REINFORCED FILL PRODUCT CERTIFICATE

Certificate No. RF 3/2010

Fortrac® Geogrids

Certified Products

Products	:	Fortrac® geogrids grade 35/20-20, 55/30-20, 80/30-20 and 110/30-20
Certificate holder	:	Huesker Synthetic GmbH, Fabrikstraße, 13-15, D-48712 Gescher, Germany
Product distributor	:	Spray Engineering Co., Ltd., Room 1111, 11/F., C C Wu Building, 302 – 8 Hennessy Road, Wanchai, Hong Kong

Conditions of Certification

This Certificate is granted only to Huesker Synthetic GmbH. No other company, firm or person may hold or claim any entitlement to this Certificate.

In granting this Certificate, the Civil Engineering and Development Department makes no representation as to the presence or absence of patent rights subsisting in the product and/or as to the legal right of the certificate holder and product distributor to market, install or maintain the product.

Where the Fortrac® geogrids are used in permanent reinforced fill slopes in Hong Kong, the design tensile strengths of the product shall comply with the values specified in Tables 3 to 6 of this Certificate, and the design shall be in accordance with Geoguide 6 – Guide to Reinforced Fill Structure and Slope Design (GEO, 2002).

This Certificate shall cease to be valid if the product data or specifications are withdrawn or re-issued in an amended form by the certificate holder. Applications for amendment to this Certificate shall be made to the Head of Geotechnical Engineering Office of the Civil Engineering and Development Department by the certificate holder in all cases of changes in the products, the manufacturing details or the conditions of use, or of changes of the product distributor.

The Government of the Hong Kong Special Administrative Region
Civil Engineering and Development Department

Date Issued : 2 May 2010
Valid until : 1 May 2012

(John S V CHAI)
Director of Civil Engineering and Development

Fortrac® geogrids

Fortrac® geogrids are intended to be used as reinforcing elements in reinforced fill slopes. Each geogrid consists of a regular open network of integrally connected tensile elements of yarn. The yarn, is made from high modulus polyester fibres of polyethylene terephthalate (PET). The yarn is woven into grids and coated with a protective layer of black polymer, by Huesker Synthetic GmbH.

Fortrac® geogrids are manufactured in four standard grades of various strengths and mesh sizes. A typical geogrid is illustrated in Figure 1. The longitudinal direction of the geogrid is along the roll length and is indicated by a wrap-around yarn bundle (see Figure 1).

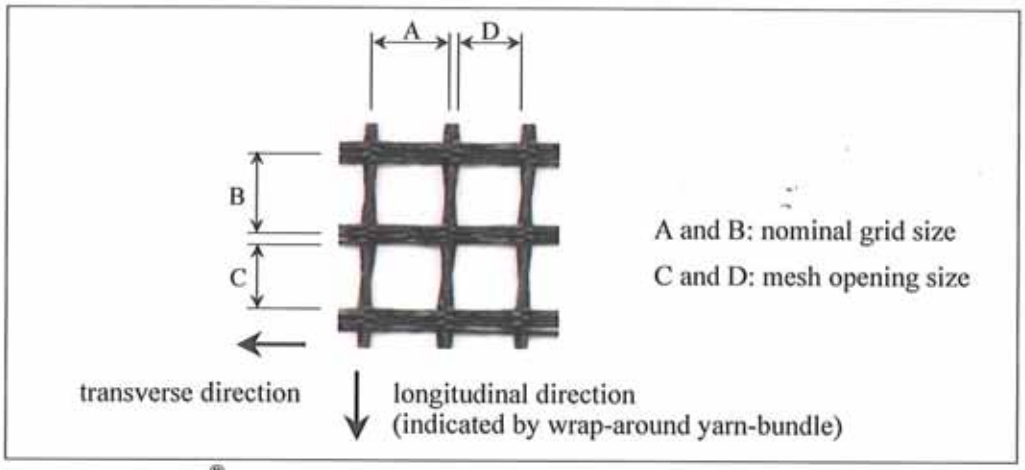


Figure 1 – Fortrac® geogrid

Fortrac® geogrids are described by a three-numbered system. For each grade of geogrid the first and second number indicate the characteristic short-term tensile strength in kN/m in longitudinal and transverse direction respectively, while the final number indicates the nominal grid size in mm. Thus, grade 35/20-20 geogrid has a characteristic short-term tensile strength of 35kN/m in the longitudinal direction, a characteristic short-term tensile strength of 20kN/m in the transverse direction and a nominal grid size of 20mm x 20mm. The typical dimensions, mass and identification of Fortrac geogrids are provided in Table 1:

