REINFORCED FILL PRODUCT CERTIFICATE

Certificate No. RF 1/2011

Tenax TT Geogrids

Certified Products

Products	:	Tenax TT 045 SAMP, TT 060 SAMP, TT 090 SAMP, TT 120 SAMP, TT 160 SAMP geogrids
Certificate holder	:	TENAX SpA, Via dell'Industria, 3 I-23897 Vigano (Lecco) Italy
Product distributor	:	G and E Company Limited, 14/F, Kiu Yin Commercial Building, 361 - 363 Lockhart Road, Wanchai, Hong Kong

Conditions of Certification

This Certificate is granted only to TENAX SpA. 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 Tenax TT geogrids are used in permanent reinforced fill structures and slopes in Hong Kong, the design tensile strengths of the product shall comply with the values specified in Tables 3 to 7 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This Certificate shall cease to be valid if the product data or specifications are withdrawn or re-issued in an amended form by the certificate holder.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 : 4 April 2011
Valid until : 3 April 2013

(Raymond K S CHAN)
for Director of Civil Engineering and Development

Tenax TT geogrids

Tenax TT geogrids are intended to be used as reinforcing elements in reinforced fill structures and slopes. The geogrids are made of high density polyethylene (HDPE) of Type III, Class A, Category 5 according to ASTM D1248 (ASTM, 2005) which contains minimum 2.0 % and maximum 3 % of carbon black stabiliser to protect the HDPE against UV degradation. The density of the polymer is from 0.950 to 0.960 g/cm³ when determined by ISO 1183 (ISO, 2005) and the melt index of the polymer is 0.20 ± 0.10 g/10 min when determined by ISO 1133, Condition 4 (ISO, 2005).

The holes of the geogrids are formed during the extrusion process of the HDPE sheets, which are stretched under temperature controlled conditions to the dimensions shown in Figure 1.

The typical dimensions, mass and identification of Tenax TT 045 SAMP, TT 060 SAMP, TT 090 SAMP, TT 120 SAMP and TT 160 SAMP geogrids are given in Table 1.

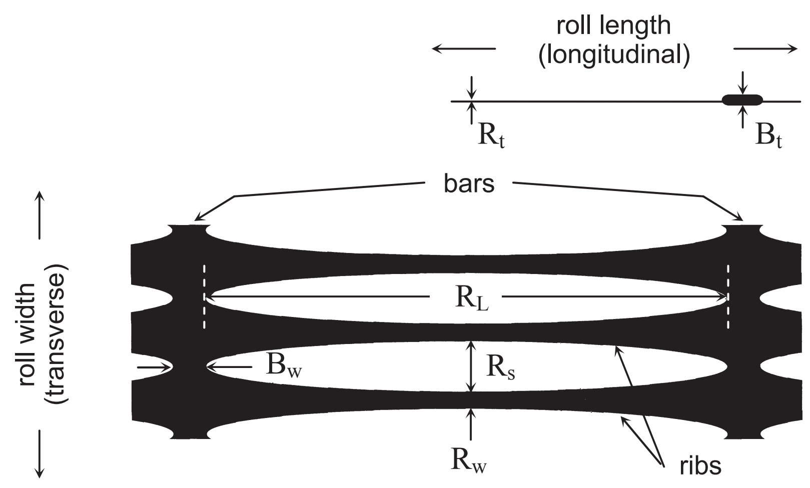


Figure 1 – Tenax TT geogrid

Product grade	Grid dimensions						Roll dimensions		Mass per unit area	Colour coding
	R_L (mm)	R_s (mm)	B_w (mm)	R_w (mm)	B_t (mm)	R_t (mm)	Length (m)	Width (m)	(g/m^2)	
TT 045 SAMP	220	18	12.5	2.7	3.6	1.3	100	1 or 2	300	Orange
TT 060 SAMP	220	18	17	2.8	3.8	1.5	75	1 or 2	400	Blue
TT 090 SAMP	220	15	15	3.3	5.5	1.7	50	1 or 2	600	Yellow
TT 120 SAMP	220	15	16.8	4.0	7.0	2.4	30	1 or 2	800	Red
TT 160 SAMP	220	13	19.5	6.1	7.5	2.3	30	1 or 2	1000	Green

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 TENAX SpA are provided in Table 2. The load-strain properties of the geogrids are shown in Figure 2. The actual strain at break is approximately 13 %.

