REINFORCED FILL PRODUCT CERTIFICATE

Certificate No. RF 2/2010

Enkagrid PRO Geogrids

Certified Products

Products	:	Enkagrid PRO 40, PRO 60, PRO 90, PRO 120, PRO 180 geogrids
Certificate holder	:	Colbond bv, Westervoortsedijk 73, PO Box 9600, 6800 TC Arnhem, the Netherlands
Product distributor	:	Colbond bv, Westervoortsedijk 73, PO Box 9600, 6800 TC Arnhem, the Netherlands

Conditions of Certification

This Certificate is granted only to Colbond bv. 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 Enkagrid PRO 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This Certificate shall cease to be valid if the product data or specifications are withdrawn or re-issued in an amended form by the certificate holder.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 : 16 March 2010
Valid until : 15 March 2012

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

Enkagrid PRO geogrids

Enkagrid PRO geogrids are intended to be used as reinforcing elements in reinforced fill structures and slopes. The geogrids are manufactured in five grades of various strengths and mesh sizes. A typical geogrid is illustrated in Figure 1. Each geogrid consists of a regular open network of welded bars which are made from extruded polyester. The black longitudinal bars contain a minimum of 2% carbon black to protect the bars against photo-oxidation. The transparent transverse bars are welded onto the longitudinal bars to maintain the geometric form of the grid.

The typical dimensions, mass and identification of Enkagrid PRO 40, PRO 60, PRO 90, PRO 120 and PRO 180 geogrids are given in Table 1:

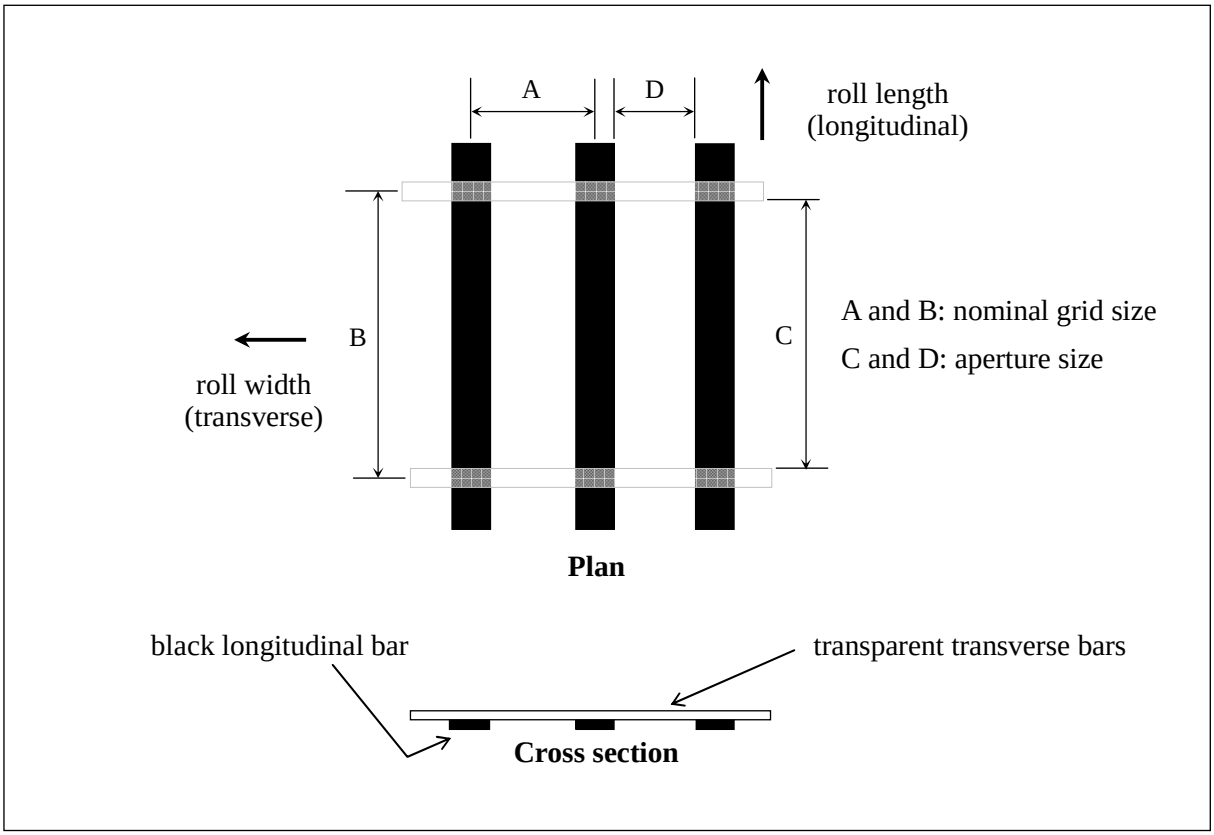


Figure 1 – Enkagrid PRO geogrid

Product grade	Grid dimensions		Roll dimensions		Mass per unit area	Colour coding
	Grid size (A x B) (mm)	Aperture size (C x D) (mm)	Length (m)	Width (m)	(g/m^2)	
PRO 40	50 x 120	111 x 41	100	5	220	white + yellow
PRO 60	50 x 120	111 x 37	100	5	280	white + green
PRO 90	50 x 120	111 x 35	100	5	390	white + blue
PRO 120	50 x 120	111 x 34	100	5	440	white + grey
PRO 180	50 x 120	111 x 34	100	5	640	white + black

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 Colbond bv are provided in Table 2. The load-strain properties of the geogrids are shown in Figure 2. The actual strain at break is approximately 6.5%.

Product grade	PRO 40	PRO 60	PRO 90	PRO 120	PRO 180
Characteristic short-term tensile strength (kN/m)	40	60	90	120	180

Table 2 – Characteristic short-term tensile strength

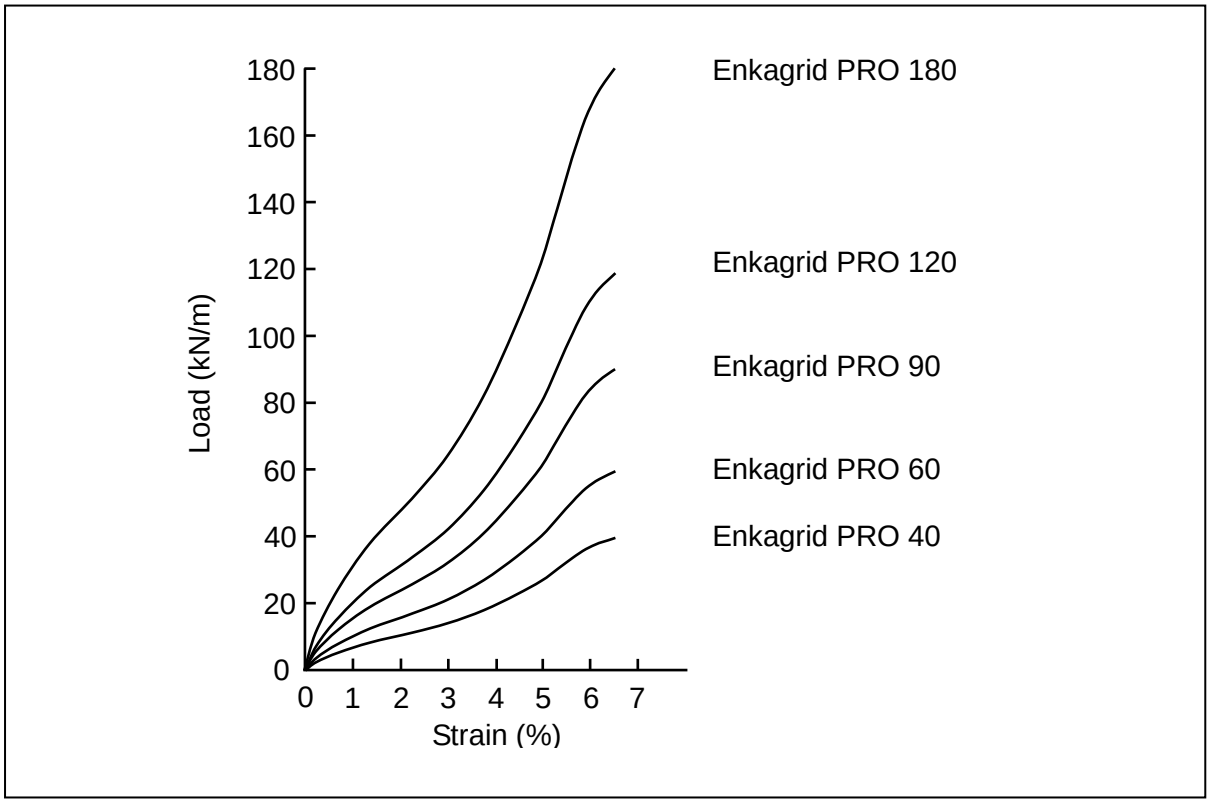


Figure 2 – Typical short-term load-strain properties (longitudinal direction)