Product grade	Grid dimensions		Roll dimensions		Mass (±9%)	Colour coding
	Grid size (A x B) (mm)	Mesh opening size (C / D) (mm)	Length (m)	Width (m)	(g/m^2)	
35/20-20	23 x 23	20 / 18	200	3.7 or 5.0	250	red
55/30-20	23 x 23	20 / 18	200	3.7 or 5.0	350	green
80/30-20	23 x 23	19 / 19	200	3.7 or 5.0	440	pink
110/30-20	23 x 23	19 / 19	200	3.7 or 5.0	490	white

Table 1 – Geogrid dimensions, mass and identification

Tensile strength and load-strain properties

Quality control tensile tests are performed on specimens in accordance with BS EN ISO 10319: 2008 (BSI, 2008). The characteristic short-term tensile strengths in the longitudinal direction of the geogrids guaranteed by Huesker Synthetic GmbH are provided in Table 2. The load-strain properties of the geogrids are shown in Figure 2. The actual strain at break is approximately 12.5%.

Product grade	35/20-20	55/30-20	80/30-20	110/30-20
Characteristic short-term tensile strength (kN/m)	35	55	80	110

Table 2 – Characteristics short-term tensile strength (longitudinal direction)

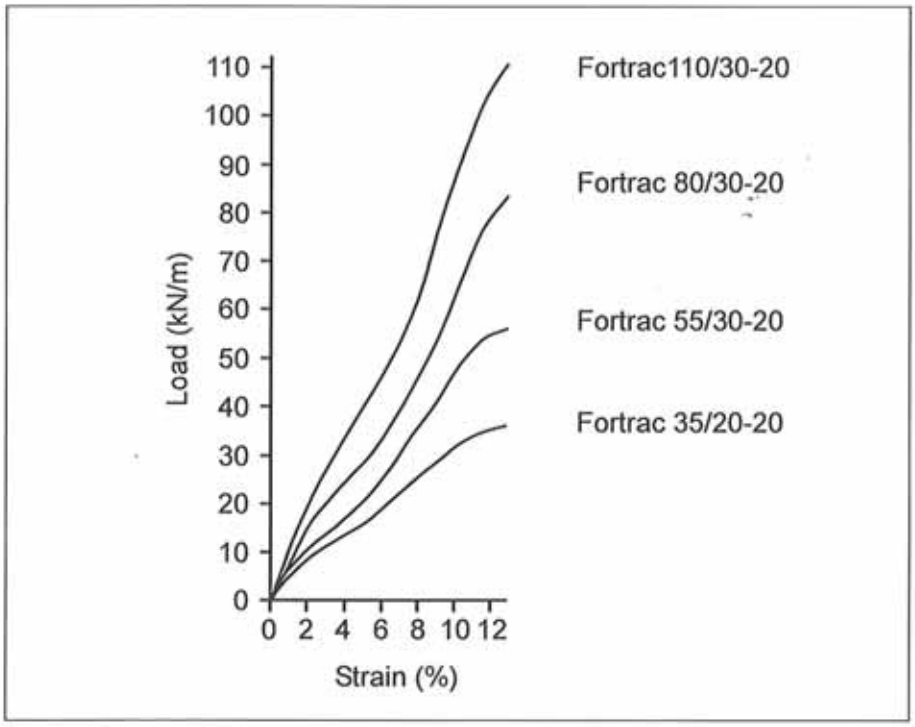


Figure 2 – Typical short-term load-strain properties (longitudinal direction)

Quality assurance

Fortrac® geogrids supplied to Hong Kong are manufactured by Huesker Synthetic GmbH, Gescher, Germany, under ISO 9001 Quality Assurance Certificate. Independent audits are carried out periodically by TÜV NORD Cert, Germany.