Product grade	TT 045 SAMP	TT 060 SAMP	TT 090 SAMP	TT 120 SAMP	TT 160 SAMP
Characteristic short-term tensile strength (kN/m)	45	60	90	120	160

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

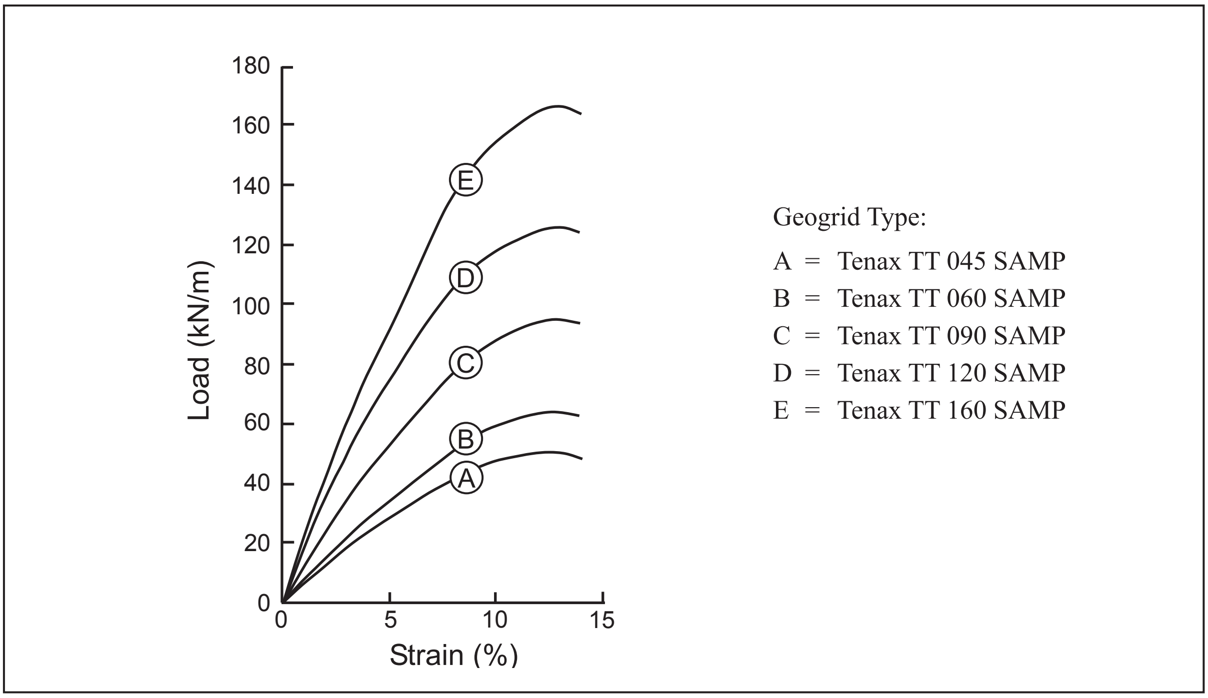


Figure 2 – Typical short-term load-strain properties (longitudinal direction)

Quality assurance

Tenax geogrids supplied to Hong Kong are manufactured by TENAX SpA at Vigano (LC) Italy and Tianjin Tenax Industrial Plastics Co., Ltd. – Tenax Group at Tianjin, China. Both TENAX SpA and Tianjin Tenax Industrial Plastics Co., Ltd. – Tenax Group manufacture Tenax TT 045 SAMP, TT 060 SAMP, TT 090 SAMP, TT 120 SAMP and TT 160 SAMP geogrids under ISO 9001 Quality Assurance Certificate. Independent audits are carried out periodically by SGS Italy S.p.A.

Identification

Tenax TT geogrids are imported into Hong Kong from Italy or China. Each roll of Tenax TT geogrid has an identification label with particulars of the product and its manufacturing code and it is wrapped with a tape having a specific colour (Table 1). A copy of the manufacturer's test certificate will accompany each shipment of delivery and the test certificate is available from the product distributor.

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 TENAX SpA (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 Tenax TT geogrids in the longitudinal direction given in Tables 3 to 7, which have been agreed with TENAX SpA, shall be used.