Quality assurance

Enkagrid PRO geogrids supplied to Hong Kong are manufactured by Colbond bv at Westervoortsedijk 73, P O Box 9600, 6800 TC Arnhem, the Netherlands, under ISO 9001 Quality Assurance Certificate. Independent audits are carried out periodically by Lloyd's Register Quality Company.

Identification

Enkagrid PRO geogrids are imported into Hong Kong from the Netherlands. Each roll of Enkagrid PRO geogrid is wrapped in a black polythene bag and each bag labelled with the geogrid grade and

identification and CE mark (see Figure 3). The ends of the rolls are sprayed with colour-coded paint to assist identification on site of a particular grade of geogrid (see 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.

Figure 3 – Example of 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 Colbond bv (see Table 2)
γ_m = partial material factor on tensile strength of reinforcement
γ_n = partial consequence factor to account for consequence of failure

The design tensile strengths of the Enkagrid PRO geogrids in the longitudinal direction given in Tables 3 to 7, which have been agreed with Colbond bv, shall be used.

Particle size of fill material (mm)	γ_m	Design tensile strength (kN/m)	
		$\gamma_n = 1.0$	$\gamma_n = 1.1$
$D_{85} \leq 10$	1.8	22.2	20.2
$10 < D_{85} \leq 40$	1.9	21.1	19.1

Table 3 – Design tensile strengths of Enkagrid PRO 40 geogrid

Particle size of fill material (mm)	γ_m	Design tensile strength (kN/m)	
		$\gamma_n = 1.0$	$\gamma_n = 1.1$
$D_{85} \leq 10$	1.8	33.3	30.3
$10 < D_{85} \leq 40$	1.9	31.6	28.7

Table 4 – Design tensile strengths of Enkagrid PRO 60 geogrid

Particle size of fill material (mm)	γ_m	Design tensile strength (kN/m)	
		$\gamma_n = 1.0$	$\gamma_n = 1.1$
$D_{85} \leq 10$	1.8	50.0	45.5
$10 < D_{85} \leq 40$	1.8	50.0	45.5

` Table 5 – Design tensile strengths of Enkagrid PRO 90 geogrid

Particle size of fill material (mm)	γ_m	Design tensile strength (kN/m)	
		$\gamma_n = 1.0$	$\gamma_n = 1.1$
$D_{85} \leq 10$	1.8	66.7	60.6
$10 < D_{85} \leq 40$	1.8	66.7	60.6

Table 6 – Design tensile strengths of Enkagrid PRO 120 geogrid

Particle size of fill material (mm)	γ_m	Design tensile strength (kN/m)	
		$\gamma_n = 1.0$	$\gamma_n = 1.1$
$D_{85} \leq 10$	1.8	100.0	90.9
$10 < D_{85} \leq 40$	1.8	100.0	90.9

Table 7 – Design tensile strengths of Enkagrid PRO 180 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 Enkagrid PRO 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 40mm 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 Colbond bv, 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}	0.85	0.80
Pullout coefficient α_p	0.70	0.60

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 Colbond bv for the construction of reinforced fill structures and slopes using Enkagrid PRO 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 and 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 with specification. Each batch of reinforcement delivered to site should be sampled, tested and properly labelled 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.

