

ProGrid® 20/20 Supporting Document

Biaxial Extruded Polypropylene Geogrid

Stiff and high modulus reinforcing and stabilising geogrid



Introduction

ProGrid biaxial extruded geogrid has an established successful history of use in a wide range of civil engineering applications across Australia. This technical document is designed to provide reassurance supporting the use of ProGrid® as a equivalent or superior geogrid to Tensar TriAx TX160 triaxial extruded geogrid.

Geogrid Properties and Performance Parameters

According to research over the past 30 years and references published by international and local road authorities including US Department of Transportation (US DOT), Federal Highway Administration (FHWA), and the available best practice/specification for geogrid reinforcement in Australia developed by QLD Transport and Main Roads (TMR) in 2015, MRTS58, the performance of a geogrid reinforced section depends on the geogrid performance parameters below:

1. Geogrid secant stiffness at 2% elongation/geogrid tensile strength at low elongation (The most important performance parameter)
2. Geogrid installation damage resistance
3. Junction performance
4. Torsional rigidity (geogrid aperture stability by in-plane rotation due to interlocking with aggregates)
5. Ultimate tensile strength

These properties are discussed separately in coming sections. A full comparison table comparing the above properties for ProGrid® 20/20 and TX160 geogrids is provided in Appendix 1, which shows equivalent superior values for the above parameters for both products.

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Geogrid Secant Stiffness at 2% Elongation

According to last 30 years research works, laboratory testing and field monitoring, the maximum strain in the geogrid during traffic on geogrid reinforced roads is 1%-2%. Geogrid stiffness is the strength of geogrid at low elongation, which is the most important tensile performance geogrid property.

Geogrid secant stiffness is the strength of geogrid at low elongation (2% strain). secant stiffness of a geogrid at 2% strain is calculated by dividing the tensile strength at 2% strain, by the strain value (2%).

Results show a higher secant stiffness value for ProGrid® 20/20 (350 kN/m) compared to TX160 (225 kN/m):

Secant stiffness at 2% for ProGrid® 20/20 $\geq 7 \text{ (kN/m)} / 0.02 = 350 \text{ kN/m}$

Secant stiffness at 2% for TX160 $\geq 225 \text{ kN/m}$ (Note 1)

NOTE 1: The TX160 data sheet shows secant stiffness value as 290 kN/m with the tolerance of -65 kN/m. Therefore, the minimum secant stiffness value will be $290 - 65 = 225 \text{ kN/m}$. Both data sheets are presented in Reference: manufacturers technical specification and data sheet

Geogrid Installation Damage

If a geogrid is damaged during placement and compaction of the granular layer, it will not provide the designed and anticipated performance. Geogrid installation damage resistance is the most important durability requirement for a geogrid reinforced road.

Independent test results show installation damage resistance of 98% to 100% for ProGrid®, while the installation damage resistance for TX160 is 87% according to its data sheet.

In addition, a full-scale field trial has been conducted on different products including biaxial extruded geogrid and triaxial extruded geogrid (TX160) by US Department of Transportation (USDOT) which has shown no damage on extruded biaxial geogrid and a high damage to triaxial extruded geogrids (TX160) products (reference: FHWA/MT-14-002/7712-251, page 125):

“[Triaxial extruded geogrid] sustained the greatest rib damage of all the materials in this study. Forensic excavations of the Tensar TX140 and TX160 materials conducted immediately after trafficking in area of high rut revealed that these materials had ruptured.”

Junction Performance

Geogrid junction stiffness is the important junction strength requirement for road application. For extruded geogrids, junction performance can be shown as junction efficiency. Test results show equivalent or higher junction efficiency for ProGrid® compared to TX160 (Reference: Manufacturers Technical Specification):

1. Junction efficiency for ProGrid® 20/20 = 100%
2. Junction efficiency for TX160 = 100% (-10% tolerance, which makes the minimum value 90%)

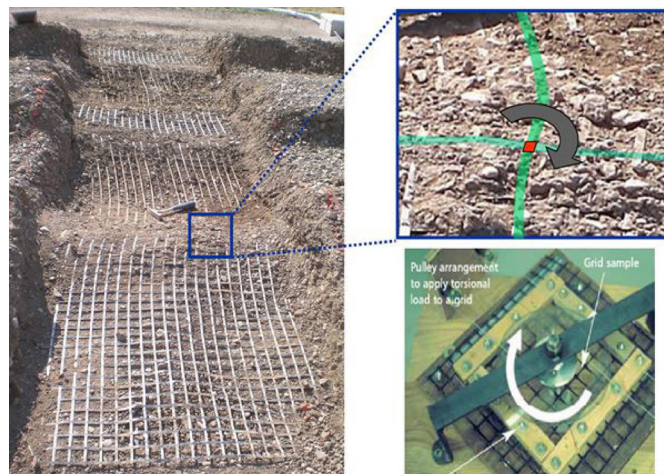
Torsional Rigidity/Aperture Stability

The main effect which is improving the bearing capacity would be related to the stiffness of the geogrid and its ability to interlock with the base course material. Several tests have been carried out with the “Geogrid Aperture Stability by In-Plane Rotation” test (called Torsional Rigidity or Torsional Stiffness), showing a particularly good correlation to the large-scale test results by US Army Corps of Engineers. Research results concluded that geogrids with high torsional rigidity behaved superiorly to geogrids with less torsional stability due to more effective interlocking and lateral restraint of the granular material.

