REINFORCED FILL PRODUCT CERTIFICATE

Certificate No. RF 2/2021

Tensar RE500 Geogrids

Certified Products

Products:	Tensar RE520, RE540, RE560, RE570 and RE580 geogrids
Certificate holder:	Tensar International Limited, Units 2-4 Cunningham Court, Shadsworth Business Park, Blackburn, BB1 2QX, United Kingdom
Product distributor:	Tensar Geosynthetics (China) Limited, 289# Checheng Avenue, Wuhan Economic & Technical Development Zone, Hanyang District, Wuhan, Hubei Province 430056, China

Conditions of Certification

This Certificate is granted only to Tensar International Limited. 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 Tensar RE500 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, 2017).

This Certificate shall cease to be valid if the product data or specifications are withdrawn or re-issued in an amended form by the certificate holder.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: **9 October 2021**

Valid Until: **8 October 2023**

(Raymond W M Cheung)

for Director of Civil Engineering and Development

Tensar RE500 geogrids

Tensar RE500 geogrids are intended to be used as reinforcing elements in reinforced fill structures and slopes. The geogrids are made of co-polymer high density polyethylene (HDPE) of class BS3412: 1992, PE, E1, W, 50-003 Condition 5 (BSI, 1992). The carbon black content when determined by ASTM D1603 – 14 (ASTM, 2014) will not be less than 2.0% and not more than 4.0%.

The Tensar RE500 geogrids are manufactured in five grades by punching holes in a sheet of polyethylene, which is then stretched under temperature controlled conditions to the shape and form as shown in Figure 1. The typical dimensions, mass and identification of Tensar RE520, RE540, RE560, RE570 and RE580 geogrids are given in Table 1.