Identification

Fortrac® geogrids are imported into Hong Kong from Germany. Each roll of Fortrac® geogrid is protected by a black polyethylene bag with labels giving details of fabric grade and identification (see Figure 3). A copy of the manufacturer's test certificate will accompany each shipment of delivery. This certificate is available from the product distributor.

Figure 3 - Product identification

Design Aspects

Design tensile strength

According to Geoguide 6 - Guide to Reinforced Fill Structure and Slope Design (GEO, 2002), the design tensile strength, T_D, per unit width of reinforcement is:

$$T_D = \frac{T_{ult}}{\gamma_m \gamma_n}$$

where T_{ult} = characteristic short-term tensile strength guaranteed by Huesker Synthetic GmbH (see Table 2)

γ_m = partial material factor on tensile strength of geogrid

γ_n = partial consequence factor to account for consequence of failure

The design tensile strengths of the Fortrac® geogrids in the longitudinal direction given in Tables 3 to 6, which have been agreed with Huesker Synthetic GmbH, shall be used.

Particle Size of Fill Material (mm)	γ_m	Design Tensile Strength (kN/m)	
		$\gamma_n = 1.0$	$\gamma_n = 1.1$
$D_{85} \leq 10$	2.3	15.2	13.8
$10 < D_{85} \leq 50$	2.7	13.0	11.8

Table 3 – Design tensile strengths of Fortrac® 35/20-20 geogrid

Particle Size of Fill Material (mm)	γ_m	Design Tensile Strength (kN/m)	
		$\gamma_n = 1.0$	$\gamma_n = 1.1$
$D_{85} \leq 10$	2.2	25.0	22.7
$10 < D_{85} \leq 50$	2.5	22.0	20.0

Table 4 – Design tensile strengths of Fortrac® 55/30-20 geogrid

Particle Size of Fill Material (mm)	γ_m	Design Tensile Strength (kN/m)	
		$\gamma_n = 1.0$	$\gamma_n = 1.1$
$D_{85} \leq 10$	2.2	36.4	33.1
$10 < D_{85} \leq 50$	2.5	32.0	29.1

Table 5 – Design tensile strengths of Fortrac® 80/30-20 geogrid

Particle Size of Fill Material (mm)	γ_m	Design Tensile Strength (kN/m)	
		$\gamma_n = 1.0$	$\gamma_n = 1.1$
$D_{85} \leq 10$	2.1	52.4	47.6
$10 < D_{85} \leq 50$	2.4	45.8	41.7

Table 6 – Design tensile strengths of Fortrac® 110/30-20 geogrid

The following notes apply to Tables 3 to 6:

(a) The design tensile strengths given in Tables 3 to 6 are in kN per metre width of the geogrids (not per metre run of the slope).

(b) D_{85} is the particle size corresponding to 85% by weight of particles passing in a grading test.

(c) The partial material factor, γ_m, applies to the tensile strength of the individual grades of Fortrac® geogrid. It has taken into account the environmental effects on material durability, construction damage and other special factors including hydrolysis, creep and stress rupture for a 120-year design life at a design temperature of 30°C.

(d) The fill material used within the reinforced fill block shall comply with the requirements specified for either the Type I or the Type II materials given in Geoguide 6 (GEO, 2002). In addition, the maximum particle size and the D_{85} value of the fill material shall not exceed 150mm and 50mm respectively.

(e) The pH value of the fill material used within the reinforced fill block shall be greater than or equal to 4 and smaller than or equal to 9 for both submerged and non-submerged conditions.

