TENCATE
Miragrid

Miragrid GX - Geogrids

Design Strength according BS 8006:2010

Properties [Standard]				Unit	GX 35	GX 55	GX 80	GX 110	GX 160	GX 200
Mechanical properties										
Characteristic tensile strength [EN ISO 10319]		MD		kN/m	35	55	80	110	160	200
Elongation at characteristic strength [EN ISO 10319]		MD		%	< 10.5	< 10.5	< 10.5	< 10.5	< 10.5	< 10.5
Creep										
RF_{CR} - Reduction factor for creep rupture										
10 years					1.45	1.45	1.45	1.45	1.45	1.45
60 years					1.51	1.51	1.51	1.51	1.51	1.51
120 years					1.56	1.56	1.56	1.56	1.56	1.56
Mechanical damage										
RF_{ID} - Reduction factor for mechanical damage										
Material beneath	Material on top	d_{max}	d_{50}							
clayey	clayey	-	0,04 mm		1.09	1.08	1.06	1.06	1.06	1.06
Sandy gravel	Sandy gravel	32 mm	8,5 mm		1.14	1.15	1.15	1.14	1.05	1.05
Sandy gravel	Sandy gravel	63 mm	20 mm		1.31	1.10	1.14	1.10	1.08	1.08
Crushed gravel	Crushed gravel	125 mm	20 mm		1.62	1.45	1.35	1.11	1.11	1.11
Chemical and biological effects										
RF_{CH} - Reduction factor for chemical and biological effects at 20 °C										
	60 years				1.03	1.03	1.03	1.03	1.03	1.03
	120 years				1.05	1.05	1.05	1.05	1.05	1.05
f_s – Factor of safety					1.20	1.20	1.20	1.20	1.20	1.20
Friction										
Friction Coefficient (tan $\delta_{soil / Miragrid GX}$ / tan δ_{soil})										
CEN Norm Sand	(φ = 41°)				0.92	0.92	0.92	0.92	0.92	0.92
Sandy Gravel 0/8	(φ = 43°)				0.86	0.86	0.86	0.86	0.86	0.86
Gravel 0/32	(φ = 48°)				0.82	0.82	0.82	0.82	0.82	0.82
Gravel 0/45	(φ = 48°)				0.81	0.81	0.81	0.81	0.81	0.81

MD = machine direction / CD = cross direction

The values given are obtained in our laboratories and in accredited testing institutes. The information given in this datasheet is to the best of our knowledge true and correct. However new research results and practical experience can make revisions necessary. The right is reserved to make changes without notice at any time. No guarantee or liability can be drawn from the information mentioned herein.

TENCATE GEOSYNTHETICS EUROPE
Schachermayerstr. 18,
A-4021 Linz – Austria

Tel. : +43 732 69830 / Fax : +43 732 6983 5353
www.tencate.com
service.at@tencate.com

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1. General
Miragrid GX geogrids are engineered materials suitable for short and long term soil reinforcement applications.

To use Miragrid GX geogrids in soil reinforcement applications an assessment of their load carrying capabilities for different design lives is required. Several assessments procedures have been proposed each adopting the use of the partial material factor approach to describe the behaviour of the reinforcement material over time under specific load and environmental regimes. The procedure adopted in this Miragrid GX design properties sheet is in accordance with the BS 8006 standard. The procedure utilises the following reduction factor approach to determine long term design strengths for the reinforcement materials at different design lives:

$$T_D = \frac{T_{DU}}{(RF_{CR} \times RF_{ID} \times RF_W \times RF_{CH} \times f_s)}$$

where:

- T_D is the long-term strength;
- T_{DU} is the unfactored long-term strength (characteristic strength);
- RF_{CR} is the reduction factor to allow for the effect of sustained static load;
- RF_{ID} is the reduction factor to allow for the effect of mechanical damage;
- RF_W is the reduction factor to allow for weathering;
- RF_{CR} is the reduction factor to allow for chemical and biological effects;
- f_s is a safety factor to allow for statistical variations in the predicted reduction in strength due to installation damage and chemical degradation and to allow extrapolation uncertainty.

