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Roads and Bridges
Agrément Certificate
99/R117
Product Sheet 1

LINK MIDDLE EAST (LME) EARTH RETENTION AND PROTECTION SYSTEMS

LME WOVEN HEXAGONAL MESH GABIONS

The Highways Agency requirements to which this Certificate is subject are detailed on page 2

PRODUCT SCOPE AND SUMMARY OF CERTIFICATE

This Certificate relates to LME Woven Hexagonal Mesh Gabions, containers formed from woven hexagonal mesh of PVC-U coated galvanized wire, for use in retaining wall applications.

AGRÉMENT CERTIFICATION INCLUDES:

- factors relating to compliance with Highways Agency requirements where applicable
- factors relating to compliance with Regulations 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 product, 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 requirements of this Certificate, the gabion structure may be considered to have a life expectancy in excess of 60 years (see section 7).

The BBA has awarded this Agrément Certificate to the company named above for the product described herein. This product has been assessed by the BBA as being fit for its intended use provided it is installed, used and maintained as set out in this Certificate.

On behalf of the British Board of Agrément

Date of First issue: 12 October 2010

Originally certified on 1 November 1999

Brian Chamberlain

Head of Approvals — Engineering

Greg Cooper

Chief Executive

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 are advised to check the validity and latest issue number of this Agrément Certificate by either referring to the BBA website or contacting the BBA direct.

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Highways Agency Requirements

The general requirements for gabions are contained in the Highways Agency *Manual of Contract Documents for Highway Works* (MCHW)⁽¹⁾, Volume 1 *Specification for Highway Works*, August 1998 (as amended).

Additional site requirements may apply to particular projects.

The gabion system is for use on projects which fall within the scope of Departmental Standard HD22/08 (DMRB 4.1.2) *Geotechnics and Drainage – Managing Geotechnics Risks*. This assumes a design life of not less than 60 years.

(1) The MCHW is operated by the Overseeing Organisations: the Highways Agency (HA), Transport Scotland, the Welsh Assembly Government and The Department for Regional Development (Northern Ireland).

Regulations

Construction (Design and Management) Regulations 2007

Construction (Design and Management) Regulations (Northern Ireland) 2007

Information in this Certificate may assist the client, CDM co-ordinator, designer and contractors to address their obligations under these Regulations.

See sections: 2 *Delivery and site handling* (2.1 and 2.4) and 9 *Procedure* (9.13 and 9.14) of this Certificate.

General

This Certificate relates to LME Woven Hexagonal Mesh Gabions for retaining walls.

Construction of the system is usually carried out by civil engineering or building contractors who must ensure that installation of the system is in accordance with the Certificate holder's instructions and information given in this Certificate.

The gabions are marketed in the UK by Cerana Ltd (trading as Enviromesh), Garner Street Business Park, Etruria, Stoke-on-Trent, Staffordshire ST4 7BH. Tel: 0845 1360101; Fax: 0845 1360202; e-mail: enquiries@enviromeshsolutions.com; website: www.enviromeshsolutions.com.

Technical Specification

1 Description

1.1 LME Woven Hexagonal Mesh Gabions are cages formed from hexagonal galvanized woven-steel wire mesh, laced together and filled with selected granular material (stone) (see section 3.2).

1.2 The nominal dimensions of standard gabions, in metres, are:

- height 0.5 or 1.0
- length 1.0, 1.5, 2.0, 3.0, 4.0 or 5.0
- depth 1.0 or 2.0.

1.3 Details of mesh sizes, the wire used for the range of standard mesh/wire combinations and the associated lacing wire required for on-site fabrication are given in Table 1.

