HAPAS

Tensar International Limited
2-4 Cunnigham Court
Shadsworth Business Park
Blackburn BB1 2QX

Tel: 01254 262431
e-mail: info@tensar-international.com
website: www.tensar-international.com

HAPAS Certificate
13/H201
Product Sheet 3

TENSAR RETAINING WALL SYSTEMS

TENSARTECH ARES WALL SYSTEM FOR REINFORCED SOIL RETAINING WALLS AND BRIDGE ABUTMENTS

This HAPAS Certificate Product Sheet(1) is issued by the British Board of Agrément (BBA), supported by Highways England (HE) (acting on behalf of the Overseeing Organisations of the Department for Transport; Transport Scotland; the Welsh Government and the Department for Infrastructure, Northern Ireland), the Association of Directors of Environment, Economy, Planning and Transport (ADEPT), the Local Government Technical Advisers Group and industry bodies. HAPAS Certificates are normally each subject to a review every three years.
(1) Hereinafter referred to as 'Certificate'.

This Certificate relates to TensarTech(1) ARES Wall System for reinforced soil retaining walls and bridge abutments. The system comprises TensarTech ARES precast concrete facing panels, Tensar RE500 geogrids and high-density polyethylene (HDPE) Tensar polymer bodkins.

(1) TensarTech is a registered trademark of the Certificate holder in the UK and other countries.

CERTIFICATION INCLUDES:

- factors relating to compliance with HAPAS requirements
- 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

Design — interaction between the soil and geogrids has been considered and coefficients relating to direct sliding and pull-out resistance are proposed (see section 6).

Mechanical properties and factor of safety for the extrapolation of data — the short and long-term tensile strength and elongation properties of the geogrids, loss of strength due to installation damage and reduction in strength at the connection to the precast concrete facing panels have been assessed and reduction factors established for use in design (see sections 7 and 9).

Effects of environmental conditions and durability — the resistance of the geogrids to the effects of oxidation, chemical and biological degradation and exposure to UV light normally encountered in reinforced soil retaining walls and bridge abutments has been assessed and reduction factors established for use in design. The precast concrete facing panels must have adequate durability for the proposed life of the structure (see sections 8 and 11).

The BBA has awarded this Certificate to the company named above for the system described herein. This system 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 Second issue: 29 July 2021

Originally certificated on 22 May 2020

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 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.
Any photographs are for illustrative purposes only, do not constitute advice and should not be relied upon.

Requirements

In the opinion of the BBA, TensarTech ARES Wall System for reinforced soil retaining walls and bridge abutments, when used in conjunction with the precast concrete facing panels and compacted fill material, in accordance with the provisions of this Certificate, can satisfy the requirements of Highways England and local Highway Authorities for the design and construction of reinforced soil retaining walls and bridge abutments.

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 section: 3 *Delivery and site handling* (3.3) of this Certificate.

Additional Information

CE marking

The Certificate holder has taken the responsibility of CE marking Tensar RE500 geogrids in accordance with harmonised European Standard BS EN 13251 : 2016.

Technical Specification

1 Description

1.1 The system incorporating the products covered by this Certificate comprises:

- Tensar RE500 geogrids
- TensarTech ARES concrete facing panels
- Tensar HDPE bodkins
- Compacted fill material.

Tensar RE500 geogrids

1.2 Tensar RE500 geogrids are uniaxial geogrids manufactured from sheet polyethylene, punched and stretched under temperature-controlled conditions. For more information about the range and specifications of the geogrids, please refer to BBA HAPAS Certificate 13/H201, Product Sheet 1.

Specification for precast concrete facing panels

1.3 The precast concrete facing panels used in conjunction with the geogrids must provide adequate strength and be designed and manufactured in accordance with BS 8006-1 : 2010, BS EN 14475 : 2006, BS EN 1992-2 : 2005, BS EN 206 : 2013, including relevant national annexes.

