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BBA APPROVAL INSPECTION TESTING CERTIFICATION
TECHNICAL APPROVALS FOR CONSTRUCTION

HAPAS Certificate
13/H197
Product Sheet 3

FORTRAC GEOSYNTHETICS

FORTRAC T AND R-T GEOGRIDS

This HAPAS Certificate Product Sheet(1) 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 Certificates are normally each subject to a review every five years.
(1) Hereinafter referred to as 'Certificate'.

This Certificate relates to Fortrac T and R-T Geogrids, polymeric geogrids consisting of polyester fibres coated with a black styrene butadiene polymer for use as reinforcement in embankments with slope angles up to 70°.

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

Mechanical properties — short- and long-term tensile strength and elongation properties of the geogrids and loss of strength due to installation damage have been assessed and reduction factors established for use in design (see section 7).

Durability — the resistance of the geogrids to the effects of hydrolysis, chemical and biological degredation, UV exposure and temperature conditions normally encountered in civil engineering practice have been assessed and reduction factors established for use in design (see sections 8 and 11).

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

On behalf of the British Board of Agrément

Date of Second issue: 5 September 2014

Brian Chamberlain
Head of Approvals — Engineering

Claire Curtis-Thomas
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, Fortrac T and R-T Geogrids 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 embankments with slope angles up to 70°.

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), 3 *Delivery and site handling* (3.1, 3.4 and 3.5) and the *Installation* part of this Certificate.

Additional Information

CE marking

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

Technical Specification

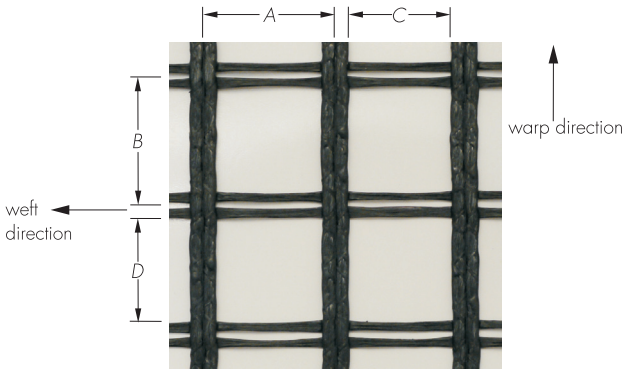
1 Description

1.1 Fortrac T and R-T Geogrids are planar structures consisting of a regular open network of woven, integrally-connected tensile elements of yarn. The yarn is made from high modulus polyester fibres of polyethylene terephthalate (PET). The woven grid is coated with a protective layer of black styrene butadiene polymer.

1.2 The geogrids are manufactured in sixteen standard grades of various strengths and mesh sizes. A typical geogrid is illustrated in Figure 1 and the range and specification of the geogrids assessed by the BBA are listed in Tables 1 and 2.

1.3 The warp (machine) direction is along the roll length and is indicated by a paper tape (see Figure 1).

Figure 1 Fortrac T and R-T Geogrids



A and *B*: average grid size
C and *D*: average aperture size

Table 1 General specification

Grade[1]	Nominal mass[2] ($g \cdot m^{-2}$)	Average grid size[3] warp/weft (mm) *A x B*	Average aperture size[3] warp/weft (mm) *C x D*	Colour code[4]	Nominal roll weight for standard 5 m width rolls	Standard roll length (m)
35T	185	29.0 x 30.0	26.0 x 24.0	Red	190	200
55T	240	29.0 x 30.0	25.0 x 24.0	Green	250	200
65T	280	29.0 x 30.0	25.0 x 23.0	Orange	290	200
80T	320	29.0 x 30.0	25.0 x 23.0	Pink	330	200
110T	350	29.0 x 30.0	24.0 x 23.0	White	360	200
150T	440	29.0 x 30.0	23.0 x 23.0	No colour	450	200
200T	530	30.0 x 30.0	23.0 x 23.0	No colour	540	200
35/20-20T	210	23.1 x 23.0	21.0 x 18.0	Red	230	200
55/30-20T	280	23.0 x 25.5	20.0 x 20.5	Green	300	200
80/30-20T	350	25.0 x 23.0	20.0 x 18.0	Pink	370	200
110/30-20T	420	25.1 x 22.8	20.0 x 18.0	White	480	200
R150/30-30T	520	41.7 x 32.8	33.0 x 27.0	No colour	630	200
R200/30-30T	630	40.0 x 32.5	31.0 x 27.0	No colour	750	200
R400/50-30T	1200	67.0 x 33.5	37.0 x 27.5	No colour	650	100
R600/50-30T	1650	50.0 x 33.0	30.0 x 28.0	No colour	900	100
R800-100-30T	2400	90.0 x 30.0	30.0 x 25.0	No colour	1250	100