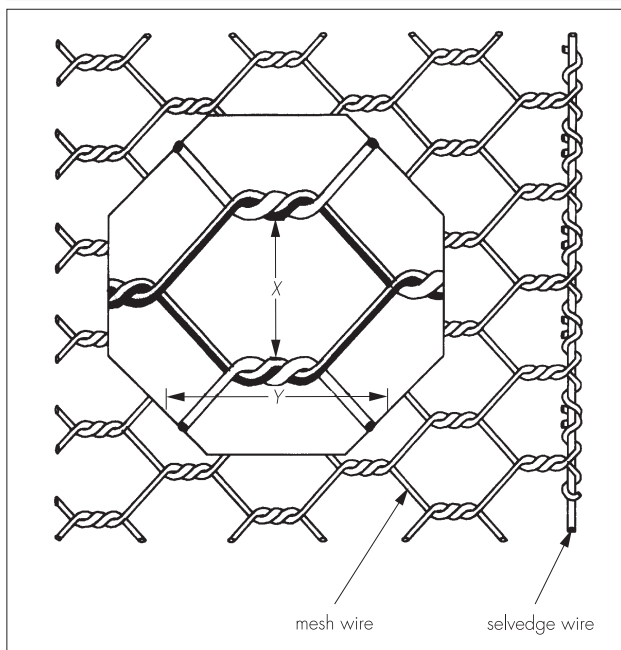
Table 1 Standard mesh and wire sizes

Mesh size ⁽¹⁾ X x Y (mm)	Wire diameter ⁽²⁾ (mm)					
	Mesh		Selvedge		Lacing	
	Galvanized/Galfan	PVC	Galvanized/Galfan	PVC	Galvanized/Galfan	PVC
60 x 80	2.0	3.0	2.4	3.4	2.2	3.2
60 x 80	2.2	3.2	2.7	3.7	2.4	3.4
60 x 80, 80 x 100	2.4	3.4	3.0	4.0	–	–
60 x 80, 80 x 100, 100 x 120	2.7	3.7	3.4	4.4	–	–
80 x 100, 100 x 120	3.0	4.0	3.9	4.9	–	–
100 x 120	3.4	4.4	4.4	5.4	–	–

(1) See Figure 1.

(2) To BS EN 10218-2 : 1997, tolerance class T1.

Figure 1 Details of gabion mesh



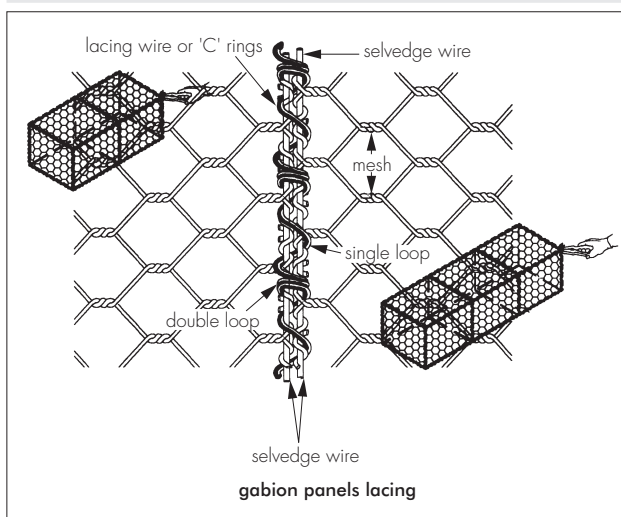
1.4 The wire used in the meshes is generally to BS EN 10218-2 : 1997 and BS EN 10223-3 : 1998 with an ultimate tensile strength of between 350 N·mm⁻² and 500 N·mm⁻² and with a minimum elongation at failure of 10% on a gauge length of 250 mm and drawn from rods complying with BS EN 10016-1 : 1995 and BS EN 10016-2 : 1995. The wire is galvanized in accordance with BS EN 10244-2 : 2009 (Tables 1 and 2, Class A) prior to being PVC-U coated in accordance with BS EN 10245-1 : 2001 and BS EN 10245-2 : 2001. The minimum coating thickness for the various diameters is given in Table 2. Different specifications are used for the selvedge wire, mesh and lacing coil (see Tables 1 and 2 and Figure 2).

Table 2 Details of coatings

Nominal core wire diameter (mm)	Minimum overall diameter of PVC-coated wire ⁽¹⁾ (mm)	Tolerance on core diameter (t ₁) (± mm)	Minimum mass of zinc/Galfan coating (g·m ⁻²)
2.0	3.0	0.05	215
2.2	3.2	0.06	230
2.4	3.4	0.06	230
2.7	3.7	0.06	245
3.0	4.0	0.07	255
3.4	4.4	0.07	265
3.9	4.9	0.07	275

(1) Including PVC coating.

Figure 2 Details of gabion construction



1.5 Steel lifting frames, with the appropriate number of slings/chains attached, are available and must be used to install pre-filled gabions (see section 9.14).

1.6 Quality control is carried out on raw materials, during production process and finished products.

2 Delivery and site handling

2.1 Generally, the gabions are delivered to site in bales of from one to several bundles, with each bundle consisting of from 1 to 45 gabion boxes weighing up to a maximum of 1000 kg. The bundles of boxes are strapped together to form a bale, which has a maximum height of 2 m and maximum weight of from 2.5 tonnes to 3.5 tonnes.

