HAPAS

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BBA APPROVAL INSPECTION TESTING CERTIFICATION
TECHNICAL APPROVALS FOR CONSTRUCTION

HAPAS Certificate
12/H182
Product Sheet 1

REINFORCED EARTH SOIL REINFORCEMENT SYSTEMS

GEOSTRAP REINFORCEMENT FOR REINFORCED SOIL RETAINING WALLS AND BRIDGE ABUTMENTS

This HAPAS Certificate is issued by the British Board of Agrément (BBA), supported by the Highways Agency (HA) (acting on behalf of the overseeing organisations of the Department for Transport; Transport Scotland; the Welsh Assembly Government and the Department for Regional Development, Northern Ireland), the Association of Directors of Environment, Economy, Planning and Transport (ADEPT), the Local Government Technical Advisers' Group and industry bodies. HAPAS Agrément Certificates are normally each subject to a review every five years.

PRODUCT SCOPE AND SUMMARY OF CERTIFICATE

This Certificate relates to GeoStrap Reinforcement for Reinforced Soil Retaining Walls and Bridge Abutments, a geosynthetic strip used in conjunction with precast concrete facing units and compacted fill material to construct reinforced soil retaining walls and bridge abutments.

HAPAS 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 five-yearly review.

KEY FACTORS ASSESSED

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

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

Durability — the resistance of the GeoStrap Reinforcement to the effects of hydrolysis, chemical and biological degradation and exposure to UV light normally encountered in reinforced soil retaining walls and bridge abutments in the UK has been assessed and reduction factors established for use in design (see sections 8, 9 and 11).

The BBA has awarded this HAPAS 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 First issue: 17 April 2012

B C Chamberlain
Brian Chamberlain
Head of Approvals — Engineering

G N Cooper
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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Requirements

In the opinion of the BBA, GeoStrap Reinforcement for Reinforced Soil Retaining Walls and Bridge Abutments when used in accordance with the provisions of this Certificate, will meet the requirements of the Highways Agency and local Highway Authorities for the design and construction of reinforced soil retaining walls and bridge abutments.

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: 1 *Description* (1.2 and 1.4), and 13 *Installation* (13.9) of this Certificate.

Additional Information

CE marking

The manufacturer has taken responsibility for CE marking the GeoStrap Reinforcement in association with harmonised Standard BS EN 13251 : 2001. An asterisk (*) appearing in this Certificate indicates that data shown is given in the manufacturer's Declaration of Performance.

General

GeoStrap(1) Reinforcement is used in conjunction with precast concrete facing units and compacted fill material to construct reinforced soil retaining walls and bridge abutments.

The reinforcement strips are connected to the facing units either via galvanised mild steel loops and toggles or via proprietary GeoMega(1) connectors made from high density polyethylene.

(1) GeoStrap and GeoMega are registered trademarks.

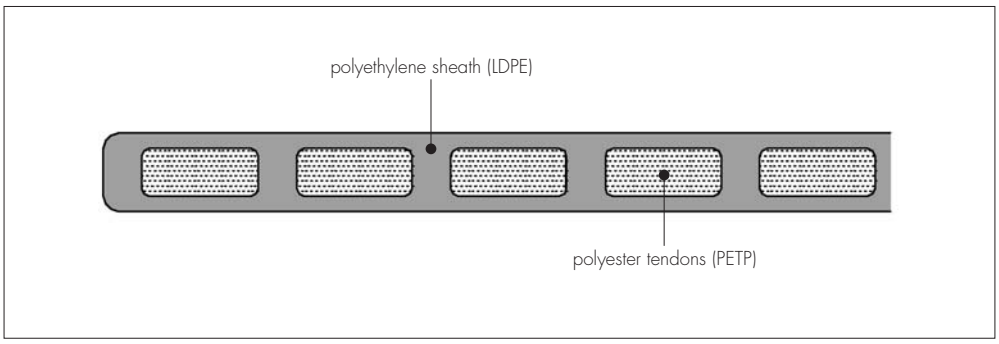
Technical Specification

1 Description

GeoStrap Reinforcement

1.1 GeoStrap Reinforcement is a geosynthetic strip comprising a number of discrete channels of individually tensioned, closely packed, high-tenacity polyester tendons, encased in a low-density polyethylene sheath (see Figure 1).

Figure 1 Typical GeoStrap Reinforcement — cross section



1.2 The types and grades of GeoStrap Reinforcement assessed by the BBA and covered by this Certificate are shown in Table 1.