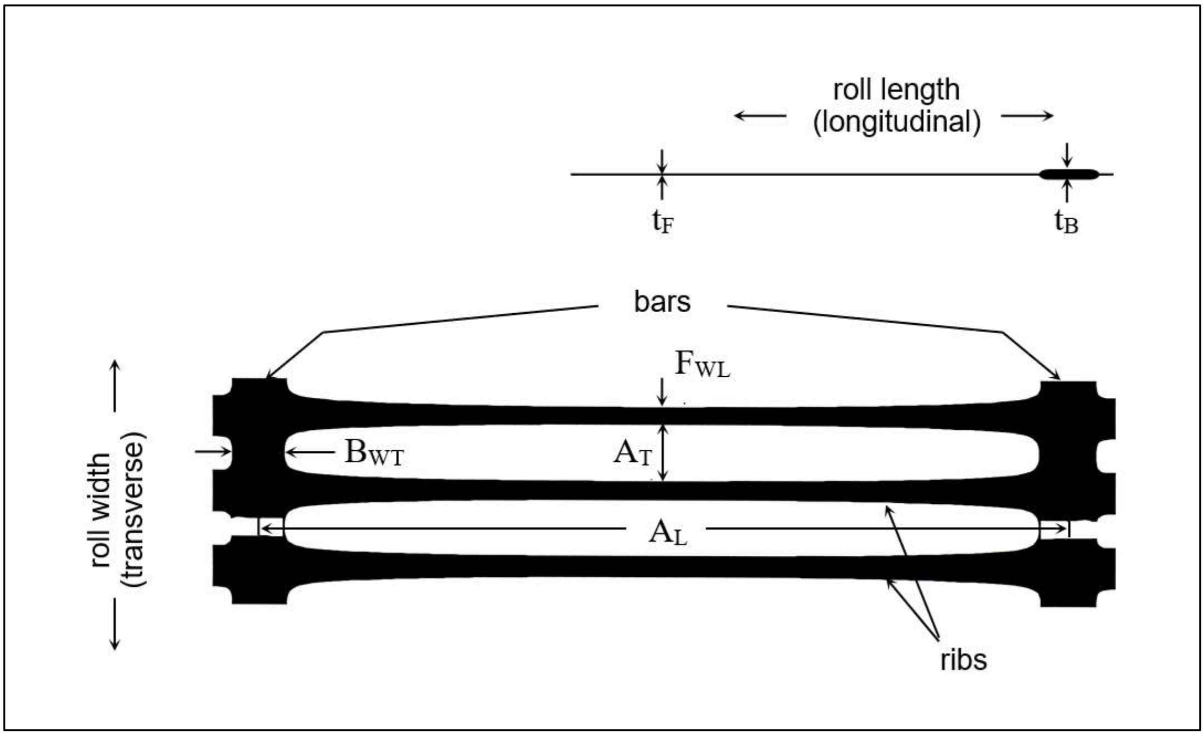


Figure 1 – Tensar RE500 geogrid

Product grade	Grid dimensions						Roll dimensions		Mass per unit area	Colour coding
	A_L (mm)	A_T (mm)	B_{WT} (mm)	F_{WL} (mm)	t_B (mm)	t_F (mm)	Length (m)	Width (m)	(g/m^2)	
RE520	235	16	17	6	2.0 – 2.2	0.9	75	1.0 or 1.3	360	Blue
RE540	235	16	17	6	2.5 – 2.7	1.1	50	1.0 or 1.3	450	Yellow
RE560	235	16	17	6	3.6 – 3.9	1.5	50	1.0 or 1.3	650	Orange
RE570	235	16	17	6	4.8 – 5.2	2.0	50	1.0 or 1.3	870	White
RE580	235	16	17	6	5.6 – 6.0	2.3	50	1.0 or 1.3	980	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: 2015 (BSI, 2015). The characteristic short-term tensile strengths in the longitudinal direction of the geogrids guaranteed by Tensar International Limited are provided in Table 2. The load-strain properties of the geogrids are shown in Figure 2. The actual strain at maximum load is approximately 10%.

Product grade	RE520	RE540	RE560	RE570	RE580
Characteristic short-term tensile strength (kN/m)	52.8	64.5	88.7	118.4	137.3

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

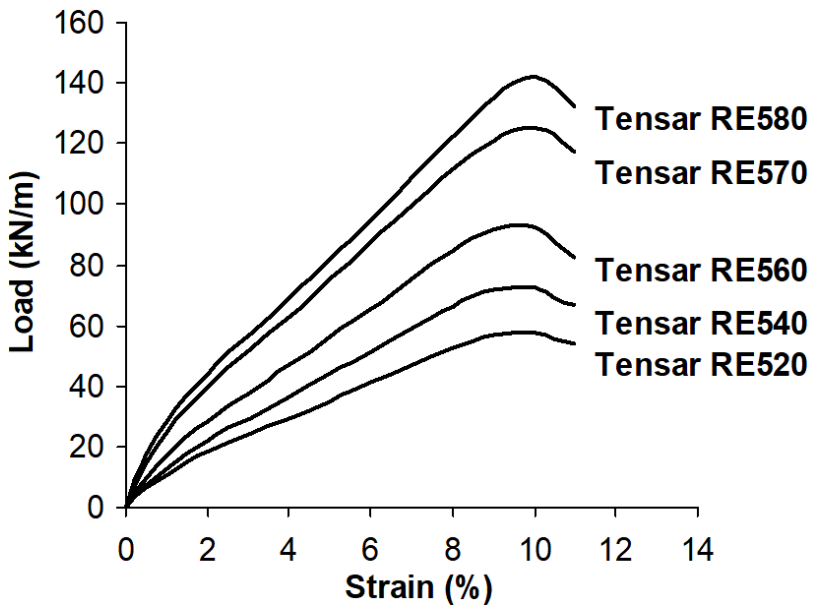


Figure 2 – Typical short-term load-strain properties (longitudinal direction)

Quality assurance

Tensar RE500 geogrids supplied to Hong Kong are manufactured by Tensar International Limited at Shadsworth, Blackburn, UK (by Tensar Manufacturing Limited), and Wuhan, China (by Tensar Geosynthetics (China) Ltd) under ISO 9001 Quality Assurance Certificates. Independent audits are carried out periodically by BSI in UK and China Certification Centre, Inc. in China.