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

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

2.4 Bundles must be handled with due care to avoid damage to the coatings. Individual cages can be manhandled.

Assessment and Technical Investigations

The following is a summary of the assessment and technical investigations carried out on LME Woven Hexagonal Mesh Gabions.

Design Considerations

3 General

3.1 LME Woven Hexagonal Mesh Gabions comply with the requirements of the MCHW, Volume 1 *Specification for Highway Works*, clause 626, and therefore are suitable for use as described in the *Highways Agency Requirements* section of this Certificate.

3.2 Selected granular material (as detailed in the MCHW, Volume 1, Series 600, Table 6/1, Class 6G) must be used to fill the gabions. The fill material should be of hard durable stone such as quarried or naturally occurring rounded stone. The maximum and minimum particle size must comply with the MCHW, Volume 1, clause 626.5.

3.3 The design of gabion structures should be based on the principle of mass earth-retaining walls.

3.4 The density of filled 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.

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

3.6 Placing the external layer of stone by hand can give a better appearance to the completed wall without affecting the strength of the gabion structure.

4 Practicability of installation

The products are designed to be installed by competent civil engineering or building contractors experienced with these types of products, and are installed easily under normal site conditions.

5 Structural performance

5.1 The design of the gabion structures should be carried out by a suitably qualified engineer.

5.2 The mesh has adequate strength to resist all loads associated with handling and positioning. Care must be taken when installing pre-filled gabions (see sections 9.12 to 9.14).

5.3 Correctly laced gabions will remain in position and adequately sustain the load associated with placing the stone infill.

5.4 Gabion walls are permeable and will not permit hydrostatic pressure to build up behind the wall. Gabion structures are not normally designed to withstand hydrostatic pressure.

5.5 Where cohesive materials, such as clay, 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.

5.6 The lifting frames and slings have adequate strength when used in accordance with the manufacturer's instructions.

6 Maintenance and repair

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

7 Durability

7.1 The life of a gabion structure is dependent on the quality of the mesh, the durability of the stone and, in the longer term, the stability of the consolidated mass of the infill material.

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

7.3 Some local damage may occur to the PVC-U coating during installation and in exposed areas, and may lead to corrosion of the mesh. From site evidence and test data, it is indicated that such damage will remain local and not cause sequential corrosion underneath the intact adjacent area of mesh. The design of the wire mesh and the fact that the strength of the mesh is not taken into account in the design of the structure as a whole, indicate that this local damage will not affect the integrity of the structure.

7.4 A gabion wall is a mass earth-retaining structure and settlement may occur under the action of its self-weight. The movement associated with this will gradually increase the density of the structure and a reduction in the volume of voids. Additional settlement may occur when gabions are founded on weak soils.

7.5 A gabion wall will permit the growth of vegetation which will contribute to the integrity of the structure and to maintaining a natural appearance.

7.6 The design life of a gabion structure constructed in accordance with this Certificate, with suitable stone infill and adequate maintenance (see section 6), will be in excess of the 60 years required by the HA.

Installation

8 General

Installation of LME Woven Hexagonal Mesh Gabions must be in accordance with this Certificate and the Certificate holder's installation instructions.

9 Procedure

In-situ filled gabion boxes

9.1 Gabion boxes are opened and folded on a hard surface, pressing out any unwanted creases.

9.2 Front and rear sides, ends and diaphragms are lifted into position to form a box shape (see Figure 3a).

9.3 Top corners are secured with the thick selvedge wire.

9.4 The edges are laced together, starting from the top corner in a continuous operation using alternate single and double twists at intervals of one mesh length. The ends of the lacing wire are secured at each corner with triple loops and turned into the gabions (see Figure 3b). Individual ties of lacing wire must not be used.

9.5 The initial layer of gabions should be placed on a flat surface.

9.6 A number of empty gabion boxes may be placed in position and secured together with lacing wire or 'C' rings using the method described in section 9.4.

9.7 The end gabion is partly filled with suitable stone to form an end anchor and bracing wires are fixed at 500 mm intervals to prevent the front side from bulging (see Figure 3c). The gabions are tensioned by applying a load to the end remote from the anchor gabion, ensuring the load is distributed over the whole area of the last gabion (see Figure 3d).