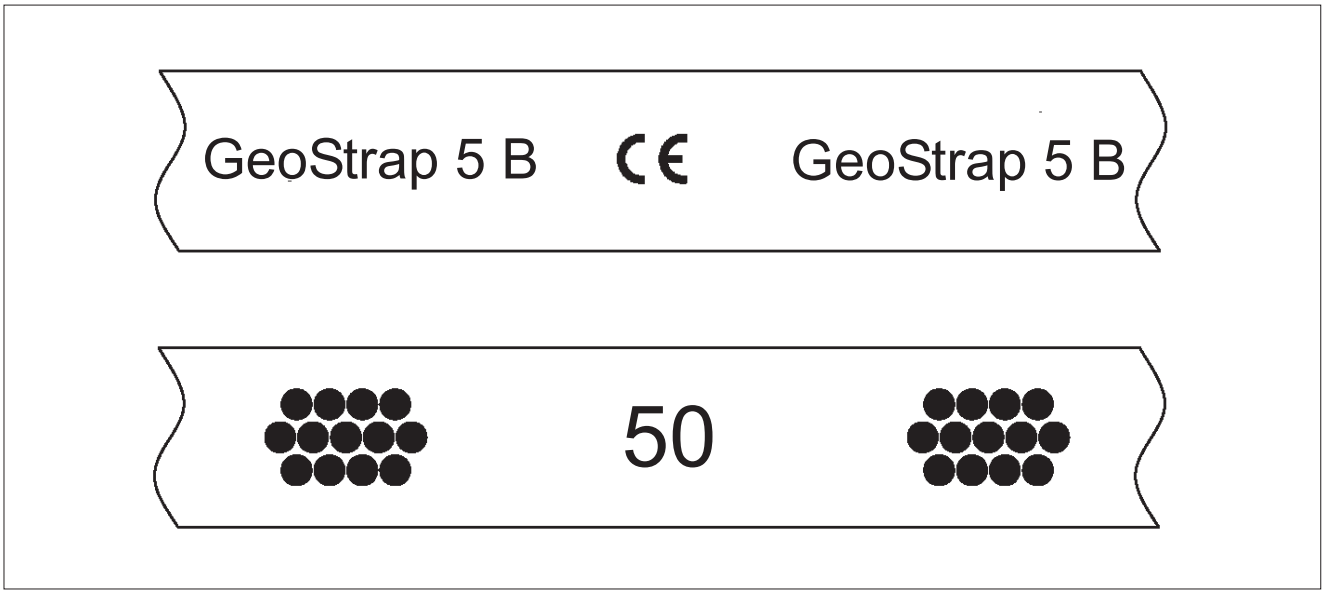
Table 1 Dimensions and short-term tensile strength

Type	Strength grade (kN)	Coil length (m)	Nominal Weight of coil (kg)	Mean width (mm)	Mean thickness (mm)	Weight of LDPE Coating ($g.m^{-1}$)	Characteristic short-term tensile strength[1] (T_{Char})(kN)
5B	37.5	100	11.3	49.5 ± 0.5	2.5 ± 0.5	62 ± 2	37.5*
5B	50	100	14.0	49.5 ± 0.5	4.0 ± 0.5	70 ± 2	50*
5B	65	100	18.2	49.5 ± 0.5	4.5 ± 0.5	90 ± 3	65*
9B	30	100	14.6	90 ± 1.0	1.5 ± 0.5	105 ± 3	30*
9B	50	100	19.3	90 ± 1.0	2.5 ± 0.5	125 ± 4	50*
9B	75	100	26.2	90 ± 1.0	3.5 ± 0.5	150 ± 5	75*
9B	100	100	30.4	90 ± 1.0	4.0 ± 0.5	165 ± 5	100*

(1) Short-term tensile strength of virgin material in accordance with BS EN ISO 10319 : 2008.

1.3 The product type and CE mark are embossed on one face of the product during the manufacturing process and the product grade and company logo are embossed on the other face (see Figure 2).

Figure 2 GeoStrap Reinforcement — face markings



Specification for precast concrete facing units

1.4 The BBA has assessed GeoStrap Reinforcement for use with precast concrete facing units designed and manufactured in accordance with BS 8006-1 : 2010, BS EN 14475 : 2006, BS EN 1990 : 2002 and BS EN 1992-2 : 2005, including relevant national annexes and the requirements of the Design Section of this Certificate (see sections 6.7 to 6.13). Other facing systems are available but are outside the scope of the Certificate.

1.5 The following two alternative means of attaching GeoStrap Reinforcement to the precast concrete facing units have been assessed by the BBA:

- loops — galvanized steel attachment loops cast into the concrete during manufacture of the panel units, with galvanized steel toggle bars spanning between them (see Figure 3). This system can be used with all grades of GeoStrap Reinforcement. The strip is wrapped around the toggle bars during installation. All metallic components must be designed to BS 8006-1 : 2010. The toggle bars must have a minimum diameter of 25 mm (see sections 6.7 and 7.9)
- GeoMega connectors — one-piece, high density polyethylene sleeve (see Figure 4) cast into the concrete during manufacture of the panel units. This system can only be used with Type 5B (50 mm wide) GeoStrap Reinforcement. The strip is pulled through the sleeve during installation with the aid of a draw chord. As with steel attachment loops, the pull-out strength is dependent upon the concrete strength, panel dimensions and reinforcement details[1]. This system gives a minimum bend radius of 22.5 mm (equivalent to a 45 mm diameter toggle bar).

(1) For more information, the advice of the Certificate holder should be sought.

Figure 3 Typical connection detail (galvanized steel loops)