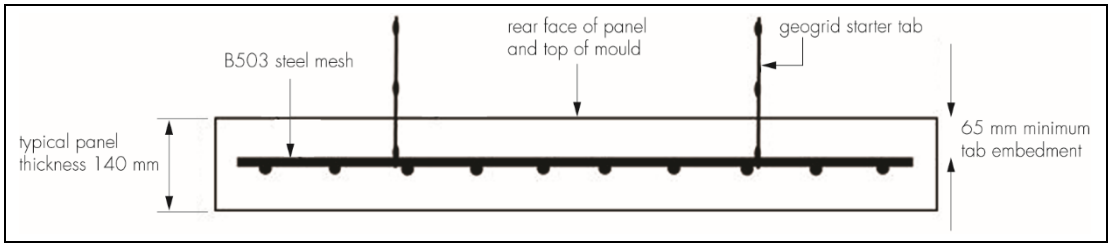
1.4 The Typical panel specification is shown in Table 1 and Figure 1.

Table 1 Typical panel specification

Typical dimensions – Height	1500 mm ±2 mm – Standard panel
Typical dimensions – Width	1500 mm ±2 mm – Standard panel
Typical dimensions – Thickness	140 mm ±2 mm – Standard panel
Steel reinforcement mesh	Grade B503 conforming to BS 4449 : 2005 and UK National Annex to BS EN 1992-1-1 : 2004
Minimum cover to steel	50 mm
Minimum compressive strength	BS 8006-1 : 2010 and Section 7.2

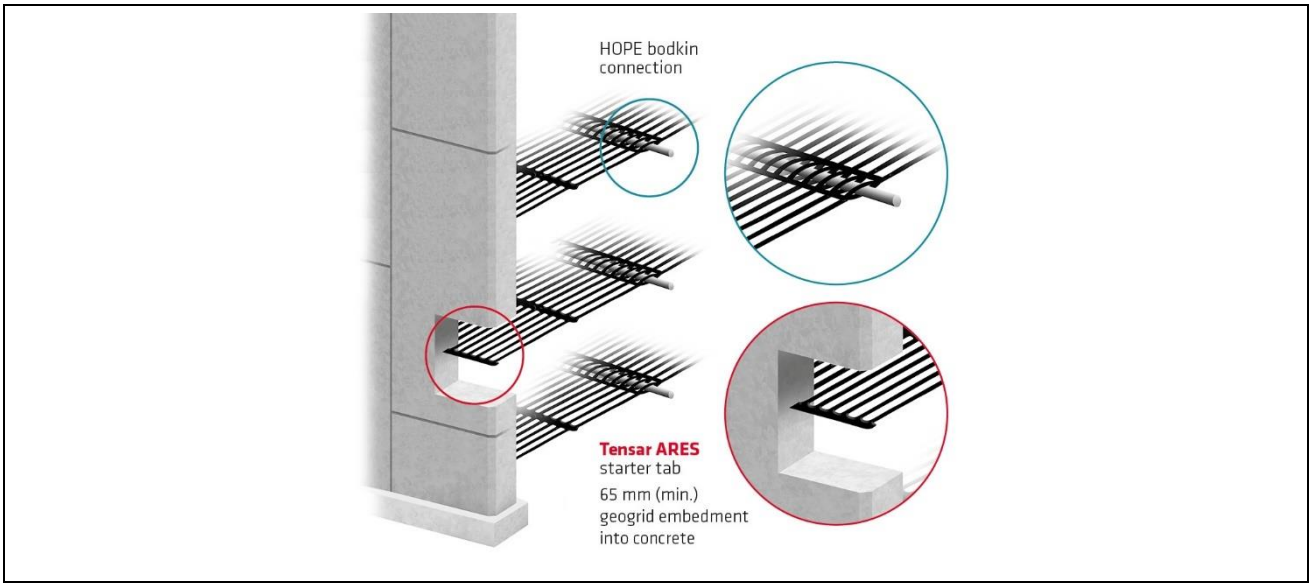
1.5 The geogrid starter tabs are positioned such that the transverse bar butts up to the steel reinforcement mesh. The minimum embedment of the geogrid starter tab is 65 mm, measured from the transverse bar against the steel reinforcement mesh to the rear face of the concrete panel. The geogrid is located centrally across the width of the mould at the positions dictated by the design and exits the concrete surface at the back of the panel at 90°. The transverse bars of the geogrid are straight and parallel to the concrete surface of the back of the panel. Further details can be sought from the Certificate holder

Figure 1 Precast concrete facing panels



1.6 The connection detail assessed by the BBA for connection of the geogrids to the precast concrete facing panels is shown in Figure 2. A starter tab of two ribs and three transverse bars of Tensar RE500 geogrid is cast into the rear of the panel at 65 mm depth. A 100% connection efficiency can be achieved (see section 7.2).