(1) R denotes the goegrid is knitted.
(2) Mass/unit area measured in accordance with BS EN ISO 9864 : 2005.
(3) Reference dimensions (see Figure 1).
(4) In accordance with BS EN ISO 10320 : 1999

Table 2 Performance characteristics

Grade	Machine Direction (MD)				Cross Machine Direction (CMD)			
	Short term tensile strength[1] $kN \cdot m^{-1}$			Strain at maximum tensile strength[1] (%) (*)	Short term tensile strength[1] $kN \cdot m^{-1}$			Strain at maximum tensile strength[1] (%) (*)
	Mean value (*)	Tolerance (*)	T_{char}		Mean value (*)	Tolerance (*)	T_{char}	
35T	35	–0	35	9.5 (±1.5)	20	–0	20	9.5 (±1.5)
55T	55	–0	55	9.5 (±1.5)	20	–0	20	9.5 (±1.5)
65T	65	–0	65	9.5 (±1.5)	20	–0	20	9.5 (±1.5)
80T	80	–0	80	9.5 (±1.5)	20	–0	20	9.5 (±1.5)
110T	110	–0	110	9.5 (±1.5)	20	–0	20	9.5 (±1.5)
150T	150	–0	150	9.5 (±1.5)	20	–0	20	9.5 (±1.5)
200T	200	–0	200	9.5 (±1.5)	20	–0	20	9.5 (±1.5)
35/20-20T	35	–0	35	10 (+0/–3)	20	–0	20	10 (+0/–3)
55/30-20T	55	–0	55	10 (+0/–3)	30	–0	30	10 (+0/–3)
80/30-20T	80	–0	80	11 (+0/–3)	30	–0	30	11 (+0/–3)
110/30-20T	110	–0	110	11 (+0/–3)	30	–0	30	10 (+0/–3)
R150/30-30T	150	–0	150	11 (+0/–3)	30	–0	30	11 (+0/–3)
R200/30-30T	200	–0	200	10 (+0/–3)	30	–0	30	10 (+0/–3)
R400/50-30T	400	–0	400	10 (+0/–3)	50	–0	50	10 (+0/–3)
R600/50-30T	600	–0	600	10 (+0/–3)	50	–0	50	10 (+0/–3)
R800-100-30T	800	–0	800	10 (+0/–3)	100	–0	100	10 (+0/–3)

(1) Tests in accordance with BS EN ISO 10319 : 2008, the values given are the mean and tolerance values in accordance with BS EN 13251 : 2001.

2 Manufacture

2.1 Fortrac T and R-T Geogrids are manufactured from yarn woven or knitted into grids and coated with a protective layer of black styrene butadiene polymer.

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

- agreed with the manufacturer the quality control procedures and product testing to be undertaken
- assessed and agreed the quality control operated over batches of incoming materials

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

2.3 The management system of Huesker Synthetic GmbH has been assessed and registered as meeting the requirements of BS EN ISO 9001 : 2008 by TÜV NORD CERT GmbH, Germany (Certificate 04 100 970084).

3 Delivery and site handling

3.1 The rolls of geogrid are delivered to site stacked and strapped to timber pallets. The rolls are 5.0 metres wide and between 0.5 m to 0.9 m diameter dependent on the product grade and roll length (see Table 1).

3.2 Each roll is wrapped for transit and site protection in black polythene film and is labelled with the geogrid grade and identification (see Figure 2).

Figure 2 Label

3.3 The ends of the rolls are sprayed with colour-coded paint to assist identification of a particular grade of geogrid on site (Table 1) in accordance with BS EN ISO 10320 : 1999.