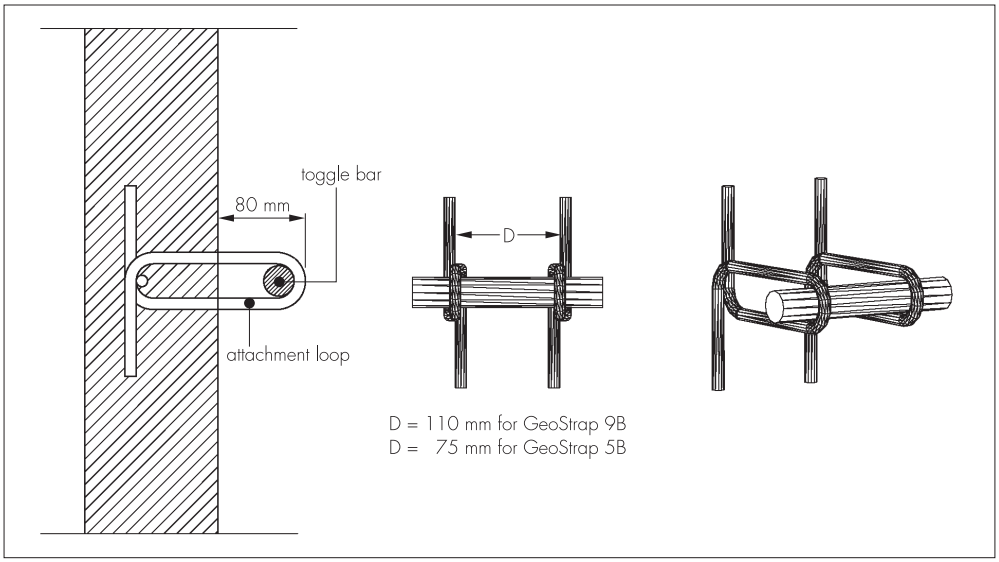
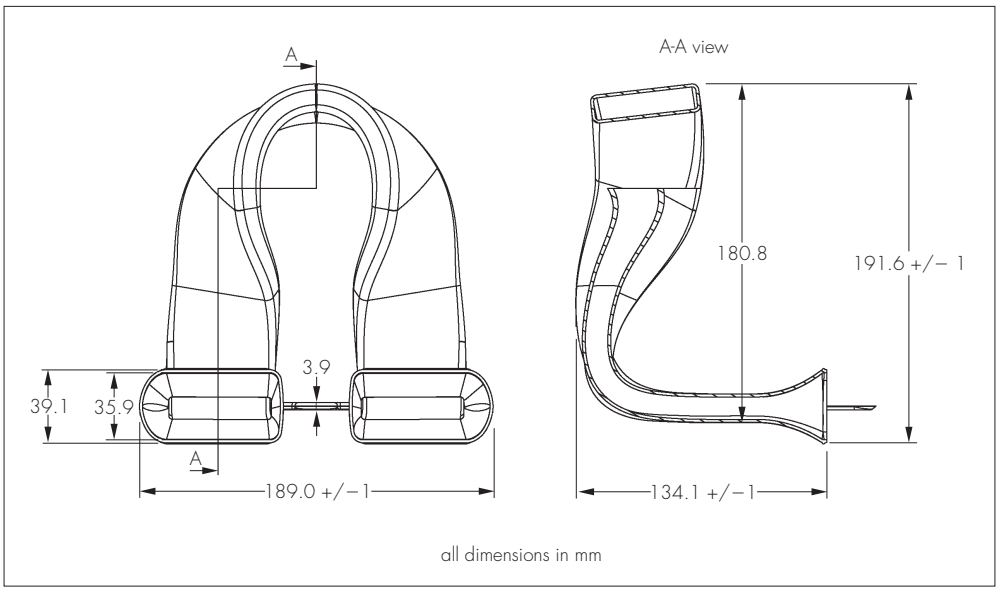


Figure 4 GeoMega connector



Specification for fill materials

1.6 Fill materials must comply with the requirements set out in BS 8006-1 : 2010 and the MCHW, Volume 1, Specification for Highway Works.

Ancillary items used during installation

1.7 The following ancillary items are used during installation, but are outside of the scope of the Certificate:

- clamps and wedges — to temporarily hold the panels in position during installation
- timber pegs or steel pins — for temporary fixing of the GeoStrap Reinforcement.

2 Manufacture

2.1 GeoStrap Reinforcement is manufactured from high-tenacity polyester yarns drawn through an extrusion-coating die where they are individually and homogeneously tensioned and packed. The yarns are finally coated in a low-density polyethylene sheath. The coated yarns are then fed between rollers to ensure dimensional accuracy and are cooled.

2.2 To check product quality is consistently maintained to the required specification, the BBA has:

- agreed with the Certificate holder/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 non-conformities
- checked that equipment has been properly tested and calibrated
- undertaken to carry out the above measures on a regular basis as part of a surveillance process to check that standards are maintained and that the product or system remains as Certificated.

2.3 GeoStrap Reinforcement is manufactured by Terre Armée Internationale.

3 Delivery and site handling

3.1 GeoStrap Reinforcement is delivered to site in 100 m coils, wrapped in transparent polythene film.

3.2 Each coil of GeoStrap Reinforcement includes a label bearing the product name, product type, characteristic strength, coil length and weight, product width and constituent materials (see Figure 5).

Figure 5 Label

GEOSTRIP	
TYPE	GEOSTRAP 5 B
CHARACTERISTIC STRENGTH	50 KN
LENGTH / WEIGHT	100 M / 14 ± 1 KG
WIDTH	50 MM
RUN No	
SHEATH	POLYETHYLENE
YARN	HIGH-TENACITY POLYESTER
TERRE ARMEE INTERNATIONALE	

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3.3 Care should be taken to prevent damage to the product during transit and handling and whilst in storage.

3.4 GeoStrap Reinforcement should be stored under cover, in clean, dry conditions and should be protected from exposure to sunlight and extreme temperatures (see also Section 8.1).

3.5 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 Highways Agency's Specification for Highway Works.

Assessment and Technical Investigations

The following is a summary of the assessment and technical investigations carried out on GeoStrap Reinforcement for Reinforced Soil Retaining Walls and Bridge Abutments.

Design Considerations

4 General

4.1 When designed and installed in accordance with this Certificate, GeoStrap Reinforcement is satisfactory for use in the construction of reinforced soil retaining walls and bridge abutments.

4.2 Structural stability is achieved by the connection strength between the GeoStrap Reinforcement and concrete facing panels and by the frictional interaction between the soil particles and the GeoStrap Reinforcement.

4.3 The fill specification and method of placement and compaction, design strength of the GeoStrap Reinforcement and length of embedment within the compacted fill 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 facing units.