Identification

Tensar RE500 geogrids are imported into Hong Kong from UK or China. Each roll of Tensar RE500 geogrid has adhesive tape fixing bands identifying the particular product grade and the ends of the rolls are sprayed with colour coded paint (Table 1). A copy of the manufacturer's test certificate will accompany each shipment of delivery. This certificate is available from the product distributor.

Design tensile strength

According to Geoguide 6 - Guide to Reinforced Fill Structure and Slope Design (GEO, 2017), 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 Tensar International Limited (see Table 2)

γ_m = partial material factor on tensile strength of geogrid (see Note (c))

γ_n = partial consequence factor to account for consequence of failure

The design tensile strengths of the Tensar RE500 geogrids in the longitudinal direction given in Tables 3 to 7, which have been agreed with Tensar International Limited, shall be used.

Particle size of fill material (mm)	γ_m	Design tensile strength (kN/m)	
		$\gamma_n = 1.0$	$\gamma_n = 1.1$
$D_{85} \leq 10$	2.48	21.3	19.4
$10 < D_{85} \leq 50$	2.88	18.3	16.6
$50 < D_{85} \leq 100$	3.46	15.3	13.9
$100 < D_{85} \leq 125$	3.72	14.2	12.9

Table 3 – Design tensile strengths of Tensar RE520 geogrid

Particle size of fill material (mm)	γ_m	Design tensile strength (kN/m)	
		$\gamma_n = 1.0$	$\gamma_n = 1.1$
$D_{85} \leq 10$	2.46	26.3	23.9
$10 < D_{85} \leq 50$	2.76	23.3	21.2
$50 < D_{85} \leq 100$	3.22	20.0	18.2
$100 < D_{85} \leq 125$	3.41	18.9	17.2

Table 4 – Design tensile strengths of Tensar RE540 geogrid

Particle size of fill material (mm)	γ_m	Design tensile strength (kN/m)	
		$\gamma_n = 1.0$	$\gamma_n = 1.1$
$D_{85} \leq 10$	2.43	36.5	33.2
$10 < D_{85} \leq 50$	2.62	33.8	30.7
$50 < D_{85} \leq 100$	2.93	30.2	27.5
$100 < D_{85} \leq 125$	3.10	28.6	26.0

Table 5 – Design tensile strengths of Tensar RE560 geogrid

Particle size of fill material (mm)	γ_m	Design tensile strength (kN/m)	
		$\gamma_n = 1.0$	$\gamma_n = 1.1$
$D_{85} \leq 10$	2.43	48.7	44.3
$10 < D_{85} \leq 50$	2.55	46.4	42.2
$50 < D_{85} \leq 100$	2.77	42.8	38.9
$100 < D_{85} \leq 125$	2.91	40.7	37.0

Table 6 – Design tensile strengths of Tensar RE570 geogrid

Particle size of fill material (mm)	γ_m	Design tensile strength (kN/m)	
		$\gamma_n = 1.0$	$\gamma_n = 1.1$
$D_{85} \leq 10$	2.41	57.0	51.8
$10 < D_{85} \leq 50$	2.48	55.4	50.3
$50 < D_{85} \leq 100$	2.62	52.4	47.6
$100 < D_{85} \leq 125$	2.74	50.1	45.5

Table 7 – Design tensile strengths of Tensar RE580 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 Tensar RE500 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, 2017). In addition, the maximum particle size and the D_{85} value of the fill material shall not exceed 150mm and 125mm respectively.

Fill-to-reinforcement interaction

According to Geoguide 6 (GEO, 2017), 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 Tensar International Limited, 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, 2017).

Facings

The typical facing types recommended by Tensar International Limited for the construction of reinforced fill structures and slopes using Tensar RE500 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, 2017).

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, 2017).

References

ASTM (2014). Standard Test Method for Carbon Black Content in Olefin Plastics (ASTM D1603 – 14). ASTM International, United States.

BSI (1992). Methods of specifying general purpose polyethylene materials for moulding and extrusion (BS 3412: 1992). British Standards Institution, London.

BSI (2015). Geosynthetics – Wide width tensile test (BS EN ISO 10319: 2015). British Standards Institution, London.