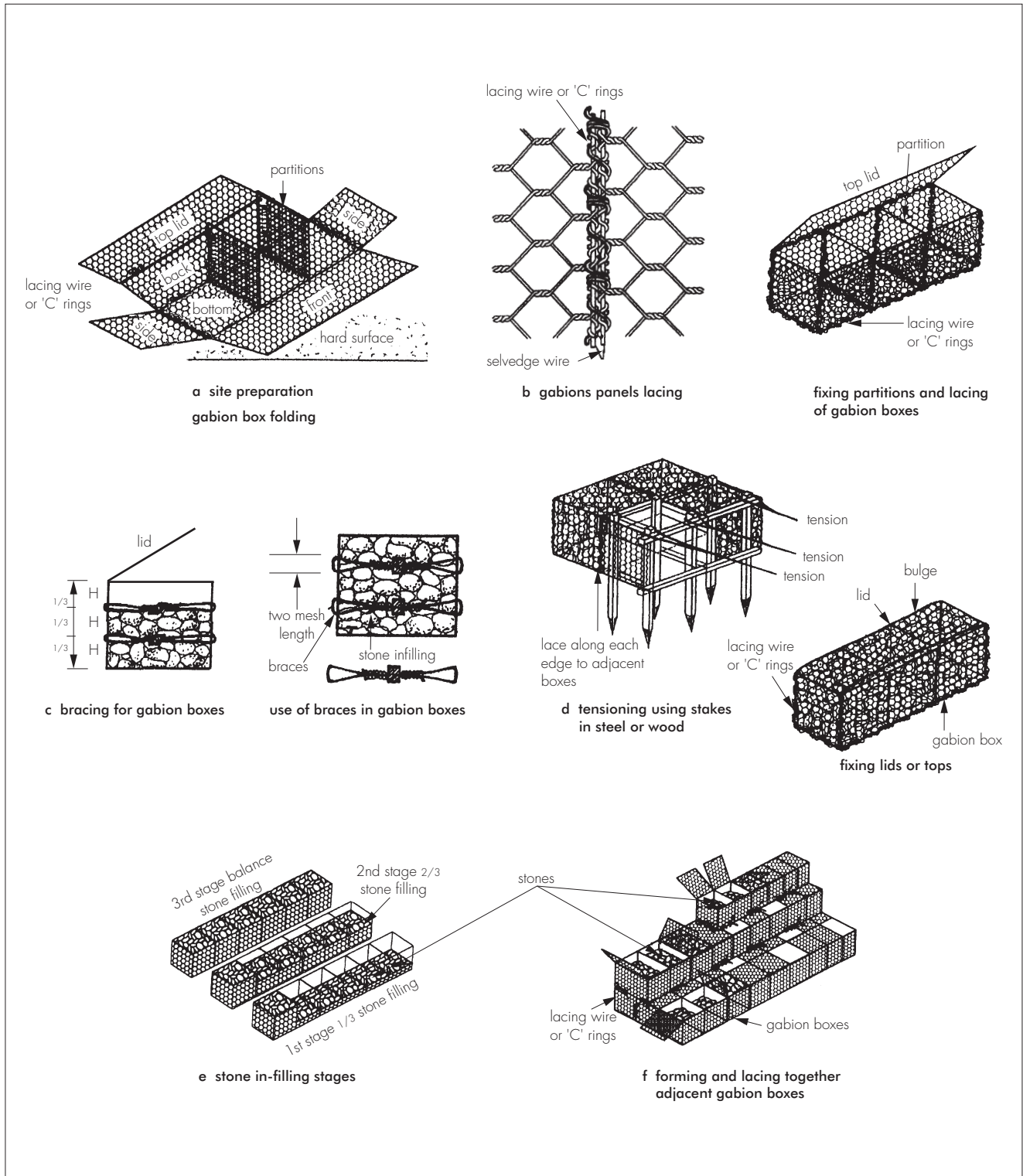
9.8 One-metre high gabions should be filled to one-third height, braced, filled to two-thirds height and braced again. A 0.5 m-high gabion requires only one row of bracing at 250 mm height. The gabion is overfilled by approximately 50 mm to 75 mm to allow for settlement of the infill (due to self-weight).

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

9.10 The remaining row of gabions may be filled sequentially as shown in Figure 3e.

9.11 It is essential that each gabion box is properly secured to adjacent gabion boxes above, below and on each side (see Figure 3f).