4.6 Particular attention should be paid in design to:

- site preparation
- fill material properties
- specification for placing and compaction of the fill material
- drainage
- protection of the GeoStrap Reinforcement against damage during installation
- design of the facing units and means of attachment of the GeoStrap Reinforcement
- the required construction tolerances for the completed structure.

4.7 Typical sectional and plan views of reinforced soil structures constructed using GeoStrap Reinforcement are shown in Figures 6 and 7.

Figure 6 Typical reinforced soil structure — diagrammatic sectional view

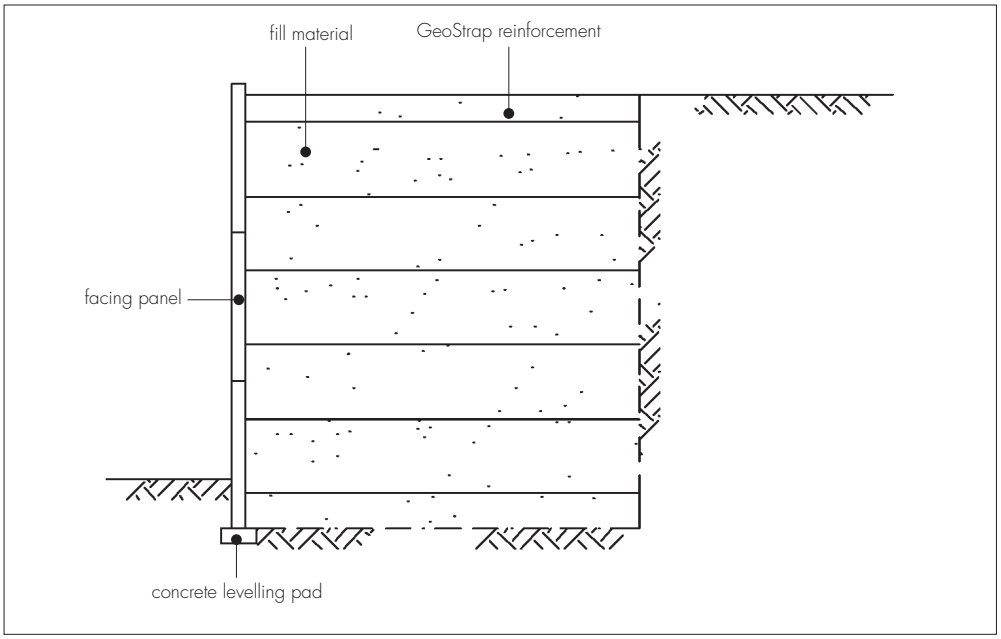
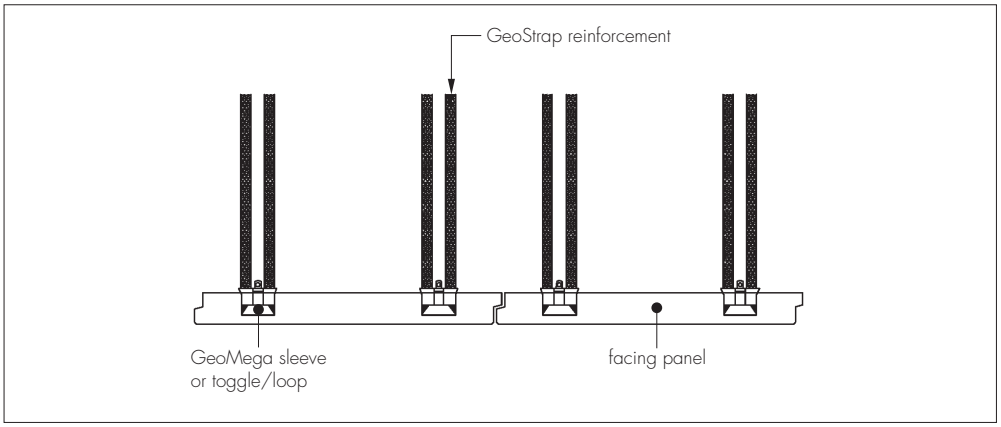


Figure 7 Typical reinforced soil structure — diagrammatic plan view



5 Practicability of installation

GeoStrap Reinforcement is easily installed in accordance with the specifications and construction drawings by trained contractors.

6 Design

Design methodology

6.1 Reinforced soil retaining walls and bridge abutments constructed using GeoStrap Reinforcement should be designed in accordance with BS 8006-1 : 2010 and the Specification for Highway Works.

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

GeoStrap Reinforcement

6.3 The design strength of the GeoStrap Reinforcement (T_D) is calculated as:

- for ultimate limit state (ULS): $T_D = T_{CR} / f_n.f_m$
- for serviceability limit state (SLS): $T_D = T_{CS} / f_m$

where:

T_{CR} is the long-term tensile creep rupture strength of the reinforcement at the specified design life and design temperature.

T_{CS} is the maximum allowable tensile load to ensure that the prescribed post-construction, limiting strain specified for the SLS is not exceeded.

f_n is the partial factor for ramification of failure in accordance with BS 8006-1 : 2010, Table 9.

f_m is the material safety factor to allow for the strength reducing effects of installation damage, weathering (including exposure to sunlight), chemical and other environmental effects and to allow for the extrapolation of data required to establish the above reduction factors.

6.4 The long-term tensile creep rupture strength (T_{CR}) for each grade of GeoStrap Reinforcement is calculated using the formula:

$T_{CR} = T_{char} / RF_{CR}$

where:

T_{char} is the characteristic short-term strength taken from Table 1.

R_{FCR} is the reduction factor for creep (see Section 7).