Particle size of fill material (mm)	γ_m	Design tensile strength (kN/m)	
		$\gamma_n = 1.0$	$\gamma_n = 1.1$
$D_{85} \leq 10$	2.7	16.7	15.2
$10 < D_{85} \leq 50$	3.0	15.0	13.6

Table 3 – Design tensile strengths of Tenax TT 045 SAMP geogrid

Particle size of fill material (mm)	γ_m	Design tensile strength (kN/m)	
		$\gamma_n = 1.0$	$\gamma_n = 1.1$
$D_{85} \leq 10$	2.7	22.2	20.2
$10 < D_{85} \leq 50$	2.9	20.7	18.8

Table 4 – Design tensile strengths of Tenax TT 060 SAMP geogrid

Particle size of fill material (mm)	γ_m	Design tensile strength (kN/m)	
		$\gamma_n = 1.0$	$\gamma_n = 1.1$
$D_{85} \leq 10$	2.6	34.6	31.5
$10 < D_{85} \leq 50$	2.8	32.1	29.2

Table 5 – Design tensile strengths of Tenax TT 090 SAMP geogrid

Particle size of fill material (mm)	γ_m	Design tensile strength (kN/m)	
		$\gamma_n = 1.0$	$\gamma_n = 1.1$
$D_{85} \leq 10$	2.6	46.2	42.0
$10 < D_{85} \leq 50$	2.7	44.4	40.4

Table 6 – Design tensile strengths of Tenax TT 120 SAMP geogrid

Particle size of fill material (mm)	γ_m	Design tensile strength (kN/m)	
		$\gamma_n = 1.0$	$\gamma_n = 1.1$
$D_{85} \leq 10$	2.6	61.5	55.9
$10 < D_{85} \leq 50$	2.6	61.5	55.9

Table 7 – Design tensile strengths of Tenax TT 160 SAMP geogrid

The following notes apply to Tables 3 to 7:

(a) The design tensile strengths given in Tables 3 to 7 are in kN per metre width of the geogrids (not per metre run of the structure or 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 Tenax TT 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 150 mm and 50 mm respectively.

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 8, which have been agreed with TENAX SpA, 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	0.6

Table 8 – 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 TENAX SpA for the construction of reinforced fill structures and slopes using Tenax TT 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 structures and slopes are discussed in Geoguide 6 (GEO, 2002).

Compliance Testing

The materials used for the construction of the reinforced fill structures or slopes 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. Each main delivery of reinforcement should be sampled, tested and properly labelled.

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

References

ASTM (2005). Polyethylene plastics moulding and extrusion materials (ASTM D1248: 2005). American Society for Testing and Materials, USA.

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.

ISO (2005). Plastic materials – Methods to calculate the volumetric mass density and the relative density of plastic material excluding cellular plastics (ISO 1183: 2005). ISO Genève, CH.

ISO (2005). Plastic materials – Determination of melt fluid index in mass (MFR) and in volume (MVR) of thermoplastic products (ISO 1133: 2005). ISO Genève, CH.

Certification Information

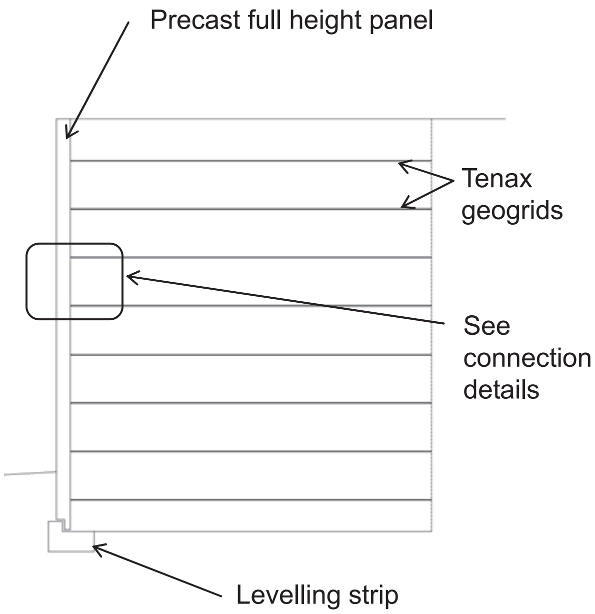
Readers are advised to check the current conditions and requirements stipulated in this Certificate by referring to the Civil Engineering and Development Department's website at http://www.cedd.gov.hk/eng/services/certification/index.htm.