Test results (Reference: manufacturers technical specification and data sheet) show a **higher torsional rigidity/aperture stability for ProGrid® 20/20 (0.5 m-N/deg) compared to TX160 (0.39 m-N/deg):**

torsional rigidity/aperture stability for ProGrid® 20/20 = 0.5 m-N/deg

torsional rigidity/aperture stability for TX160 = 0.39 m-N/deg (Note 2)



NOTE 2: The data sheet reports this value as mm-N/deg, which can be converted to m-N/deg by dividing that value by 1000)

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Geogrid Installation Damage

The ultimate tensile strength of a geogrid is important for the durability and long-term performance of the geogrid and the reinforced pavement. Higher tensile strength can guarantee a higher durability, more tensile capacity, and longer performance under cyclic loads.

The ultimate tensile strength of ProGrid® 20/20 is 20 kN/m. While the ultimate tensile strength of TX160 is not published in the data sheets, independent test results including FHWA/MT-14-002/7712-251 report by US DOT shows a low tensile capacity of about 13kN/m:

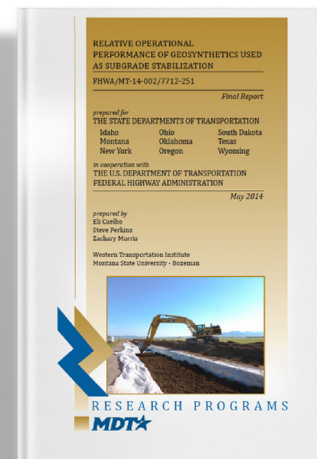
Summary of Wide-Width Tensile Strength Test Results from WTI

Geosynthetic Test Section	Strength @ 2% ^a (lb/ft)					Strength @ 5% ^a (lb/ft)		Ultimate Strength ^a (lb/ft)				Strain at Ultimate Strength (%)	
	MD	kN/m	XMD	kN/m	MD	MD	XMD	MD	kN/m	XMD	kN/m	MD	XMD
Tensar TX160	69 ^d	1.0	391	5.7	260 ^d	260 ^d	747	754 ^d	11	884	13	9.4	6.7

Full Scale Performance Test Results

The performance of different geogrid types has been tested and investigated by independent full-scale field trials and laboratory tests worldwide, as well as local field measurements and on-site testing in various projects in Australia.

The most important independent full-scale field trial was conducted by US Department of Transportation (US DOT) and Montana State University. Test results showed the highest performance for biaxial extruded and welded geogrids compared to other tested geogrids (including triaxial geogrids). In this trial, triaxial geogrids showed the lowest performance (see Table 1 reference: FHWA/MT-14-002/7712-251):



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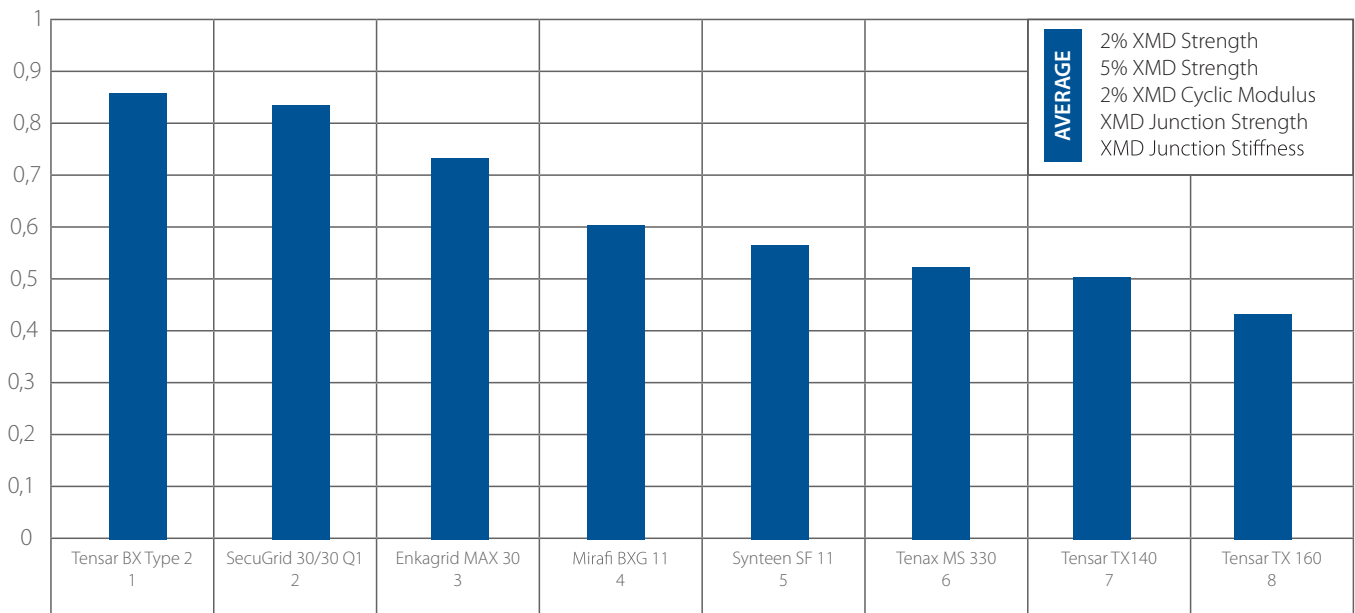