3.4 Rolls should be stored in clean, dry conditions and protected from mechanical or chemical damage, exposure to direct sunlight and extreme temperatures. When laid horizontally, the rolls may be stacked up to five high. No other loads should be stored on top of the stack. The packaging should not be removed until immediately prior to installation.

3.5 Toxic fumes are given off if the geogrids catch fire and therefore the necessary precautions should be taken following the instructions of the material safety data sheet for the product.

Assessment and Technical Investigations

The following is a summary of the assessment and technical investigations carried out on Fortrac T and R-T Geogrids.

Design Considerations

4 General

4.1 When designed and installed in accordance with this Certificate, Fortrac T and R-T Geogrids are satisfactory for the reinforcement of soil embankments with maximum slope angles of 70°.

4.2 Structural stability is achieved through the frictional interaction of soil particles and the geogrids and the tensile strength of the geogrids.

4.3 The fill specification and method of placement and compaction, design strength of the reinforcement and length of reinforcement embedded within the compacted fill are the 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 Particular attention should be paid in design to the following issues:

- site preparation and embankment construction
- fill material properties

- drainage
- protection of the product against damage from site traffic and installation equipment
- the stability of existing structures in close proximity
- design of the embankment facing.

4.6 The working drawings should show the correct orientation of the geogrids. Each layer of reinforcement must be continuous in the direction of load, ie without overlaps.

5 Practicability of installation

The products are designed to be installed by trained contractors in accordance with the specifications and construction drawings (see the *Installation* part of this Certificate).

Design methodology

6.1 Reinforced soil embankments constructed using Fortrac T and R-T Geogrids should be designed in accordance with BS 8006-1 : 2010 and the Specification for Highway Works.

6.2 The typical service life given in Table 7 of BS 8006-1 : 2010 for reinforced soil embankments is 60 years.

Geogrid reinforcement

6.3 In accordance with the methodology set out in BS 8006-1 : 2010, Annex 3, the design strength of the reinforcement (T_D) is calculated as:

$T_D = T_{CR}/f_m$

where:

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

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 geogrid is calculated using the formula:

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

where:

T_{char} is the characteristic short-term strength of the geogrid taken from Table 2.

RF_{CR} is the reduction factor for creep (see Section 7).

6.5 The material safety factor (fm) 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.

Soil/geogrid interaction

6.7 There are two limiting modes of interaction between the soil and the reinforcement that need to be considered and for which the length of reinforcement necessary to maintain equilibrium needs to be determined:

- direct sliding — in which the soil slides over the layer of reinforcement
- pullout — in which the layer of reinforcement pulls out of the soil after it has mobilised the maximum available bond stress.

6.8 In CIRIA SP123, 1996, sections 4.5 and 4.6 describe the following methods for determining resistance to direct sliding and maximum available bond, to which the appropriate partial factors should be applied in accordance with BS 8006-1 : 2010.

6.9 The theoretical expression for resistance to direct sliding is:

$f_{ds} \times \tan \phi'$

where:

f_{ds} is the direct sliding coefficient.

ϕ' is the effective angle of friction of soil.

6.10 The direct sliding coefficient (f_{ds}) is calculated as:

$f_{ds} = \alpha_s \times (\tan \delta / \tan \phi') + (1 - \alpha_s)$

where:

α_s is the proportion of plane sliding area that is solid.

δ is the angle of skin friction soil on planar reinforcement surface.

$\tan \delta / \tan \phi'$ is the coefficient of skin friction between the soil and geogrid material.

6.11 For initial design purposes, the coefficient of skin friction ($\tan \delta / \tan \phi'$) for determining the resistance to direct sliding for the product when buried in compacted frictional fill may be conservatively assumed to be 0.6. Values for the proportion of plane sliding area that is solid (α_s) are given in Table 3.