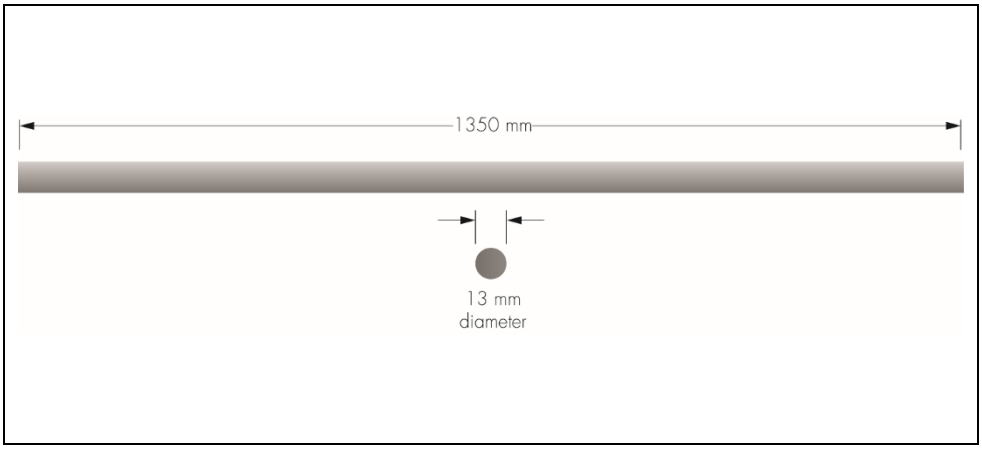
Figure 2 Connection to precast concrete facing panels



Tensar Bodkins

1.7 Tensar bodkins are manufactured from HDPE bars and are used to join lengths of Tensar RE500 geogrids when a full strength connection is necessary, see Figure 3.

Figure 3 Tensar bodkins



Specification for fill material

1.8 The fill materials must comply with the requirements set out in BS 8006-1 : 2010 and the MCHW, Volume 1, Series 600.

1.9 Ancillary Items for use with the products, but outside the scope of this Certificate, are:

- concrete levelling pads
- bearing pads between panels
- precast capping units
- geotextile liner — to stop soil spilling through the panels
- de-moulding lugs, temporary supports, clamps, wedges etc — used to install the precast concrete facing panels.

2 Manufacture

2.1 Tensar RE500 geogrids are manufactured from an approved list of polyethylene sheet polymers, which are punched and stretched under temperature-controlled conditions to give the required dimensions and short- and long-term tensile strength.

2.2 Tensar bodkins are bought-in to one agreed specification.

2.3 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 being operated by the manufacturer are being maintained.

2.4 The management systems of Tensar International Limited have been assessed and registered as meeting the requirements of BS EN ISO 9001 : 2015 and BS EN ISO 14001 : 2015 by the British Standards Institute Quality Assurance (Certificates Q 05288 and EMS 86463 respectively).

3 Delivery and site handling

3.1 Tensar RE500 geogrids are delivered to site in rolls, bound with self-adhesive tape, bearing the product grade and batch identification references (see Figure 4). In accordance with the recommendations of BS EN ISO 10320 : 2019, the self-adhesive tape is colour coded as identified in BBA HAPAS Certificate 13/H201, Product Sheet 1. The ends of the rolls are also spray painted to the same colour-coding scheme, to ease identification of the geogrid grade on site.

3.2 In accordance with harmonised European Standard BS EN 13251 : 2016, CE marking is incorporated into the product label.

Figure 4 Label

3.3 The geogrids, bodkins, precast facing panels and other components must be handled by following the relevant Health and Safety advice and guidance.

3.4 The geogrids, starter tabs attached to the concrete facing panel and bodkins should be stored under cover in clean, dry conditions, protected from mechanical or chemical damage, exposure to direct sunlight and extreme temperatures.

3.5 The precast concrete facing panels and other components should be handled and stored in accordance with the manufacturers' instructions, the requirements of BS 8006-1 : 2010, BS EN 14475 : 2006 and the MCHW, Volume 1, taking into consideration the relevant Health and Safety measures.