GEO (2017). Guide to Reinforced Fill Structure and Slope Design (Geoguide 6) (Continuously Updated E-Version released on 29 August 2017). Geotechnical Engineering Office, Civil Engineering and Development Department, HKSAR Government, 218p.

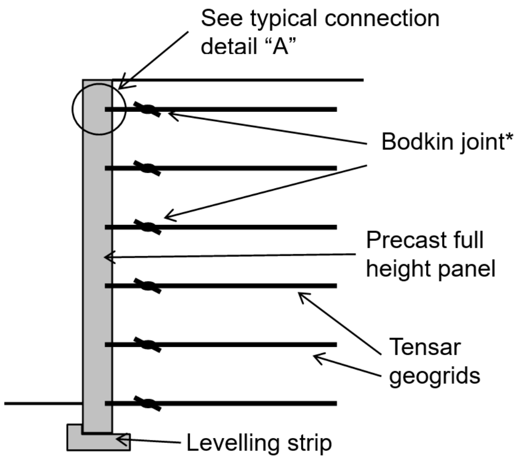
Certification Information

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 https://www.cedd.gov.hk/eng/public-services-forms/geotechnical/reinforced/index.html.

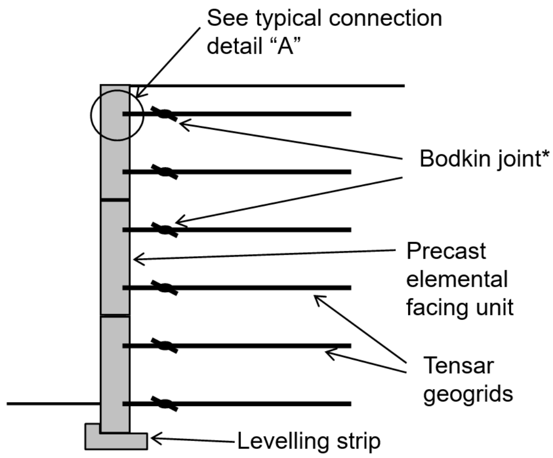
Geotechnical Engineering Office
Civil Engineering and Development Department
October 2021