Table 3 Soil geogrid interaction parameters for T and R-T Fortrac Geogrids

Grade	α_s (1)	Ratio of bearing (2) surface to plan area $\alpha_b \times B/2S$
35T	0.28	0.009
55T	0.31	0.009
65T	0.34	0.009
80T	0.34	0.009
110T	0.37	0.008
150T	0.39	0.008
200T	0.41	0.008
35/20-20T	0.29	0.014
55/30-20T	0.30	0.014
80/30-20T	0.37	0.017
110/30-20T	0.37	0.016
R150/30-30T	0.35	0.014
R200/30-30T	0.36	0.016
R400/50-30T	0.55	0.013
R600/50-30T	0.49	0.015
R800-100-30T	0.72	0.017

(1) α_s is the proportion of the plane sliding area that is solid and is required for the calculation of the bond coefficient (f_b) and the direct sliding coefficient (f_{ds}) (see sections 6.10 and 6.13).

(2) The ratio is required to calculate the bond coefficient in accordance with CIRIA SP123 : 1996 (see section 6.13):
α_b is the proportion of the grid width available for bearing
B is the thickness of a transverse member of a grid taking bearing
S is the spacing between transverse members taking bearing.

6.12 For detailed design, the resistance to direct sliding should be determined from soil and geogrid specific shear box testing.

6.13 The theoretical expression for maximum available bond stress is:

$f_b \times \tan \phi'$

where:

f_b is the bond coefficient.

ϕ' is the effective angle of friction of soil.

6.14 The bond coefficient may be calculated as:

$f_b = \alpha_s \times (\tan \delta / \tan \phi') + (\sigma'_b / \sigma'_n) \times (\alpha_b \times B/2S) \times (1/\tan \phi')$

where:

α_s is the proportion of plane sliding area that is solid.

ϕ' is the effective angle of friction of soil.

$\tan \delta / \tan \phi'$ is the coefficient of skin friction between the soil and geogrid material.

σ'_b / σ'_n is the bearing stress ratio.

$\alpha_b \times B/2S$ is the ratio of bearing surface to plan area.

δ is the angle of skin friction, soil on planar reinforcement surface

σ'_b is the effective bearing stress on the reinforcement

σ'_n is the nominal effective stress

6.15 For initial design purposes the coefficient of skin friction (tan δ/tan ϕ') for determining the bond coefficient for the product when buried in frictional fill may be conservatively assumed to be 0.6. Values for the ratio of bearing surface to plan area (α_b x B /2S) are given in Table 3. Typical values for the bearing stress ratio (σ'_b/σ'_n) are given in CIRIA SP123, 1996, Table 4.1.

6.16 The BBA recommends that site-specific pull-out tests are carried out to confirm the value of bond coefficient (f_b) used in the final design.

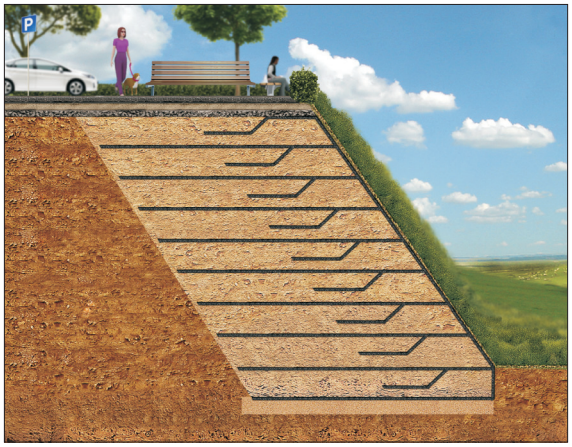
Fill material

6.17 The designer should specify the relevant properties of fill material deemed acceptable for the purpose of the design. Acceptable materials should meet the requirements of BS 8006-1 : 2010. and the Highways Agency's Specification for Highway Works.

Facings

6.18 A typical wrap around facing detail formed using the geogrid is shown in Figure 3. Where the geogrids are used to form the facing, natural or artificial protection must be provided to the grids and fill material to protect the products against damage from ultraviolet light (UV), fire and vandalism, and to protect the fill material from erosion.

Figure 3 Facings



6.19 Other types of facing including preformed panels, gabions/gabion sacks and other proprietary systems may be used, but are outside the scope of this Certificate. Further guidance is given in BS 8006-1 : 2010.