Assessment and Technical Investigations

The following is a summary of the assessment and technical investigations carried out on Tensar RE500 geogrids for reinforced soil retaining walls and bridge abutments.

Design Considerations

4 Use

4.1 When designed and installed in accordance with this Certificate, Tensar Retaining Wall Systems constructed from Tensar RE500 geogrids, TensarTech ARES Precast Concrete Facing Panels and Tensar bodkins (see sections 1.2 to 1.7) are satisfactory for use in the construction of reinforced soil retaining walls and bridge abutments.

4.2 Structural stability is achieved through the strength of the geogrid, the connection strength between the geogrid and precast concrete facing panels, and by the frictional interaction between the soil particles and geogrid.

4.3 The design of the precast concrete facing panels, the fill material specification and method of placement and compaction, the design strength of the geogrids and the length of embedment within the compacted fill material are key design factors.

4.4 Prior to the commencement of work, the designer must satisfy the design approval and certification procedures of the relevant Highway Authority.

4.5 The BBA has not assessed the structures for supporting parapet loading caused by vehicle collision at the top of the wall. Further guidance on the design of the system supporting vehicles for Highways must be sought in BS 8006-1 : 2010, Annex E.

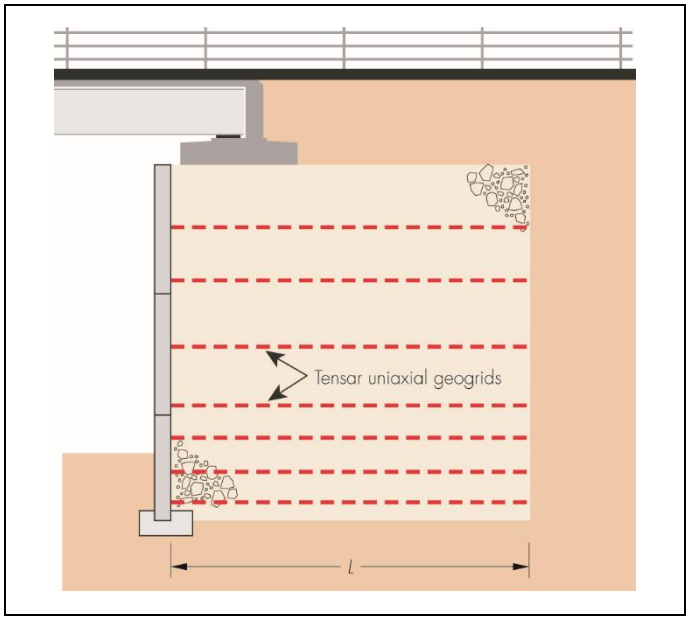
4.6 In addition to those items covered in section 6, attention must be paid in design to the following issues:

- site preparation
- fill material properties
- specification for placing and compaction of the fill material
- drainage
- protection of the geogrid against damage during installation
- design of the precast concrete facing panels
- the required construction tolerances for the completed structure.

4.7 The working drawings must show the correct orientation of the geogrids.

4.8 A typical cross section through a Tensar ARES reinforced soil wall/ bridge abutment is shown in Figure 5.

Figure 5 Typical diagrammatic cross sectional view



5 Practicability of installation

The system is designed to be installed by trained contractors in accordance with the specifications and construction drawings.

6 Design

Design methodology

6.1 Reinforced soil retaining walls and bridge abutments constructed using TensarTech ARES system must be designed in accordance with BS 8006-1 : 2010 and the MCHW, Volume 1, SHW.

6.2 In accordance with BS 8006-1 : 2010, Annex B, the required design life for permanent walls and bridge abutments is 120 years.

6.3 To evaluate the overall stability of the wall system it is necessary to consider:

- the design strength and length of embedment of the geogrid,
- the connection strength between the geogrid and TensarTech precast concrete facing panels.

Design strength of geogrids

6.4 The designer must carry out design checks to ensure that the geogrids have adequate long-term tensile strength at each layer of reinforcement, to satisfy the ultimate limit state and serviceability limit state design criteria as defined in BS 8006-1 : 2010, and that they have sufficient length of embedment to prevent pull out of the geogrid. For the calculation of the design strength of the geogrids, long-term creep rupture and other specification for the RE500 geogrids, please refer to BBA HAPAS certificate 13/H201 Product Sheet 1.