Figure 3 Installation — in-situ



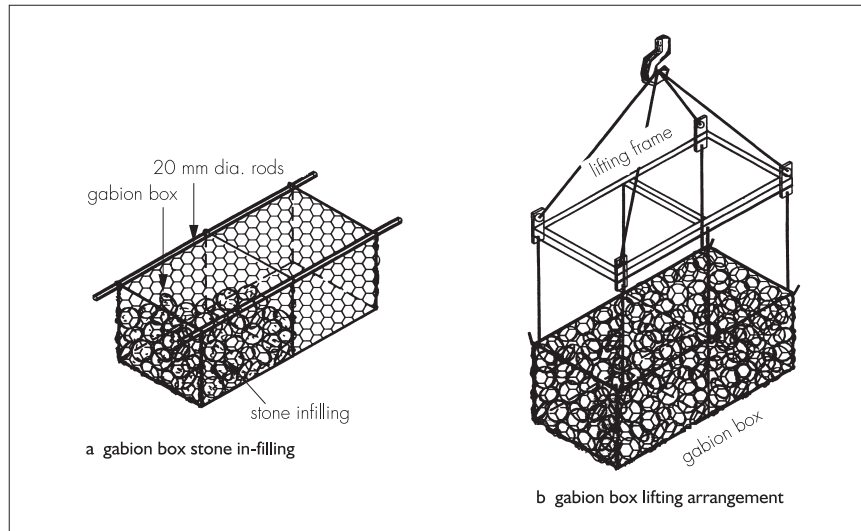
Pre-filled gabion boxes

9.12 Gabion boxes are constructed as described in sections 9.1 to 9.4, 9.8 and 9.9. However, it is advantageous to construct a slightly oversize frame within which the empty unit can be stretched taut (see Figure 4a).

9.13 After filling, the horizontal top edges are stiffened, if required, using reinforcing bars, typically 20 mm in diameter, to maintain shape during lifting. Bars should be removed after placement (see Figure 4b).

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

Figure 4 Installation — pre-filled



Technical Investigations

10 Investigations

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

10.2 An assessment of data and a series of tests were carried out to determine:

- dimensional accuracy
- tensile strength
- quantity of galvanized coating
- the effect of tolerances
- strength of wire, mesh and filled gabions
- quality of materials
- quality of organic coating
- ease of assembly
- compliance with HA specification, clause 626
- design procedures
- strength of the lifting frame
- durability
- effect of site damage.

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

Bibliography

- BS EN 10016-1 : 1995 *Non-alloy steel rod for drawing and/or cold rolling — General requirements*
BS EN 10016-2 : 1995 *Non-alloy steel rod for drawing and/or cold rolling — Specific requirements for general purpose rod*
BS EN 10218-2 : 1997 *Steel wire and wire products — General — Wire dimensions and tolerances*
BS EN 10223-3 : 1998 *Steel wire and wire products for fences — Hexagonal steel wire netting for engineering purposes*
BS EN 10224 : 2002 *Non-alloy steel tubes and fittings for the conveyance of water and other aqueous liquids — Technical*
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 : 2001 *Steel wire and wire products — Organic coatings — General rules*
BS EN 10245-2 : 2001 *Steel wire and wire products — Organic coatings on steel wire — PVC finished wire*
HD 22/08 *Design Manual for Roads and Bridges : Volume 4, Geotechnics and Drainage : Section 1, Earthworks : Part 2, Managing Geotechnical Risk*
Manual of Contract Documents for Highway Works, Volume 1 *Specification for Highway Works, August 1998 (as amended)*

11 Conditions

11.1 This Certificate:

- relates only to the product/system that is named and described on the front page
- is granted only to the company, firm or person named on the front page — no other company, firm or person may hold or claim any entitlement to this Certificate
- 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.

11.2 Publications and documents referred to in this Certificate are those that the BBA deems to be relevant at the date of issue or re-issue of this Certificate and include any: Act of Parliament; Statutory Instrument; Directive; Regulation; British, European or International Standard; Code of Practice; manufacturers' instructions; or any other publication or document similar or related to the aforementioned.

11.3 This Certificate will remain valid for an unlimited period provided that the product/system and the manufacture and/or fabrication including all related and relevant 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
- remain in accordance with the requirements of the Highways Agency.

11.4 In granting this Certificate, the BBA is not responsible for:

- the presence or absence of any patent, intellectual property or similar rights subsisting in the product/system or any other product/system
- the right of the Certificate holder to manufacture, supply, install, maintain or market the product/system
- individual installations of the product/system, including the nature, design, methods and workmanship of or related to the installation
- the actual works in which the product/system is installed, used and maintained, including the nature, design, methods and workmanship of such works.

11.5 Any information relating to the manufacture, supply, installation, use and maintenance 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 and maintained. It does not purport in any way to restate the requirements of the Health & Safety at Work etc Act 1974, or of any other statutory, common law or other duty which may exist at the date 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. 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 manufacture, supply, installation, use and maintenance of this product/system.