7 Mechanical properties

Tensile strength — short-term

7.1 Characteristic short-term tensile strength (T_{char}) and strain at maximum strength for the product range are given in Table 2.

Tensile strength — long-term

7.2 The long-term creep performance of the geogrids has been determined in accordance with the principles of PD ISO/TR 20432 : 2007 using conventional and stepped isothermal method (SIM) creep rupture test data. The resultant creep rupture diagram is shown in Figure 4.

7.3 For a 60-year design life and design temperature of 20°C, the long-term tensile strength (T_{CR}) of Fortrac T and R-T Geogrids is 66.8% of the characteristic short-term tensile strength (T_{char}), giving a long-term creep reduction factor (RF_{CR}) of 1.50.

7.4 For a 120-year design life and design temperature of 20°C, the long-term tensile strength (T_{CR}) of Fortrac T and R-T Geogrids is 66.0% of characteristic short-term tensile strength (T_{char}) giving a long-term creep reduction factor (RF_{CR}) of 1.52.

Installation damage

7.5 To allow for loss of strength due to mechanical damage that may be sustained during installation, the appropriate value for 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 whose gradings can be seen in Figure 5. For fills not covered by Table 4, appropriate values of RF_{ID} may be determined from site-specific trials or the engineer may exercise engineering judgment to interpolate between the values given.

Figure 4 Creep rupture diagram — Regression line for the expectancy at constant stress defined by % of characteristic short-term strength at 20°C

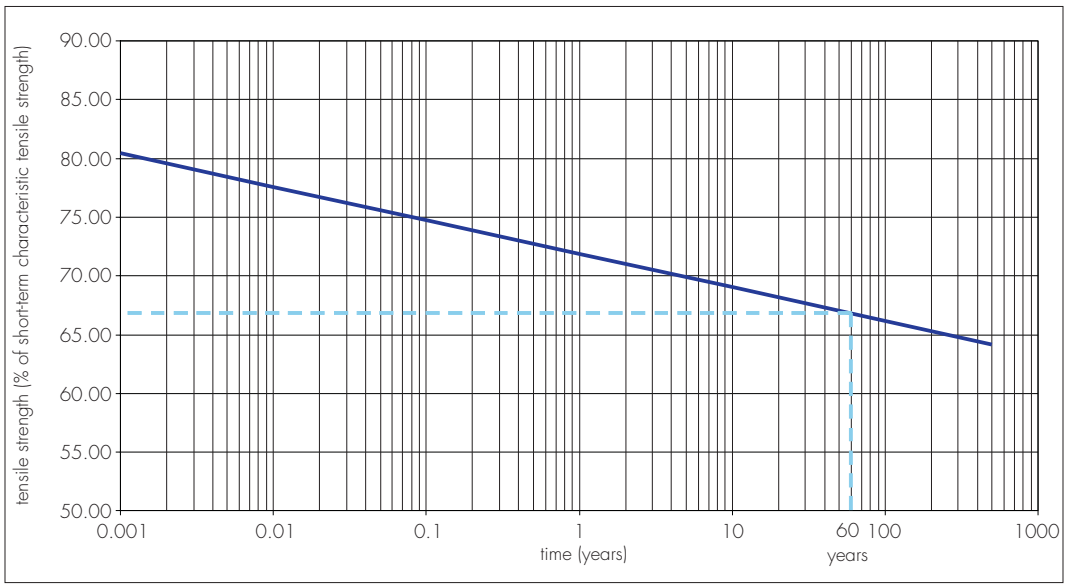


Figure 5 Particle size distributions of fills used in installation damage testing