Appendix A

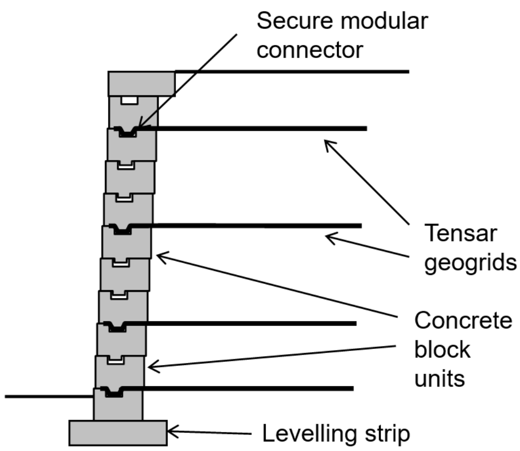
Reinforced fill structures



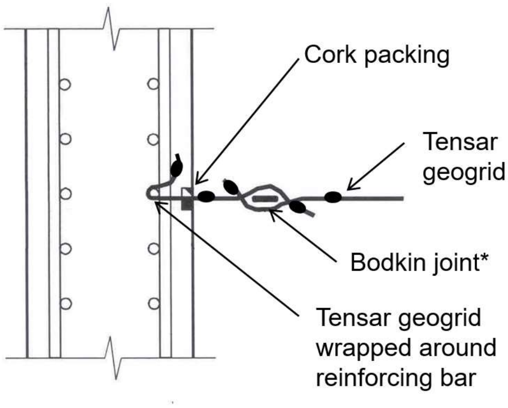
Full height facing



Elemental facing



Segmental block facing

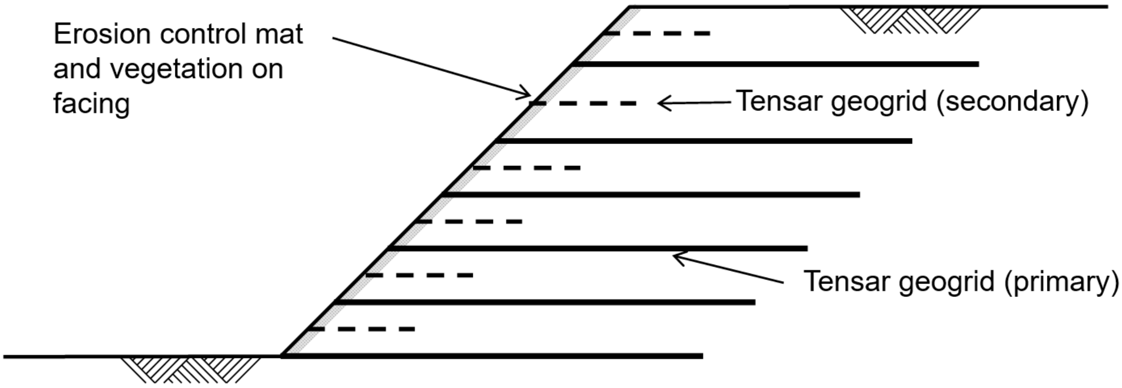


Typical connection detail "A"

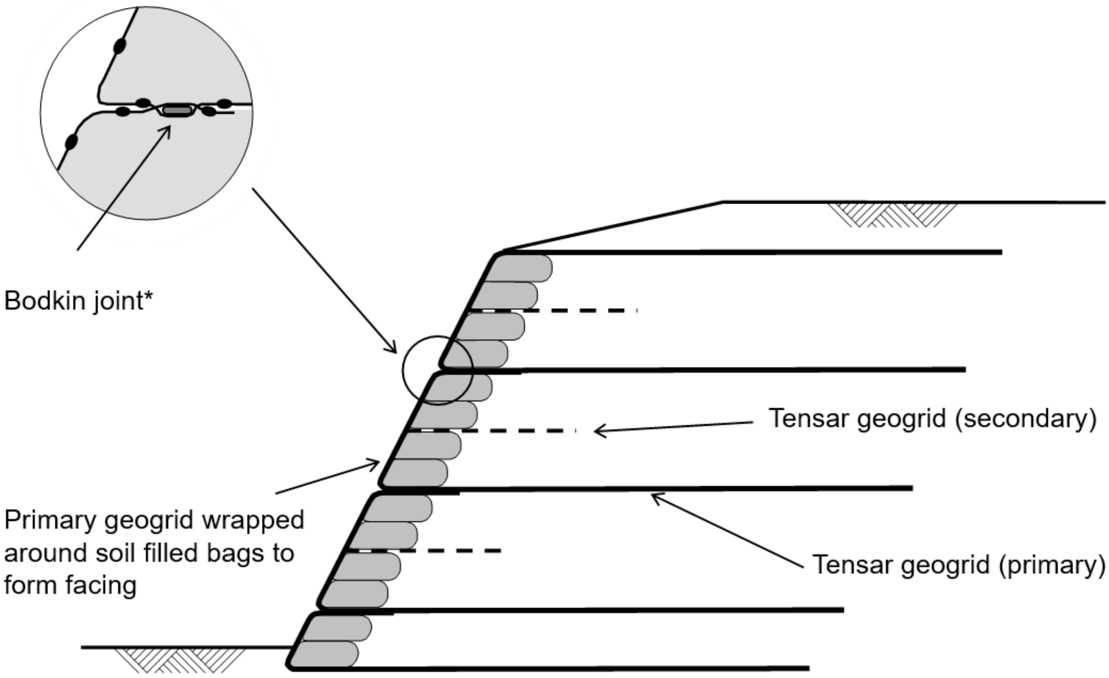
* 80mm x 8mm bodkin should be used for all grades of Tensar RE500 geogrids

Appendix A

Reinforced fill slopes



Erosion control mat protection (slope angle to 45º)



Wrap-around facing (slope angle to 70º)

* 80mm x 8mm bodkin should be used for all grades of Tensar RE500 geogrids