6.5 The material safety factor f_m used in determining T_D is calculated as:

$f_m = RF_{ID} \times RF_W \times RF_{CH} \times f_S$

where:

RF_{ID} is the reduction factor for installation damage.

RF_W is the reduction factor for weathering, including exposure to ultra violet light.

RF_{CH} is the reduction factor for chemical/environmental effects.

f_S is the factor of safety for the extrapolation of data.

6.6 Recommended values for RF_{CR}, RF_{ID}, RF_W, RF_{CH} and f_S, are given in sections 7, 8 and 9 of this Certificate. Conditions of use outside the scope for which the reduction factors are defined are not covered by this Certificate and advice should be sought from the Certificate holder.

6.7 Tests have shown that the design strength of GeoStrap Reinforcement is reduced locally at the point that it is bent to a tight radius around the connection toggle or GeoMega connector. Reduction factors for use in design are given in section 7.

Soil/GeoStrap Reinforcement interaction

6.8 For the purposes of checking direct sliding and pull out resistance, the friction coefficient (α') relating soil friction angle to the soil/GeoStrap Reinforcement bond can be taken conservatively as 0.6. Enhanced values of α' can be justified in design, by carrying out soil and site-specific pull-out tests in accordance with BS EN 13738 : 2004.

Concrete facing panels

6.9 The precast concrete facing units must be designed in accordance with the relevant provisions of BS 8006-1 : 2010, BS EN 14475 : 2006, BS EN 1990 : 2002 and BS EN 1992-2 : 2005, including relevant national annexes.

6.10 The appropriate combination of concrete exposure classes should be selected from Table A.1 of BS 8500-1: 2006 and Table 1 of BS EN 206-1: 2000 to suit the proposed location and level of exposure of the proposed structure. Design and detailing of the facing units should provide adequate durability for an intended design life of at least 100 years.

6.11 Where concrete facing units are to be embedded in soils which could be potentially aggressive, the guidance in BRE Special Digest 1 : 2005 *Concrete in aggressive ground* : Part C *Assessing the aggressive chemical environment* should be followed.

6.12 Where connection loops and toggles are used for connection of the GeoStrap Reinforcement, these should be designed in accordance with the requirements of BS 8006-1 : 2010 and with adequate anchorage strength.

6.13 The Certificate holder's advice should be sought where it is proposed to use GeoMega connectors to form the connection.

Fill materials

6.14 Fill materials should meet the requirements of BS 8006-1 : 2010 and the Highways Agency's Specification for Highway Works.