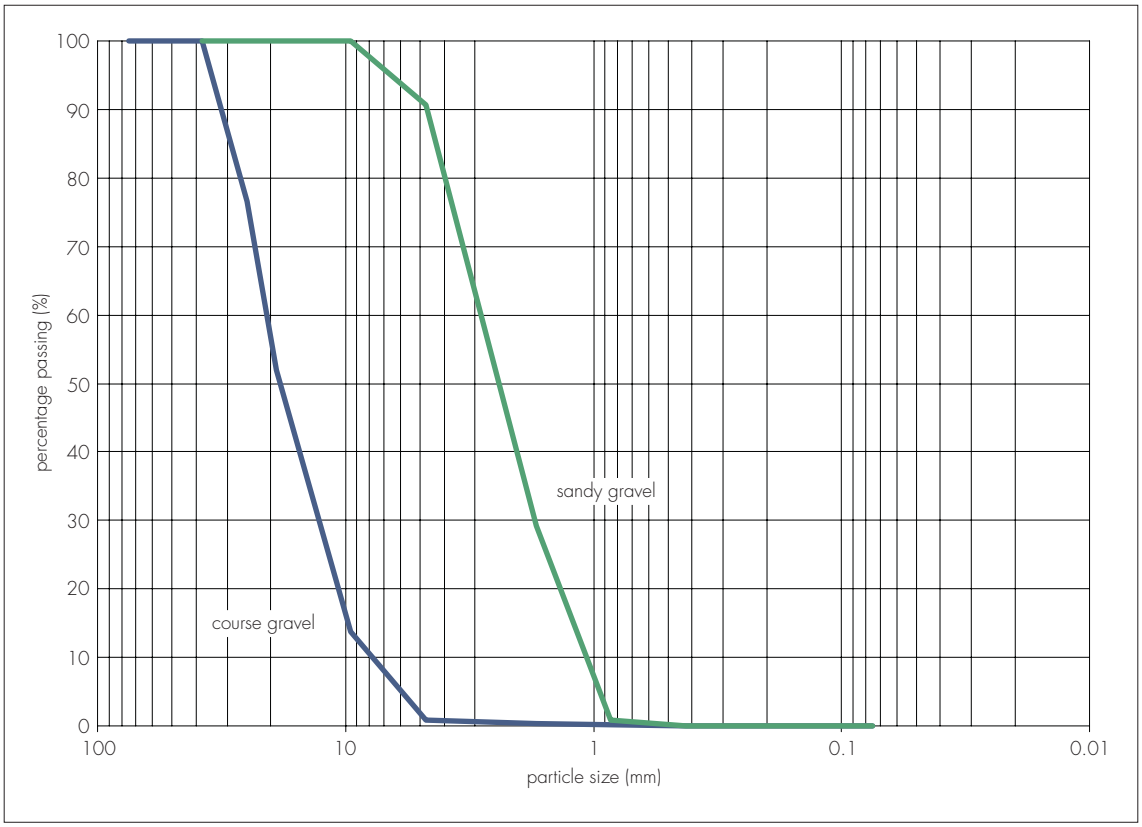


Table 4 Partial safety factor – installation damage (RF_{ID})

Soil type[1]	D_{90} particle size[2] (mm)	Grade	RF_{ID}
Sandy gravel	≤ 10	35T	1.15
		55T	1.15
		65T	1.15
		80T	1.15
		110T	1.10
		150T	1.10
		200T	1.10
		35/20-20T	1.15
		55/30-20T	1.15
		80/30-20T	1.15
		110/30-20T	1.10
		R150/30-30T	1.10
		R200/30-30T	1.10
		R400/50-30T	1.10
		R600/50-30T	1.05
		R800-100-30T	1.05
Coarse gravel	≤ 35	35T	1.20
		55T	1.20
		65T	1.20
		80T	1.15
		110T	1.10
		150T	1.10
		200T	1.10
		35/20-20T	1.20
		55/30-20T	1.20
		80/30-20T	1.15
		110/30-20T	1.10
		R150/30-30T	1.10
		R200/30-30T	1.10
		R400/50-30T	1.05
		R600/50-30T	1.05
		R800-100-30T	1.05

(1) Compacted soil thickness: 200 mm, weight of vibrating roll: 4550 kg.

(2) Detailed particle size distributions are shown in Figure 5

8 Effects of environmental conditions

Weathering (including exposure to sunlight)

8.1 The geogrids have adequate resistance to weathering and exposure to sunlight, when protected from exposure in accordance with recommendations of this Certificate. A reduction factor (RF_W) of 1.13 may be used for design provided the periods of exposure are limited to a maximum of one month. A reduction Factor (RF_w) of 1.00 may be used where the product is covered within one day.

