Synteen Technical Fabrics, Inc.

PROUDLY MADE IN THE USA by Synteen
Lancaster, South Carolina

SYNTEEN TF120 TYPE 2 GEOGRID

BASE COURSE REINFORCEMENT AND SUBGRADE IMPROVEMENT

1. The geogrid is comprised of high molecular weight, high-tenacity multifilament polymer blend, manufactured into a stable network placed under tension.
2. The properties contributing to the performance of a mechanically stabilized layer are demonstrated as follows:

INDEX PROPERTIES

Aperture Size(2)	1.0" x 1.0"	
Aperture Shape	Rectangular	
Rib Shape	Rectangular	
Nodal Thickness(2), mm (in)	2.4 (.08)	

STRUCTURAL INTEGRITY

Junction Efficiency(3), %	MD: 100% - XMD: 100%	
Aperture Stability(4), kg-cm/deg @ 5.0kg-cm	12.5	
Min. Radial Stiffness at Low Strain (5), kN/m @ 0.5% Strain	3,012	178,000lbs/ft
Max. Radial Stiffness at Low Strain(5) kN/m @ 0.5% Strain	4,270	292,515lbs/ft

DURABILITY

Resistance to Chemical Degradation(6)	100%
Resistance to Ultraviolet Light(7)	86%

Dimensions and Delivery

Roll sizes are 12' x 150', 15' x 150' and 17' x 150'. Each roll is individually wrapped and identified with roll and lot numbers.

Notes

1. Unless otherwise indicated, values shown are minimum average roll values determined in accordance with ASTM D4759-02.
2. Nominal dimensions.
3. Efficiency calculated pursuant to FHWA Sum of the Junctions and expressed as % of ultimate tensile strength.
4. In-plane torsional rigidity measured by applying a moment to the central junction of a 225mm x 225mm specimen restrained at its perimeter in accordance with U.S. Army Corps of Engineers Methodology for measurement of Torsional Rigidity.
5. Radial Stiffness is determined from tensile stiffness measured in any in-plane-axis in conjunction with ASTM D 6637- 01.
6. Inert to biological degradation and resistant to naturally encountered chemicals, alkalis and acids found in soils.
7. Resistance to loss of load capacity when subjected to 500 hours of UV light in accordance with ASTM D4355-05. All rolls are individually wrapped in UV protected wraps to insure minimal exposure.

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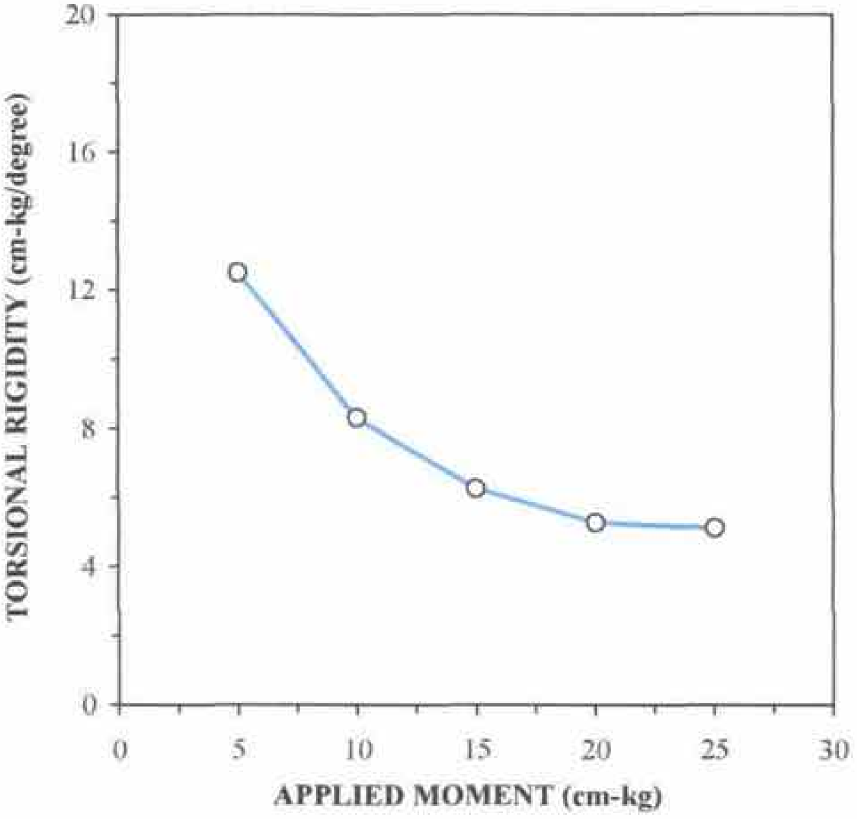
SYNTEEN TECHNICAL FABRICS, INC.

APERTURE STABILITY MODULUS (GRI-GG9) - Thomas C. Kinney Method

TF120 Geogrid, Loom # 9, Roll No: 211/171/01-01
SGI Lab Sample ID: S16140



Test No.	Applied Moment (M) (cm-kg)	Rotation at Each Loading Cycle (α)					Torsional Rigidity[1] $T_R = M/a$	
		1 (degree)	2 (degree)	3 (degree)	4 (degree)	Average (degree)	(cm-kg/deg)	(N-m/deg)
1	5	0.4					12.5	1.23
2	10	1.2					8.3	0.82
3	15	2.4					6.3	0.61
4	20	3.8					5.3	0.52
5	25	4.9					5.1	0.50

NOTE (1) The torsional rigidity is defined as the applied moment divided by the average rotation of four loading cycles.