Table 1: Correlation of averaged "Performance Parameters" vs. performance of geogrid test sections

Appendix 1

Comparison between ProGrid® and Tensar TX				
Property	Test Standard	Units	ProGrid® 20/20	Tensar TX 160(1)
Polymer	-	-	Polypropylene	Polypropylene
Ultimate Tensile Strength (MD/CMD)	ASTM D7737-11/ ISO 10319	kN/m	20/20	11/13 ⁽²⁾
Elongation @ Break	-	%	10	10
Tensile Strength @ 2% Strain (MD / CMD)	ASTM D7737-11/ ISO 10319	kN/m	7	4.5
Tensile Strength @ 5% Strain (MD / CMD)	ASTM D7737-11/ ISO 10319	kN/m	14	4 / 10 ⁽²⁾
Secant Stiffness Modulus @ 2% Strain [=Tensile Strength @ 2% Strain / 0.02]	ASTM D7737-11/ ISO 10319	kN/m	350	≥ 225
Retained strength After Installation Damage	ASTM D5818-11/ BS8006	%	> 98	87
Aperture Stability @ 5cm-kg Torque	ASTM D786	M-n/degree	0.5	0.39

(1) Reference: Tensar Technical Notes and CE Standards Document

(2) Reference: Recent Independent Test by Montana State University and FHWA (FHWA/MT-14-002/7712-251) for US Department of Transport, May 2014

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ProGrid® 20, 30 & 40

GEOGRIDS – BIAXIAL STRENGTH POLYPROPYLENE SOIL REINFORCEMENT GEOGRIDS

DESCRIPTIONS

ProGrid® geogrid is formed by punching holes and stretching a stiff plastic sheet to form a geogrid with uniform openings to contain and absorb lateral forces exerted on the reinforcement from implied loads. The transfer of implied loads to the geogrid is by way of a combination of friction and interlocking with the surrounding granular particles. ProGrid® geogrids provide a stiff, high modulus reinforcing layer to allow the construction of roads and other amenities over weak subgrades.

APPLICATIONS

- Sub Base reinforcement
- Raft reinforcement construction
- Soil reinforcement

Typical Properties	Test Method	Unit	20 / 20	30 / 30	40/40
Geogrid			Polypropylene (PP)		
Ultimate Tensile Strength (MD/CD)	ASTM D4595 or EN ISO 10319 / ASTM D6637	kN/m	20/20	30/30	40/40
Strain @ Ultimate Strength (MD/CD)	ASTM D4595 or EN ISO 10319 / ASTM D6637	kN/m	13/13	13/13	13/13
Tensile Strength @ 2% Strain (MD/CD)	ASTM D4595 or EN ISO 10319 / ASTM D6637	kN/m	7/7	11/11	14/14
Tensile Strength @ 5% Strain (MD/CD)	ASTM D4595 or EN ISO 10319 / ASTM D6637	kN/m	14/14	22/22	28/28
Junction Efficiency (MD/CD)	ASTM D7737/D7737M-15	%	100	100	100
Aperture Size (MD/CD)		mm	38/43	34/41	37/43
Aperture stability	ASTM D 7864	N-m/degree	0.50	0.75	0.98
Installation damage resistance	ASTM D5818 or ISO 10722	%	98	98	98
Radial stiffness @ 0.5% strain	ASTM D4595 or EN ISO 10319 / ASTM D6637	kN/m	≥ 350	≥ 550	NA
Roll Dimensions		m	3.95 x 50	3.95 x 50	3.95 x 50

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- Water Management
- Drainage Systems & Hydraulic Works
- Landfills
- Coastal Erosion Structures

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