Specification of fill material

6.5 The designer should specify the relevant properties of the fill material for the reinforced soil structure deemed acceptable for the purposes of the design. Acceptable materials should satisfy the requirements of BS 8006-1 : 2010 and the MCHW, Volume 1, Series 600.

Concrete facing panels

6.6 The precast concrete facing panels must be designed in accordance with the relevant provisions of BS 8006-1 : 2010, BS EN 14475 : 2006 and BS EN 1992-2 : 2005.

6.7 The appropriate combination of concrete exposure classes should be selected from BS 8500-1 : 2015, Table A.1, and BS EN 206 : 2013, Table 1, to suit the proposed location and level of exposure of the proposed structure.

6.8 Where precast concrete facing panels are to be embedded in soils which could be potentially aggressive, the guidance in BS 8500-1:2015 and BRE Special Digest 1 : 2005, Part C, should be followed.

7 Mechanical properties

7.1 Short and long-term strength values and reduction factors required for design of the geogrids are given in Product Sheet 1 of this Certificate. These include:

- characteristic short-term tensile strengths (T_{char})
- long-term creep rupture strengths (T_{CR})
- maximum permissible loads to limit post-construction creep strain (T_{CS})
- reduction factors for installation damage (RF_{ID}), weathering (RF_W) and environmental degradation (RF_{CH})
- factors of safety for extrapolation of data (f_s).

Connection strength

7.2 Connection strength tests carried out between the starter geogrid and the precast concrete facing panels have shown that no reduction factor is required in the connection when concrete of the required strength is used and the specifications given in sections 1.3 and 1.6 are followed. The Certificate holder's advice must be sought for further information.

8 Effects of environmental conditions

Weathering (including exposure to UV light)

8.1 The geogrids do not show significant reductions in strength after exposure to natural daylight and weathering.

8.2 A reduction factor (RF_W) of 1.00 may be used for design, provided the geogrids are protected from exposure to sunlight in accordance with the recommendations of this Certificate and provided the periods of exposure are limited to a maximum of one month.

Chemical/environmental effects

8.3 Tensar RE500 geogrids have good resistance to the effects of chemical and environmental action, including oxidation, resistance to acids and alkaline liquids and microbiological attack. The reduction factors (RF_{CH}) given in Table 2 may be used for a design life up to 120 years and a design temperature up to 20°C. For additional temperature, the advice of the Certificate holder should be sought.

Table 2 Reduction factors

Soil pH value	RF_{CH}
2 to 4	1.05
4 to 12.5	1.00

9 Factor of safety for the extrapolation of data (f_s)

9.1 For Tensar RE500 geogrids, the factor of safety for the extrapolation of data (f_s) may be taken as 1.00 for a design life of up to 120 years and a design temperature of up to 20°C.

9.2 The value given in section 9.1 has been calculated in accordance with PD ISO/TR 20432 : 2007 as specified in BS 8006-1 : 2010, using the R_1 and R_2 values given in Table 3.

Table 3 R_1 and R_2 values for determination of f_s

Factor	Taking account of:	Design life (years)	
		60	120
R_1	Extrapolation of creep rupture data	1.00	1.00
R_2	Extrapolation of chemical data	1.00	1.00

10 Maintenance

The exposed faces of the precast concrete facing panels may require occasional maintenance, to remove dirt build up, mould and moss growth. All other components of the system incorporating the products are confined within the fill material and do not require maintenance.

11 Durability

11.1 When designed and installed in accordance with this Certificate, the system will have adequate durability for the required 120 year design life of a retaining wall and bridge abutment in conditions encountered in the UK.

11.2 The precast concrete facing panels will have adequate durability for the proposed life of the structure under exposure conditions normally encountered in reinforced earth retaining walls and bridge abutments in the UK when designed and installed in accordance with the provisions of BS 8006-1 : 2010, BS EN 14475 : 2006 and the requirements of this Certificate (see sections 6.6 to 6.8).

12 Reuse and recyclability

The concrete facing units can be crushed and re-used as aggregate. The fill material can also be re-used.

Installation

13 General

13.1 Installation should be carried out in accordance with the Certificate holder's installation instructions, the requirements of BS 8006-1 : 2010, BS EN 14475 : 2006 and the Specification for Highway Works.