Fill-to-reinforcement interaction

According to Geoguide 6 (GEO, 2002), the design coefficients of fill-to-reinforcement interaction μ_{dsD} and μ_{pD} relating to direct sliding resistance and pullout resistance respectively are:

$$\mu_{dsD} = \frac{\alpha_{ds} \tan \phi'}{\gamma_m \gamma_n}$$

$$\mu_{pD} = \frac{\alpha_p \tan \phi'}{\gamma_m \gamma_n}$$

where μ_{dsD} = design coefficient of interaction against direct sliding
μ_{pD} = design coefficient of interaction against pullout
γ_m = partial material factor for fill-to-reinforcement interaction
γ_n = partial consequence factor to account for consequence of failure
α_{ds} = direct sliding coefficient
α_p = pullout coefficient

In preliminary design, the direct sliding coefficient, α_{ds} and the pullout coefficient, α_p given in Table 7, which have been agreed with Huesker Synthetic GmbH, may be used. The partial material factor, γ_m, for fill-to-reinforcement interaction shall be taken as 1.2.

Interaction coefficient	Fill material	
	Type I fill	Type II fill
Direct sliding coefficient α_{ds}	0.9	0.8
Pullout coefficient α_p	0.8	0.7

Table 7 – Direct sliding and pullout coefficients

The design coefficients of fill-to-reinforcement interaction should be verified by tests in accordance with the requirements of Clause A.61 and Clause A.62 given in the Appendix A of Geoguide 6 (GEO, 2002).

Facings

The typical facing types recommended by Huesker Synthetic GmbH for the construction of reinforced fill slopes using Fortrac® geogrids are presented in Appendix A. The suitability of these facing types should be carefully assessed by the designer and suitably modified to suit the individual design situations and contract requirements. The various design situations that need to be considered in the design of reinforced fill slopes are discussed in Geoguide 6 (GEO, 2002).

Compliance Testing

The materials used for the construction of the reinforced fill slope should be inspected and tested on a regular basis during construction. Testing is required to ensure that the materials conform to the specification. Particular attention should be given to materials which can change properties; these include reinforcing elements and fill. Fill from different sources may have different material parameters and should be checked for compliance with specification. Each batch of reinforcement delivered to site should be sampled, tested and properly labeled and should be accompanied by relevant documentation from the certificate holder.

The requirements for the testing of materials are recommended in the Appendix A of Geoguide 6 (GEO, 2002).

References

BSI (2008). Geotextiles – Wide width tensile test (BS EN ISO 10319: 2008). British Standards Institution, London.

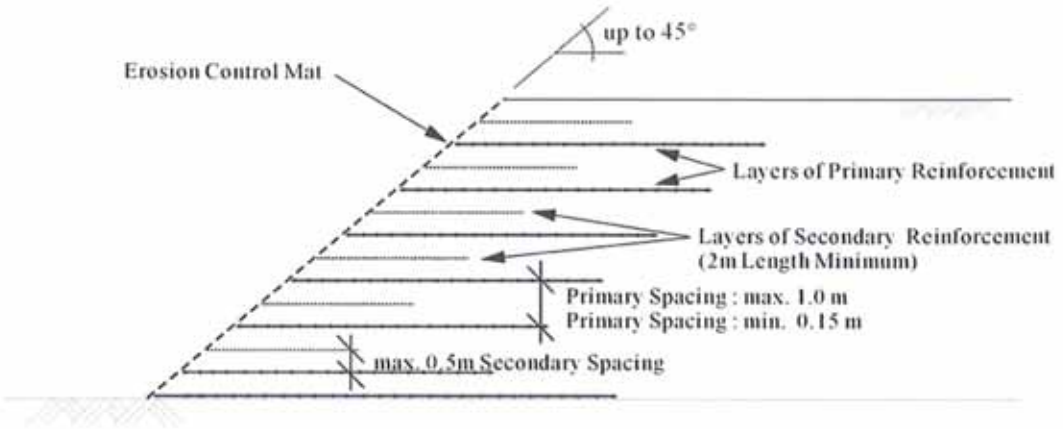
GEO (2002). Guide to Reinforced Fill Structure and Slope Design (Geoguide 6). Geotechnical Engineering Office, Civil Engineering Department, Hong Kong, 236p.