Chemical/environmental effects

8.2 Within a soil environment where pH ranges from 4.0 to 9.0, the geogrids have adequate resistance to hydrolysis for applications where sustained soil temperatures are not higher than 25°C.

8.3 The geogrids are highly resistant to microbiological attack.

8.4 When designed and installed in accordance with the requirements of BS 8006-1 : 2010, BS EN 14475 : 2006 and this Certificate, the geogrids are suitable for use in soils at temperatures normally encountered in reinforced soil embankments in the UK. Long-term resistance to chemical and microbiological attack at temperatures greater than 25°C or lower than 0°C are outside the scope of this Certificate. Where geogrids may be exposed to temperatures outside this range, the advice of the Certificate holder should be sought.

8.5 To take account of chemical/environmental effects including hydrolysis, resistance to acids and alkaline liquids and biological/microbial attack, the appropriate value for RF_{CH} shown in Table 5 may be used for design temperatures up to 25°C and pH levels in the range 4.0 to 9.0.

Table 5 Reduction factor RF_{CH}

Design life (years)	RF_{CH}
60	1.03
120	1.06

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

9.1 For Fortrac T and R-T Geogrids, the factor of safety for the extrapolation of data (f_s) should be taken as:

Table 6 Factor of safety for extrapolation of data

Design life (years)	f_s
60	1.07
120	1.11

9.2 The above values has been calculated in accordance with PD ISO/TR 20432 : 2007, using the R_1 and R_2 values given in Table 7:

Table 7 R_1 *and* R_2

Factor	Taking account of:	Design life (years)	
		60	120
R_1	Extrapolation of creep rupture data	1.05	1.05
R_2	Extrapolation of chemical data	1.05	1.10

10 Maintenance

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

11 Durability

The geogrids will have adequate durability for a design life of up to 120 years when used and installed in accordance with this Certificate.

Installation

12 General

12.1 The construction of reinforced soil embankents incorporating the geogrids should be in accordance with the Certificate holder's *Installation instructions*, BS EN 14475 : 2006 and the *Specification for Highway Works*.

12.2 Care should be exercised to ensure Fortrac T and R-T Geogrids are laid with the warp (longitudinal) direction parallel to the direction of principal stress. Design drawings should indicate geogrid orientation (see section 4.6).

13 Procedure

13.1 The geogrid is laid by unrolling the grid to the length required and cutting with a sharp knife or scissors. The unrolling of the grid may be carried out manually or mechanically.

13.2 The grids should be laid flat without folds, parallel with widths in contact to each other. Each reinforcing layer must be continuous in the direction of loading and there should be no overlapping of the grids. Strip misalignment must not exceed 50 mm over a distance of 5 m. Pins or a stretching device may be used to control alignment and also to induce a small prestressing load prior to filling.

13.3 Particular care should be taken to ensure that the grids are adequately covered before compaction or trafficking. Construction traffic will damage unprotected geogrids.

13.4 Fill materials and the thickness and compaction of the fill should be in accordance with Highways Agency's Specification for Highway Works and in line with those conditions used to determine the installation damage partial safety factors in the design (see section 7.5).

13.5 Facings are positioned as detailed on the engineer's design drawing. Where the geogrids are used as part of the facing, the geogrid must be wrapped around and anchored back into the fill and must be protected from exposure to ultra violet (UV) light as detailed in Sections 6.18 and 8.1. Formwork is used to assist in maintaining the shape of the facing. Facings, prefabricated or otherwise, are beyond the scope of this Certificate. A typical example is shown in Figure 3.

Technical Investigations

14.1 The manufacturing process of the geogrids was examined, 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
- chemical degradation
- resistance to hydrolysis
- resistance to biological attack
- resistance to weathering
- effects of temperature
- site damage trials and resistance to mechanical damage
- coefficients of interaction between the geogrids and the soil fill
- installation procedures and typical details

14.3 Calculations were made to establish the plane sliding area that is solid and the ratio of bearing surface to plane area.

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

Bibliography

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

BS EN 12224 : 2000 *Geotextiles and geotextile-related products. Determination of the resistance to weathering*

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

Manual of Contract Documents for Highway Works, Volume 2 *Notes for Guidance on the 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.

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