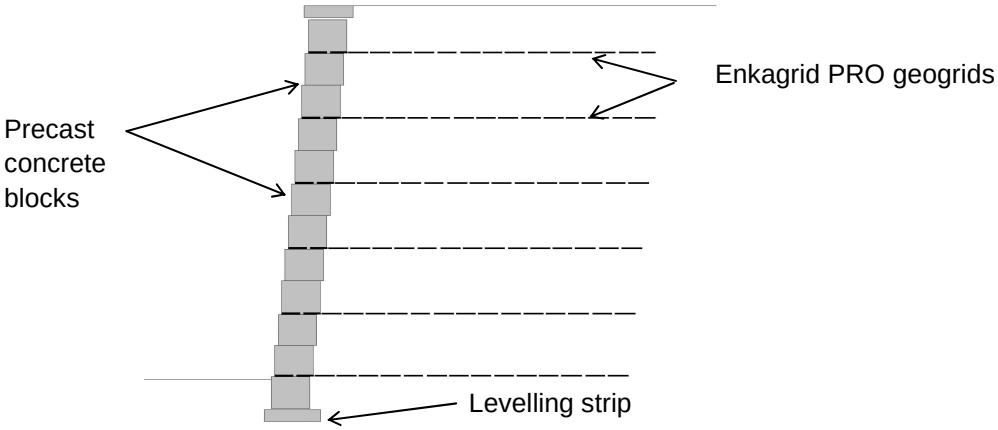
GEO (2002). Guide to Reinforced Fill Structure and Slope Design (Geoguide 6). Geotechnical Engineering Office, Civil Engineering Department, Hong Kong, 236p.

Certification Information

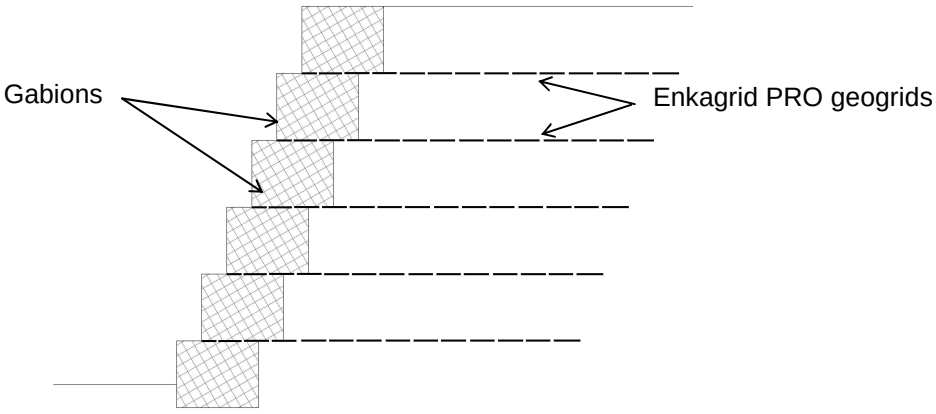
Readers are advised to check the current conditions and requirements stipulated in this Certificate by referring to the Civil Engineering and Development Department's website at http://www.cedd.gov.hk/eng/services/certification/index.htm.