2. Tensile strength-strain properties
Miragrid GX geogrids are composed of high modulus polyester fibres knitted in a flat orientation and covered with a protective polymeric coating that enables maximum load carrying efficiency.

The characteristic tensile strengths of the various Miragrid GX grades are listed at the front of this design sheet. The tensile strength-strain master curve for Miragrid GX geogrids is shown in Figure 1. The ordinate values are expressed in terms of a percentage of nominal tensile strength. Thus, this one master curve may be used for all Miragrid GX grades by converting the percentage values into actual strength values for individual grades.

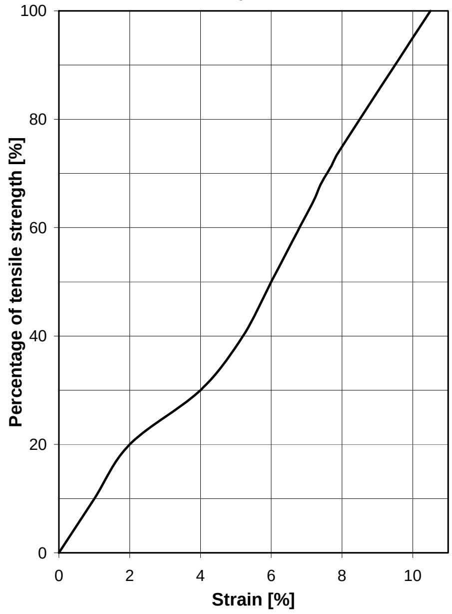

Figure 1: Strength-strain master curve for Miragrid GX geogrids.

3. Creep and creep rupture, RF_{CR}
Creep-rupture, or lifetime under sustained load, is determined by measuring times to rupture of up to a year at higher loads. The results are extrapolated to predict longer lifetimes at lower loads and thereby the reduction factor RF_{CR}. This procedure may be supported by measurements at higher temperatures. Figure 2 shows the creep rupture curve for Miragrid GX geogrids, determined according ISO 13431 and stepped isothermal methods. It should be noted that a creep-rupture diagram depicts applied load plotted against time to rupture and is not a statement of loss of strength. It has been predicted on the basis of accelerated tests that many geosynthetics exposed to sustained load do not in fact diminish in strength until close to the end of their predicted life.

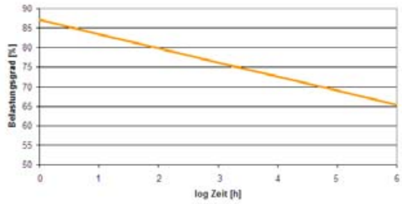

Figure 2: Creep rupture curve for Miragrid GX geogrids

From Figure 2 values of RF_{CR} can be obtained for different design lives. For example, at a 10 year design life Miragrid GX shows a 69% strength retention which equates to a reduction factor RF_{CR} = 1.45 (=1.00/0.69). Similarly, 60 and 120 year design lives have values of RF_{CR} = 1.51, and 1.56 respectively. These values are listed in the property table at the front of this sheet.

4. Installation damage, RF_{ID}
Coarse backfills and heavy compaction loads can damage geosynthetics, causing an immediate reduction in strength. The effect is referred to ad Installation Damage and the corresponding reduction factor as RF_{ID}. The magnitude of RF_{ID} is dependent on the structure of the reinforcement, the aggressiveness of the soil placed either side of the reinforcement, the fill thickness and the level of compaction performed. Values of RF_{ID} are derived from field tests according ISO 13437. Table 1 lists values of RF_{ID} for Miragrid GX geogrids for a variety of soil conditions.

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Soil combinations	Particle size		Miragrid GX grades					
	d_{max}	d_{50}	35	55	80	110	160	200
Cohesive soil	-	0,04 mm	1.09	1.08	1.06	1.06	1.06	1.06
Sandy gravel	32 mm	8,5 mm	1.14	1.15	1.15	1.14	1.05	1.05
Sandy gravel	63 mm	20 mm	1.31	1.10	1.14	1.10	1.08	1.08
Gravel	125 mm	20 mm	1.62	1.45	1.35	1.11	1.11	1.11

Table 1: Values of RF_{ID} for Miragrid GX geogrids.