Certification Information

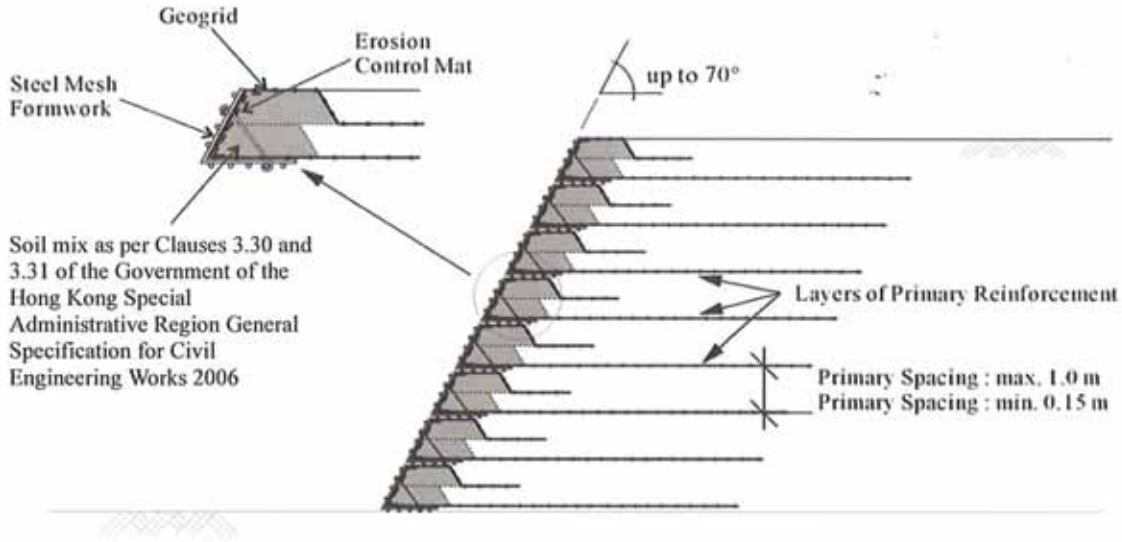
Readers are advised to check the current conditions and requirements stipulated in this Certificate by referring to the Civil Engineering and Development Department's website at http://www.cedd.gov.hk/eng/services/certification/cert_pdf.htm.

Geotechnical Engineering Office
Civil Engineering and Development Department
May 2010

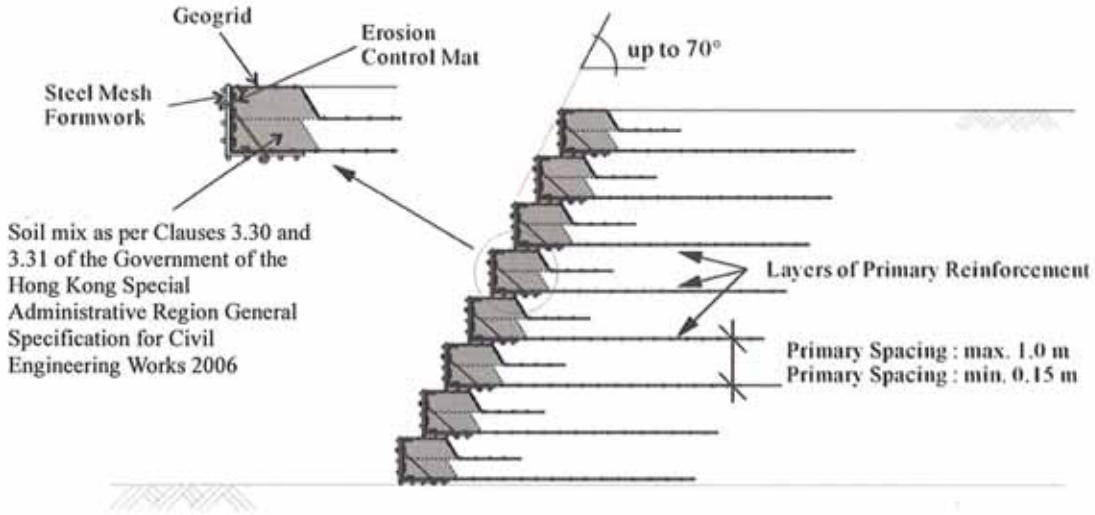
Appendix A



Erosion control mat protection (slope angle up to 45°)



Wrap-around facing (slope angle up to 70°)



Wrap-around facing (slope angle up to 70°)