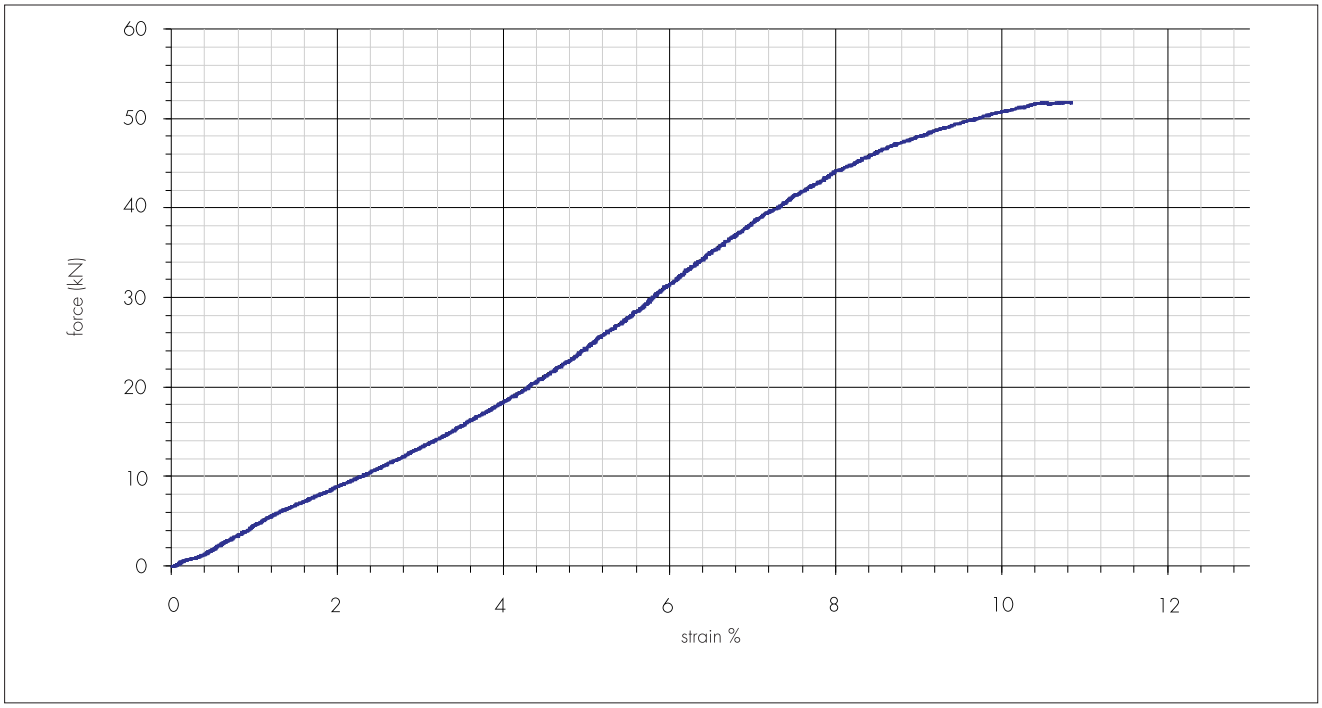
7 Mechanical properties

Short-term tensile strength

7.1 The characteristic short-term tensile strength of each grade of GeoStrap Reinforcement is given in Table 1.

7.2 A typical short-term stress/strain curve is shown in Figure 8. The average strain at breaking load is 12% ± 4%.

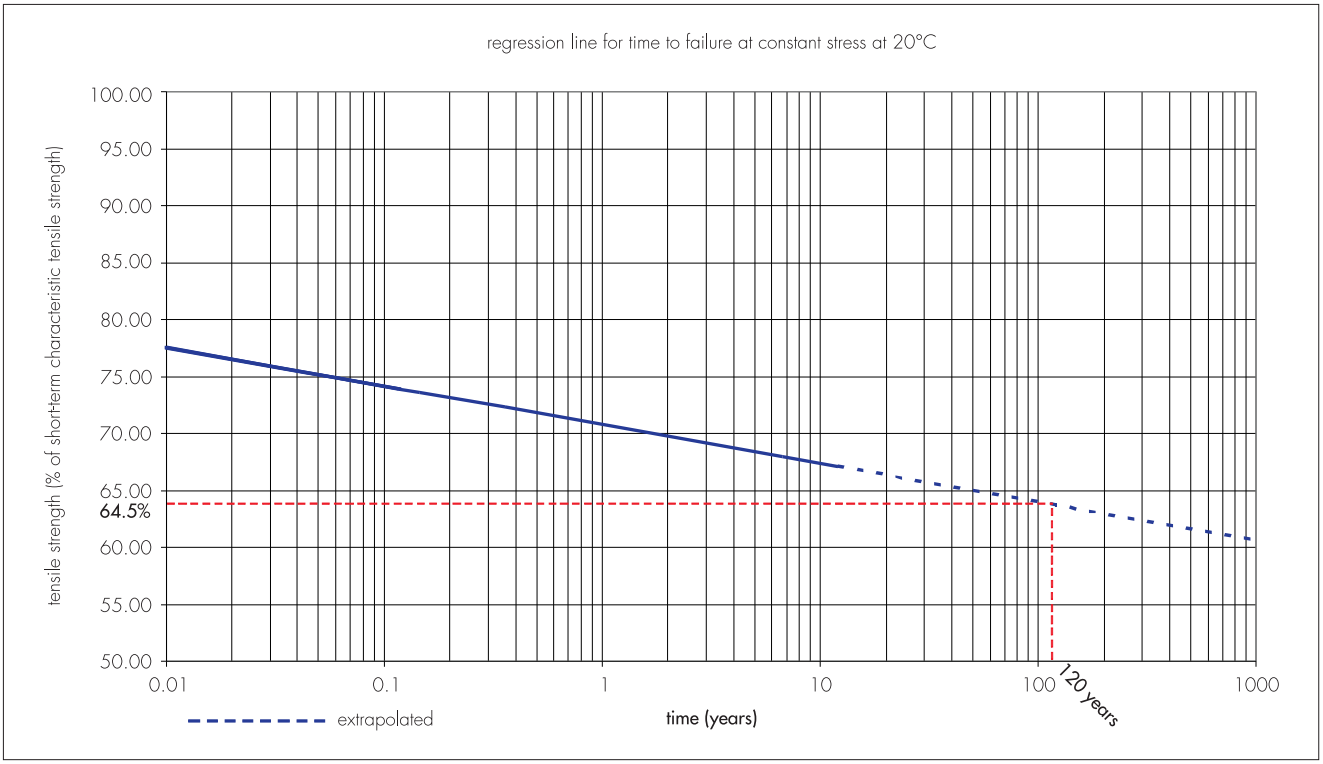
Figure 8 Typical short-term stress/strain curve



Long-term tensile creep rupture strength

7.3 The long-term creep rupture performance of GeoStrap Reinforcement has been determined in accordance with the principles of PD ISO/TR 20432 : 2007. A stress rupture line (see Figure 9) has been determined using conventional long-term creep rupture test data (up to 2,000 hours) and time-shifted stepped isothermal method (SIM) test data (up to 58,500 hours) for the load carrying polyester yarn used for manufacture of the GeoStrap Reinforcement. As the amount of available conventional test data was limited to 2,000 hours, the long-term creep performance of the load-carrying polyester has also been compared with that of other similar products, for which data is available in the public domain. The factor of safety for the extrapolation of data (f_s) presented in section 8 takes into account of the extent of available data.

Figure 9 Regression line for life expectancy at constant stress defined by percentage of characteristic short-term tensile strength



7.4 For a 120-year design life and design temperature of 20°C, the long-term tensile strength (T_{CR}) for GeoStrap Reinforcement can be taken as 64.5% of characteristic short-term tensile strength (T_{char}), giving a long-term creep reduction factor (RF_{CR}) of 1.55.

Post construction strain

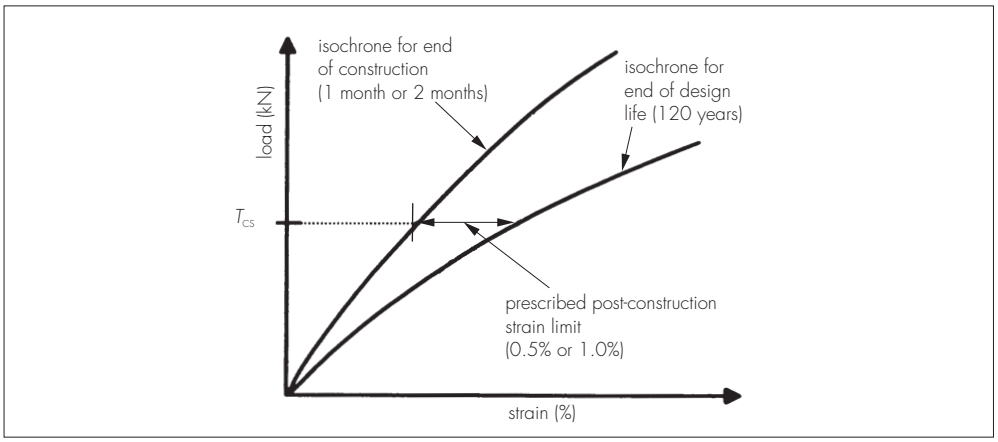
7.5 The prescribed maximum allowable post-construction creep strains allowed by BS 8006-1 : 2010 for the serviceability limit state of reinforced soil retaining walls and bridge abutments are shown in Table 2.