Interpolation may be made for other products within the product line of the subject product, provided that a relationship can be established between the unit weight or tensile strength.

5. Weathering, chemical and biological degradation, RF_W, RF_{CH}

Polymers are susceptible to environmental degradation due to weathering, including exposure to ultra-violet light, to chemical attack and to biological attack. All three effects are further influenced by temperature and for some polymers by moisture uptake.

Weathering

The requirements for weathering are related to the duration of exposure during storage and on site. If the geosynthetic is exposed to UV light for a maximum of 12 hours, no reduction factor is needed. If the exposure time is longer, then the geosynthetic should undergo the accelerated weathering index test to ISO 12959 or EN 12224. Since Miragrid GX geogrids rolls are covered with an UV stable wrapping and are in general covered within a couple of hours a RF_W of 1.0 is used.

Chemical degradation

The principal cause of degradation for polyester geosynthetics is by hydrolysis. The rate of hydrolysis is slow at typical soil temperatures. The rate of hydrolysis will be less if the soil is partially instead of fully saturated. Alkaline liquids with pH > 10 can in addition erode the fibre surface.
High molecular weight polyester Miragrid GX geogrids are not easily broken down by bacteria and fungi. For this reason it is not necessary to consider biological degradation in defining RF_{CH}.

Table 2 lists values of RF_{CH} where the soil pH ≤ 9.

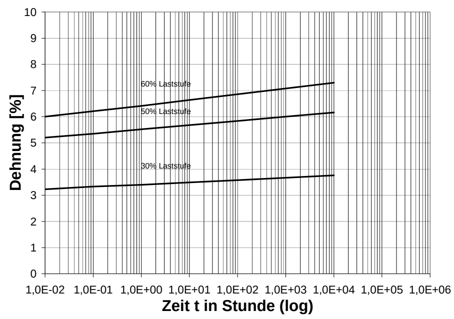
Miragrid GX design life in years	Values of RF_{CH}
	4< pH ≤ 9
60	1.03
100	1.04
120	1.05

Table 2: Values of RF_{CH} for Miragrid GX geogrids at 20˚C and 100% saturated soil.

6. Creep strain properties

In addition to the design strength of the reinforcement an assessment for strain over time also may be required in order to satisfy specific serviceability requirements. There are two components of strain – initial strain and creep strain and both components need to be assessed.
In reinforced soil structures strains occur as a result of strains developing in the Miragrid GX geogrid reinforcements. For Miragrid GX geogrids initial strains may be determined by use of either Figure 1 or the curve for time = 0 in Figure 3b.
Miragrid GX geogrids, being composed of high modulus polyester fibres, exhibit very low creep strains even at high tensile load levels. Figure 3a shows creep strains of only 1.00% over 10.000 hours at load levels approaching 50% of initial tensile strength. This would extrapolate to creep strains less than 1,5% over a 120 year design life at a design load of 50% of initial tensile strength.
Both the initial strain and the creep strain properties of Miragrid GX geogrids are shown in Figure 3b.

3a) Isostress creep curves



3b) Isochronous creep curves

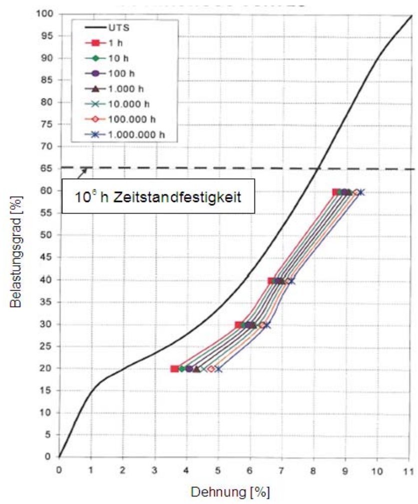


Figure 3: Creep-strain time curves for Miragrid GX geogrids.