Geotechnical Engineering Office
Civil Engineering and Development Department

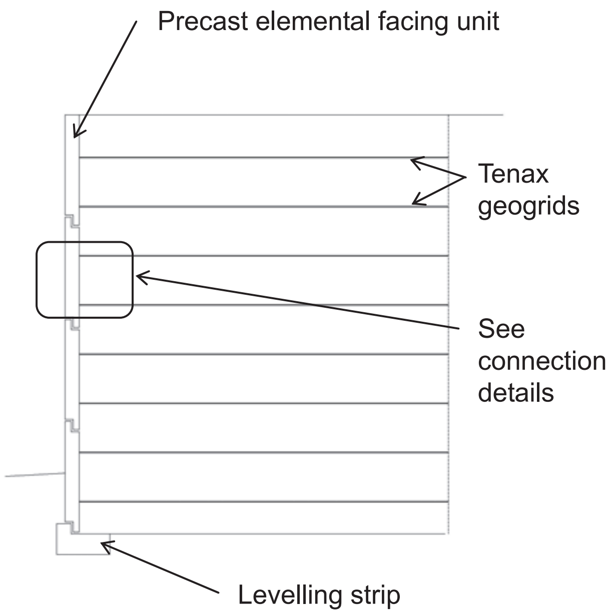
April 2011

Appendix A

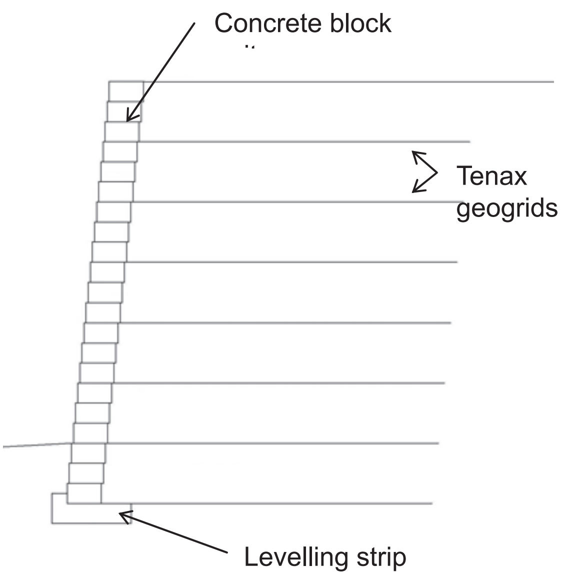
Reinforced fill structures



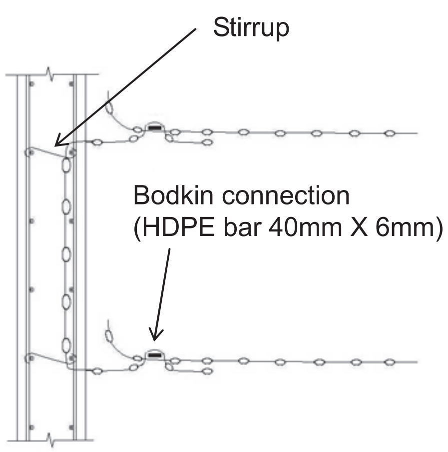
Full height facing



Elemental facing



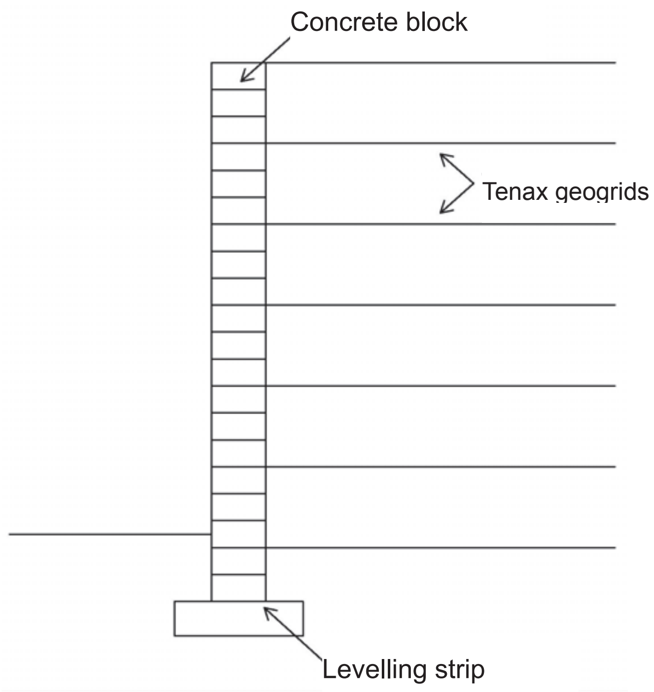
Battered segmental block facing