Appendix A

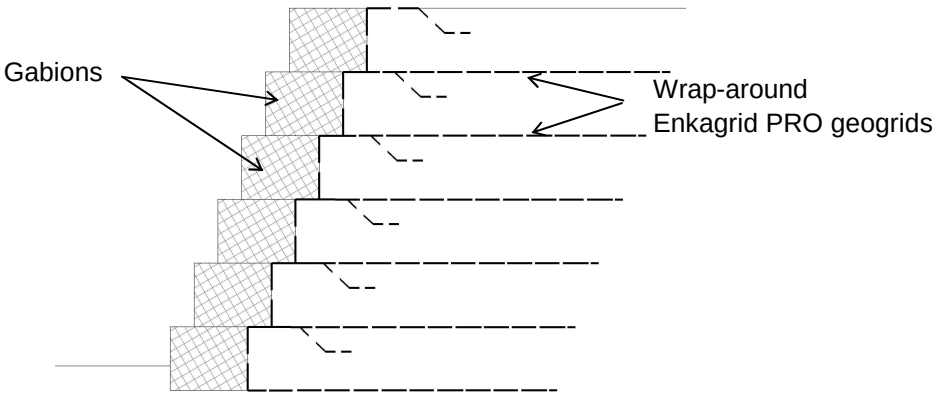
Reinforced fill structures



Segmental block facing



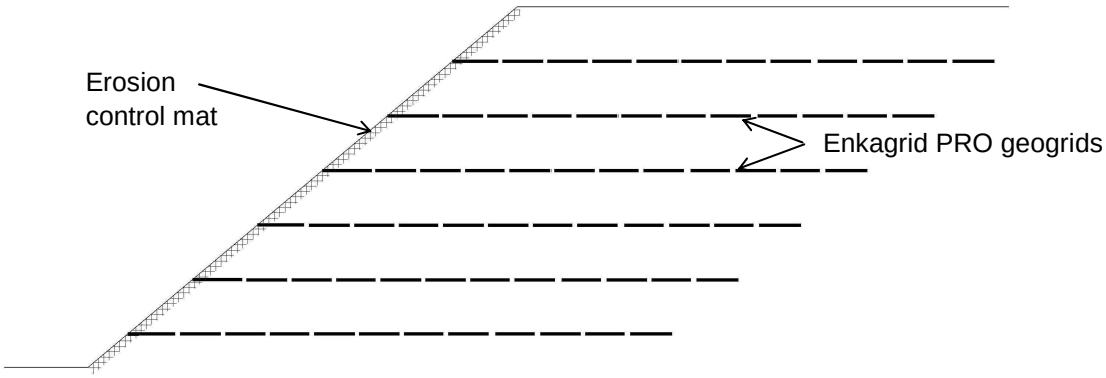
Gabion facing



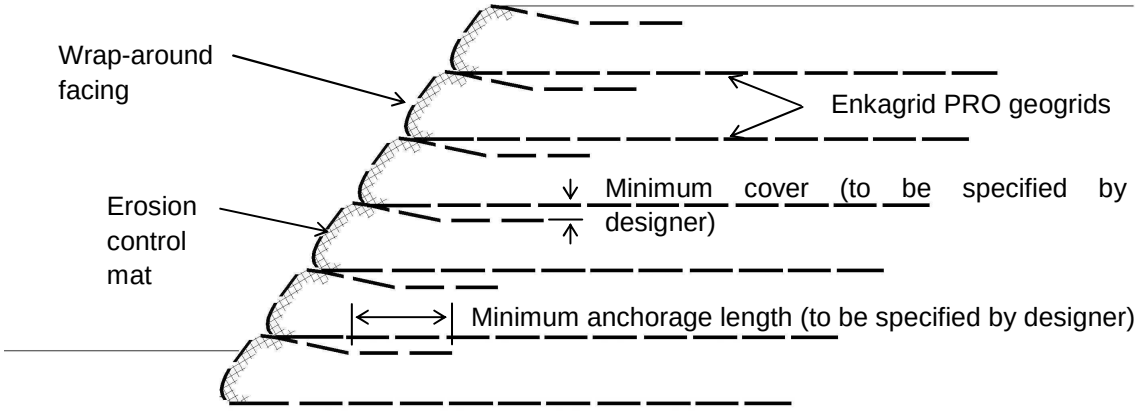
Gabion facing

Appendix A

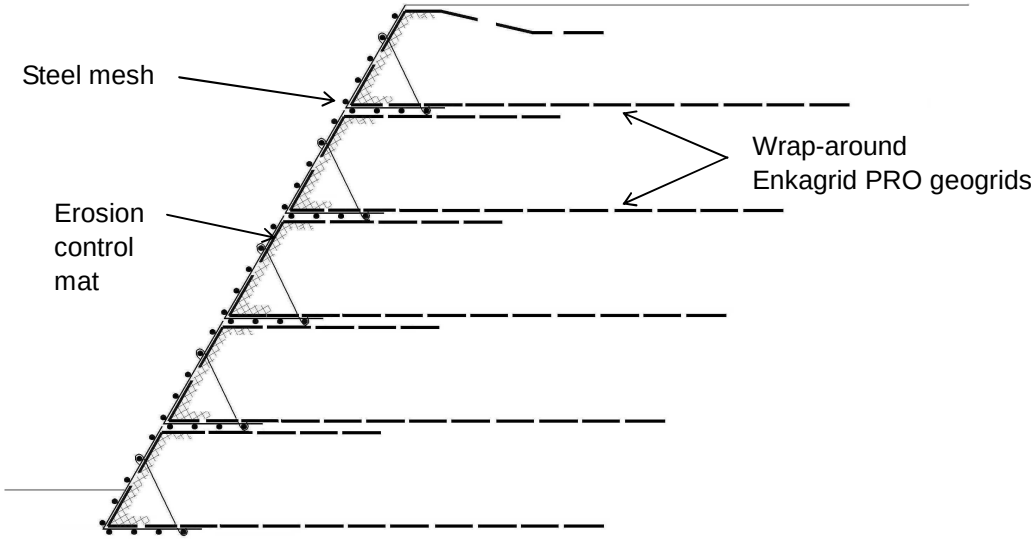
Reinforced fill slopes



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



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



Steel mesh facing (slope angle up to 70º)