Table 2 Serviceability limits on post-construction internal strains for bridge abutments and retaining walls

Structure	Strain (%)	Design period for the purposes of determining limiting strain
Bridge abutments and retaining walls with permanent structural loading	0.5	2 months – 120 years
Retaining walls, with no applied structural loading i.e. transient live loadings only	1.0	1 month – 120 years

7.6 The relationship between the prescribed post-construction strain limit and the tensile load (T_{CS}), causing that post-construction strain is illustrated in Figure 10.

Figure 10 Definition of T_{cs}



7.7 Reduction factors $RF_{CR\ (SLS)}$ for determining T_{CS} from the characteristic short-term tensile load (T_{Char}) for each grade of GeoStrap Reinforcement are given in Table 3. The following formula is used to calculate T_{CS}:

$$T_{CS} = T_{Char} / RF_{CR\ (SLS)}$$

Table 3 Long-term creep reduction factors for serviceability limit state for a 120-year design life and design temperature of 20°C

Prescribed allowable post-construction strain (%)	$RF_{CR\ (SLS)}$
0.5	2.00
1.0	1.54

Reduction factor for installation damage (RF_{ID})

7.8 To allow for loss of strength due to mechanical damage sustained during installation, the appropriate reduction factor (RF_{ID}) should be selected from Table 4. These reduction factors have been established from full-scale installation damage tests using a range of materials. For soils not covered by Table 4, appropriate values of RF_{ID} may be determined from site-specific trials or the engineer responsible for design of the project may exercise engineering judgment to interpolate between the values given. The reduction factors shown assume that well-graded material is used with a minimum compacted depth of 150 mm.

Table 4 Reduction factors for installation damage (RF_{ID})

GeoStrap Reinforcement type/grade (kN)	RF_{ID}		
	Particle size d_{100}/d_{50} (mm)		
	5 / 1.5	32 / 8	125 / 26
5B/37.5	1.00	1.02	1.09
5B/50	1.00	1.00	1.01
5B/65	1.00	1.01	1.03
9B/30	1.00	1.07	1.21
9B/50	1.00	1.03	1.15
9B/75	1.00	1.03	1.15
9B/100	1.00	1.02	1.11

Connection strength

7.9 Reduction factors to allow for the local reduction in design strength of the GeoStrap Reinforcement at the point of connection to the concrete facing panel, where the strip is wrapped around the galvanized steel attachment toggles, or fed through the GeoMega connector are given in Table 5.

Table 5 Reduction factors for reduction in strength at connections

Means of connection	Factor for reduction in strength at connection (for all grades of GeoStrap reinforcement)
Galvanised steel loops and toggles[1][2]	1.15
GeoMega connector[3][4]	1.06

(1) Suitable for use with all grades of GeoStrap Reinforcement.
(2) Toggles with a minimum diameter of 25 mm.
(3) Suitable for use with 50 mm wide GeoStrap Reinforcement only.
(4) Equivalent to a toggle with a diameter of 45 mm.

8 Effects of environmental conditions

Weathering (including exposure to ultra violet light)

8.1 Evidence from tests in accordance with BS EN 12224 : 2000 shows that GeoStrap Reinforcement has adequate resistance to weathering and exposure to sunlight, when protected in accordance with the recommendations of this Certificate and provided it is covered within one month of installation. Subject to compliance with this exposure time limit, a reduction factor (RF_W) of 1.0 may be used for design purposes. Exposure periods of up to four months may be acceptable depending upon the season and location, but are outside of the scope of this Certificate. Further guidance is given in PD ISO/TR 20432 : 2007.

Chemical and biological degradation

8.2 Evidence from tests in accordance with BS EN 12447 : 2001 shows that GeoStrap Reinforcement has adequate resistance to hydrolysis for soil environments typically encountered in the United Kingdom.

8.3 Evidence from tests in accordance with BS EN 12225 : 2000 shows that GeoStrap Reinforcement is highly resistant to microbiological attack.

8.4 For a design life of 120 years, a design temperature of 20°C and soil environments with pH values between 4.0 and 9.0, the reduction factor for chemical/environmental effects (RF_{CH}) for GeoStrap Reinforcement should be taken as 1.06.

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

For GeoStrap Reinforcement the factor of safety for the extrapolation of data (fS) should be taken as 1.15 for a 120-year design life and design temperature of 20°C.

10 Maintenance

As the product is confined within the soil and has suitable durability, maintenance is not required.

11 Durability

11.1 GeoStrap Reinforcement will have adequate durability for a design life of 120 years when used and installed in accordance with the provisions of this Certificate.

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 6.8 to 6.12).

