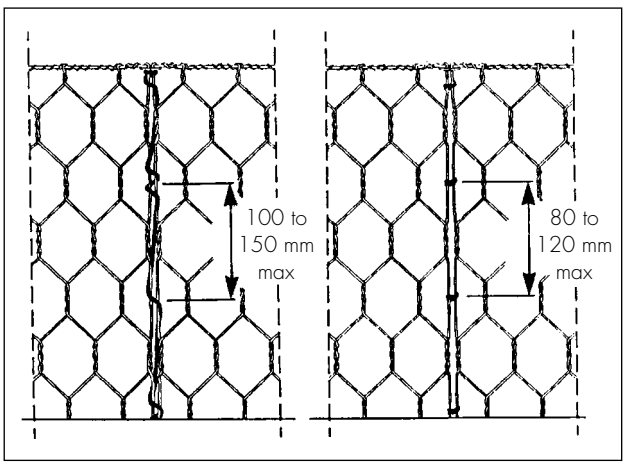


Figure 4 Forming gabions

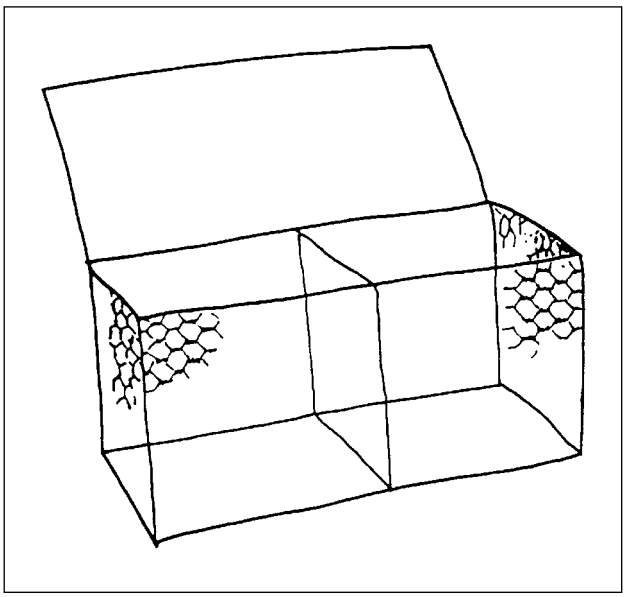


Figure 5 Bracing gabions

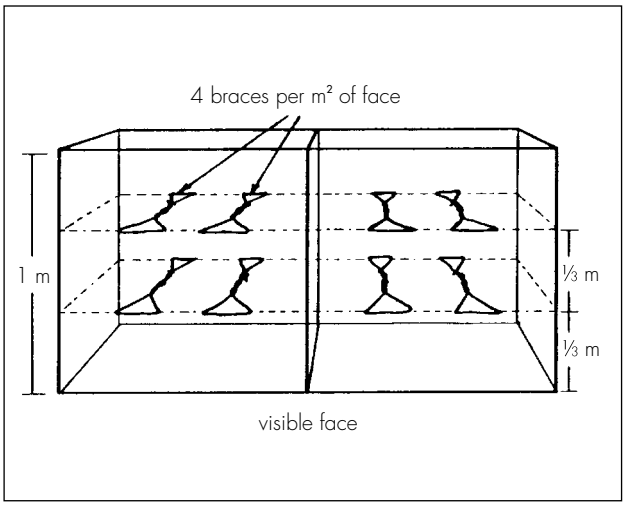
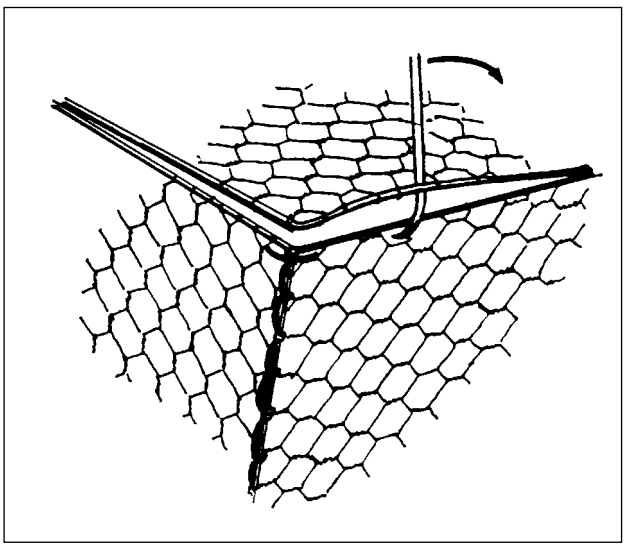


Figure 6 Closing the lid on gabions



In-situ filled mattresses (see Figures 7 to 9)

12.13 Mattresses are opened and folded on a hard surface, pressing out any unwanted creases.

12.14 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 12.3.