13.2 Formation levels are prepared and a concrete strip foundation is laid for the first course of precast concrete facing panels, which are temporarily propped. Fill material is placed and compacted behind the facing up to the level of the first layer of geogrid.

13.3 The geogrid is then laid and, using Tensar bodkins, attached to the starter tab which is cast into the precast concrete facing panel. Care must be taken so that the starter tab maintains the exit angle of 90° during installation. The newly laid geogrid is pulled and held taut, preferably with a tension beam device as shown in Figure 6, prior to fill being placed. Further precast concrete facing panels are fixed as necessary and fill material is placed and compacted to specified heights, particular care being taken to ensure that the geogrids are adequately tightened and covered before compaction or use by traffic. The sequence is repeated up to the formation level for the parapet base or finished level as appropriate.

13.4 Fill material is placed to a depth not less than 150 mm before each pass of the compaction plant. To avoid excessive movement of the precast concrete facing panels, heavy compaction plant should not be used within two metres of the face, where the depth of fill before each pass may be less than 150 mm to suit the compaction method used.

13.5 Tensar bodkins are used to join lengths of geogrid and to form a connection with the starter tab of geogrid which is cast into the concrete facing panel. The geogrid is pulled and held taut, using the tension beam supplied and the fill placed to lock it in place as shown in Figure 6. Further details can be sought from the Certificate holder's Installation instructions.

Figure 6 Installation

Technical Investigations

14 Investigations

14.1 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.

14.2 An examination was made of data relating to:

- evaluation of long and short-term tensile properties
- assessment of the test method used for determining tensile creep rupture and creep strain results in comparison with the method given in BS EN ISO 13431 : 1999
- chemical resistance
- UV and environmental degradation
- the effects of temperature
- site damage trials and resistance to mechanical damage, assessed according to BS 8006-1 : 2010, Annex D
- the friction coefficient between the products and the soil fill.

14.3 An assessment has been made of the method for connection of the starter tab of Tensar RE500 geogrid cast into the precast concrete facing panels, and the connection of geogrid using Tensar bodkins.

14.4 The practicability and ease of handling and installation were assessed.

Bibliography

BRE Special Digest 1 : 2005 *Concrete in aggressive ground* : Part C *Assessing the aggressive chemical environment*

BS 4449 : 2005 + A3 : 2016 *Steel for the reinforcement of concrete — Weldable reinforcing steel — Bar, coil and decoiled product — Specification*

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

BS 8500-1 : 2015 + A1 : 2016 + A2 : 2019 *Concrete — Complementary British Standard to BS EN 206-1 — Method of specifying and guidance for the specifier*

BS EN 206 : 2013 + A1 : 2016 *Concrete — Specification, performance, production and conformity*

BS EN 1992-1 : 2004 *Eurocode 2 — Design of concrete structures — General rules and rules for buildings*
BS EN 1992-2 : 2005 *Eurocode 2 — Design of concrete structures — Concrete bridges — Design and detailing rules*

BS EN 13251 : 2016 *Geotextiles and geotextile-related products — Characteristics required for use in earthworks, foundations and retaining structures*

BS EN 14475 : 2006 *Execution of special geotechnical works — Reinforced fill*

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

BS EN ISO 10319 : 2008 *Geosynthetics — Wide-width tensile test*

BS EN ISO 10320 : 2019 *Geotextiles and geotextile-related products — Identification on site*

BS EN ISO 14001 : 2015 *Environmental Management systems — Requirements with guidance for use*

CIRIA SP123 : 1996 *Soil reinforcement with geotextiles*

BS EN ISO 13431 : 1999 *Geotextiles and geotextile-related products — Determination of tensile creep and creep rupture behaviour*

PD ISO/TR 20432 : 2007 *Guidelines for the determination of the long-term strength of geosynthetics for soil reinforcement*

Manual of Contract Documents for Highway Works, Volume 1 *Specification for Highway Works*

15 Conditions

15.1 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.

15.2 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.

15.3 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.

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

15.5 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:

- 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
- 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.

15.6 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.

British Board of Agrément
Bucknalls Lane
Watford
Herts WD25 9BA

tel: 01923 665300
clientservices@bbacerts.co.uk
www.bbacerts.co.uk