12 Re-use and recyclability

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

12.2 The steel loops and toggles can be readily recycled.

Installation

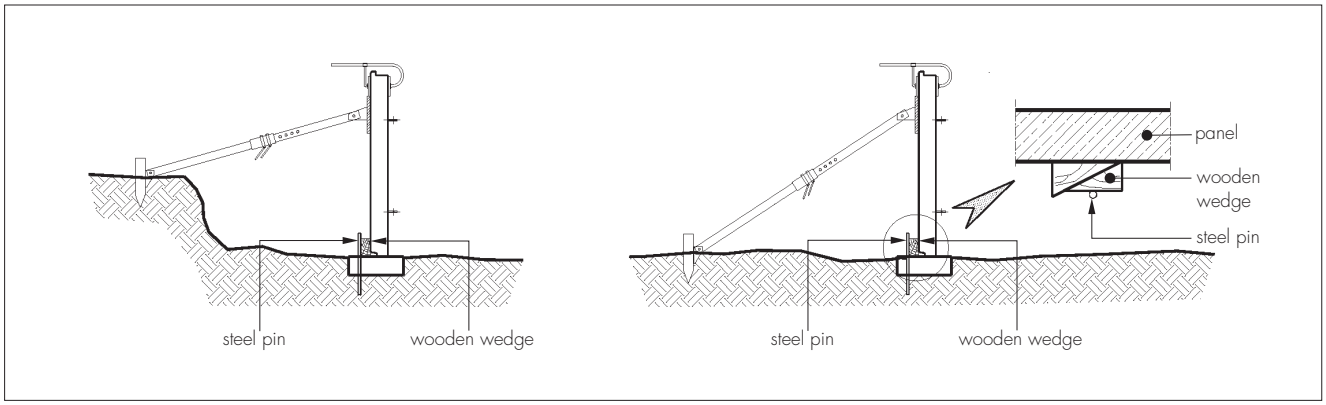
13 General

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

13.2 The site is prepared, including excavation and installation of drainage systems and a concrete levelling pad.

13.3 The initial course of facing panels is set and braced using wedges and clamps to hold the panels in position (see Figure 11). The panels are given a slight batter towards the backfill to accommodate the outward movement that will occur as the fill material is placed and compacted.

Figure 11 Temporary anchorage of concrete facing panels



13.4 Lengths of GeoStrap Reinforcement are cut to the required dimensions and threaded around the facing panel attachment toggles, or pulled through the GeoMega connectors as appropriate (see Figures 2 and 3). Where GeoMega connectors are selected as the means of connection of the GeoStrap Reinforcement to the facing panels, a draw chord may be required to pull the strip through the connector.

13.5 The GeoStrap Reinforcement strips are laid flat across the fill, parallel to each other and perpendicular to the facing panels. They are then pulled taught and fixed in position using timber pegs or steel pins. Care should be taken to ensure that the GeoStrap Reinforcement is not twisted.

13.6 To assist in tightening the GeoStrap Reinforcement before the next layer of soil is placed, a 150 mm deep step, or a 100 mm to 150 mm deep by 500 mm wide trench is excavated at a point 500 mm from the end of the reinforcement.

13.7 Placing of fill is started at the free ends of the GeoStrap Reinforcement, furthest from the facing panels and over the step/trench excavated to assist in tightening the reinforcement. Filling continues progressively outwards to within 2 m of the back face of the facing panels. The remaining 2 m of fill should be placed and compacted using lighter compaction plant in accordance with the panel manufacturer's recommendations. Backfill is placed and compacted in layers as specified by the designer until the next course of reinforcement is reached, or to within 75 mm to 150 mm of the top edge of the facing units.

13.8 The construction sequence is repeated, with further courses of facing units, GeoStrap Reinforcement and fill added, until the formation level for the parapet base or finished level of the structure is reached.

13.9 Vehicles and other construction plant should not be allowed to run directly on the GeoStrap Reinforcement until it has been adequately covered with fill material.

Technical Investigations

14 Tests

Dimensional checks have been carried out on each grade of GeoStrap Reinforcement.

15 Investigations

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

15.2 An examination was made of test data relating to:

- long- and short-term tensile properties
- resistance to damage caused during installation
- long- and short-term load/strain characteristics
- connection strength
- resistance to weathering including exposure to ultraviolet light
- resistance to hydrolysis
- resistance to biological degradation.

Bibliography

BS 8006-1 : 2010 *Code of practice for strengthened/reinforced soils and other fills*
BS 8500-1 : 2006 *Concrete — Complementary British Standard to BS EN 206-1 — Method of specifying and guidance for the specifier*
BS EN 206-1 : 2000 *Concrete — Specification, performance, production and conformity*
BS EN 1990 : 2002 *Eurocode — Basis of structural design*

BS EN 1992-2 : 2005 *Eurocode 2 : Design of concrete structures — Concrete bridges — Design and detailing rules*
BS EN 12224 : 2000 *Geotextile and geotextile-related products — Determination of the resistance to weathering*
BS EN 12225 : 2000 *Geotextile and geotextile-related products — Method for determining the microbiological resistance by a soil burial test*
BS EN 12447 : 2001 *Geotextiles and geotextile-related products — Screening test method for determining the resistance to hydrolysis in water*
BS EN 13251 : 2001 *Geotextiles and geotextile-related products — Characteristics required for use in earthworks, foundations and retaining structures*
BS EN 13738 : 2004 *Geotextiles and geotextile-related products — Determination of pullout resistance in soil*
BS EN 14475 : 2006 *Execution of special geotechnical works — Reinforced fill*
BS EN ISO 10319 : 2008 *Geotextiles — Wide-width tensile test*
PD ISO/TR 20432 : 2007 *Guidelines for the determination of the long-term strength of geosynthetics for soil reinforcement*

Conditions of Certification

16 Conditions

16.1 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.

16.2 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.

16.3 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.

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

16.5 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
- individual 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.

16.6 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.

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