Typical connection details

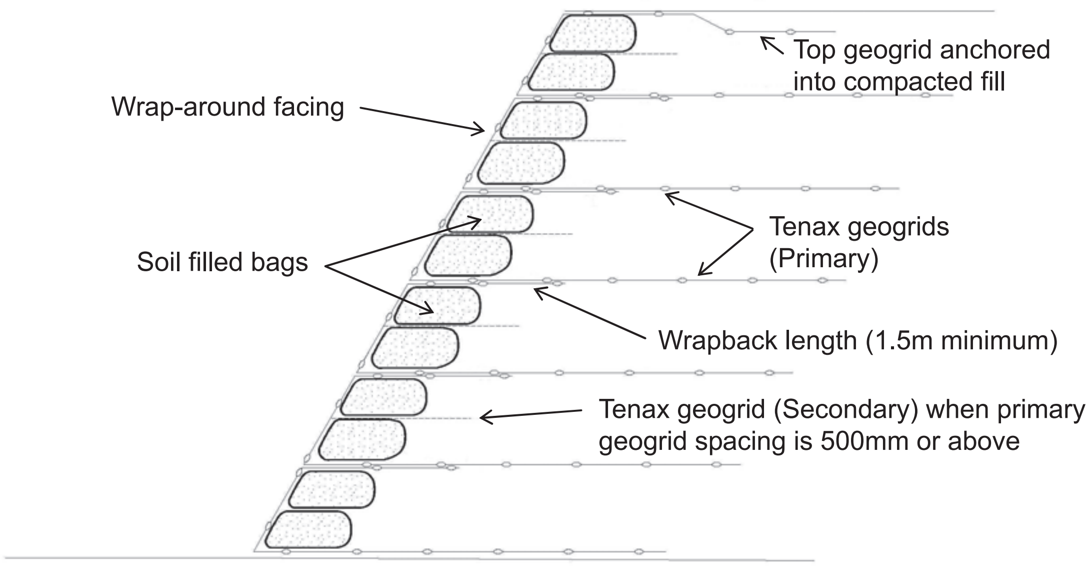
Appendix A

Reinforced fill structures (cont'd)



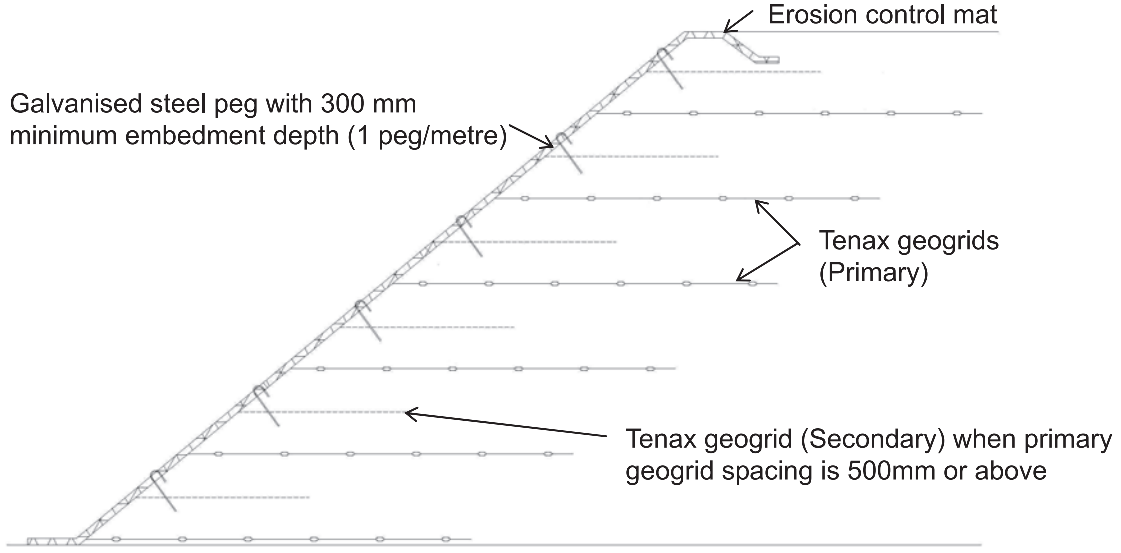
Vertical segmental block facing

Reinforced fill slopes



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

Reinforced fill slopes (cont'd)



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