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

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

12.17 The lid is secured along each edge and diaphragm using lacing wire or rings as specified.

Pre-filled mattresses

12.18 The mattress is assembled as described in section 12.14 but using double loops throughout.

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

12.20 After filling, the unit must be properly secured using the method described in section 12.3.

12.21 Purpose-made lifting frames are available with suitable attachments to enable the filled mattresses to be safely placed in position.

Figure 7 Preparation of mattresses

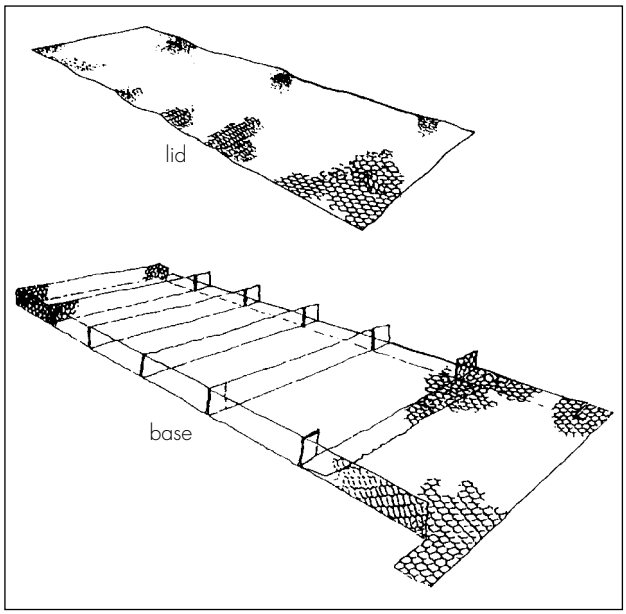


Figure 8 Forming fold in mattresses

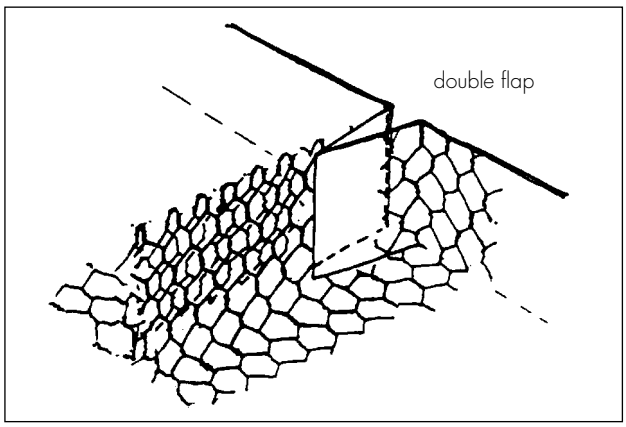
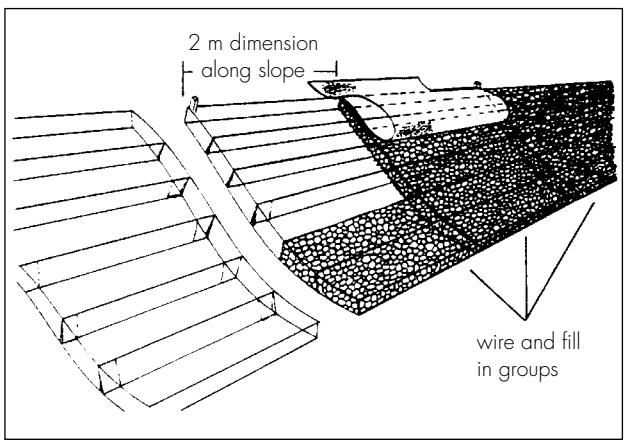


Figure 9 Placement of mattresses



Technical Investigations

The following is a summary of the technical investigations carried out in relation to Maccaferri Gabions and Reno Mattresses.

13 Investigations

13.1 The manufacturing process of the Maccaferri Gabions and Reno Mattresses was examined, including the methods adopted for quality control, and details were obtained of the quality and composition of the materials used.

13.2 An assessment of data was made to determine:

dimensional accuracy
tensile strength for Flex-C rings
quality of galvanized coating
the effect of tolerances
strength of wire, mesh and filled gabions
quality of materials
quality of plastic coating
ease of assembly
durability.

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

13.4 An assessment was made of data pertaining to site case studies where the product has been in use for a number of years.

Bibliography

BS 5390 : 1976(1984) *Code of practice for stone masonry*

BBA BRITISH BOARD OF AGRÉMENT
ASSESSMENT OF PRODUCTS FOR CONSTRUCTION

On behalf of the British Board of Agrément

Date of Second issue: 30th June 1995

Director

**The original Detail Sheet was issued on 22nd May 1995. This amended version includes the change of name of the Certificate holder.*

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