SGI TESTING SERVICES, LLC

DATE REPORTED:	8/24/2011
FIGURE NO.	2
PROJECT NO.	SGI10013
DOCUMENT NO.	
FILE NO.	

GEOGRID TEST RESULTS

TRI Client: Synteen Technologies

Material: TF 120 Synteen Geogrid
Roll # 211-053-01-90 Loom 9
TRI Log #: E2352-58-05 **Test Date: March 28, 2011**

PARAMETER	**TEST REPLICATE NUMBER**										**MEAN**	**STD. DEV.**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**		
Junction/Node Strength (GRI GG2)												
MD Maximum Junction Strength (lbs)	55	41.0	70.3	74.2	59.7	57.2	75.2	54.0	69.7	58	**61.3**	10.6
TD Maximum Junction Strength (lbs)	103	71.5	76.6	39.7	68.0	79.2	100	72.8	84.0	85.2	**78.0**	17.8

MD - Machine Direction TD - Transverse/Cross Machine Direction

Sample Material designation revised per client's request.

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior approval of TRI.

Synteen

www.synteen.com

Junction Strength/ Junction Efficiency

Junction strength tests only measure how much passive resistance might be transferred through the junction. This test is only *one* component of pullout performance. Stress transfer, surface friction and normal loads on the junctions are not measured by the junction strength test and are critical components of pullout performance for most geogrids. Measured performance by in-soil testing is a fair and unbiased performance measurement.

Use of junction strength alone to evaluate pullout performance is inaccurate and creates a bias toward products with high junction strength. Junction strength is a specific product feature without discernible or quantifiable values.

Indeed, designers that specify high junction strength requirements "exaggerate the importance of a single junction to the overall performance of the geogrid." As a tensile reinforcement, the geogrid must be able to engage the soil, by transferring the generated tensile loads into soil shear stress and/or passive resistance. It does this over a pullout length that is significantly in excess of a single junction, and controlled directly by the available soil shear strength. The direct measurement of this load transfer efficiency is the pullout coefficient of interaction.

Soil confinement is why all geogrids work well. However, the effects of confinement are equally crucial to modulus of the geogrid (increasing), and more importantly, the composite reinforced soil mass modulus. It is the composite modulus of the reinforced soil mass that controls behavior, which as of yet has been difficult to predict, particularly when using geogrid properties from index tests performed in isolation (air), and hence lack of correlation to performance.

State DOTs and the geogrid industry are moving toward a "sum of the junction strength criteria" which "ensure for geogrids, junction strength adequate to prevent failure of the grid joint throughout the design life of the structure."(Elias and Christopher, 1997).

The "sum of the junction strength" criteria: ***The minimum junction strength shall be greater than the ultimate unit strength (kN/m or lbs/ft) of a product, divided by the number of junctions present in a unit area (sq.m. or sq. ft.) of the same product. ASTM D-6637 shall define the ultimate tensile strength and the junction strength shall be defined by GRI-GG2.***

TF 120 91 junctions in a square foot X 61.1 lbs per junction (MD) = 5580 lbs /ft^2
91 junctions in a square foot X 78.0 lbs per junction (XMD) = 7098 lbs/ft^2
TF 120 Ultimate Strength 2388 lbs/ft 5268 lbs/ft^2

The "sum of the junction strength" criteria also, adopted by FHWA (see insert), is an appropriate, cost effective and conservative design alternative to specifications that deem pullout resistance. survivability, stiffness, and/or flexural rigidity as important. The "sum of the junction strength" criterion is a fair and unbiased manner to specify a minimum junction strength requirement for any project.

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EARTH IMPROVEMENT TECHNOLOGIES

March 22, 2012

Mr. Don Show
Synteen Technical Fabrics, Inc.
1950 W. Meeting St.
Lancaster, SC 29720

only sent electronically via E-mail

RE: **Calculation of Radial Stiffness for Synteen Geogrids**

EIT Project No.: **C12001**

Dear Mr. Show:

This letter is to document the calculation of "Radial Stiffness" for Synteen Geogrids. Radial stiffness is a mathematical representation of geogrid reinforcement capacity in directions other than the orthogonal (perpendicular) directions on which they are manufactured, and at which the product members are physically oriented. The orthogonal directions used in manufacturing Synteen geogrids are typically termed the Machine (roll length) Direction (MD), and the Cross-Machine (roll width) Direction (XMD). The tensile strength and tensile modulus of the MD and XMD are determined directly through testing according to ASTM D-6637. The Minimum Average Roll Values (MARVs) for MD & XMD tensile strength and modulus are routinely reported by the manufacturer on their Product Description Sheet (PDS). The MARV of MD and XMD tensile modulus at a specified strain, is utilized to calculate the minimum radial stiffness using force resolution techniques from physics, (i.e., static analysis of forces). The lowest radial stiffness for any of the examined force orientations is termed the minimum radial stiffness for the geogrid.

Attached please find example calculations for radial stiffness of **Synteen's TF-120 Type 2 geogrid**. The minimum radial stiffness is 178,000 lbs/ft at 0.5% strain, with maximum radial stiffness at 292,515 lbs/ft at 0.5% strain .

If there are any questions regarding these calculations, please call me.

Respectfully submitted,

Michael R. Simac

SOUTH CAROLINA REGISTERED PROFESSIONAL ENGINEER
No. 13138
MICHAEL R. SIMAC

March 22, 2012

Michael R. Simac, PE
Principal Engineer

Attachments: Calculation of Radial Stiffness for Synteen TF-120 Type 2 geogrid

TECHNICAL SERVICE for →

EARTH IMPROVEMENT TECHNOLOGIES

Synteen

1-800-SYNTEEN

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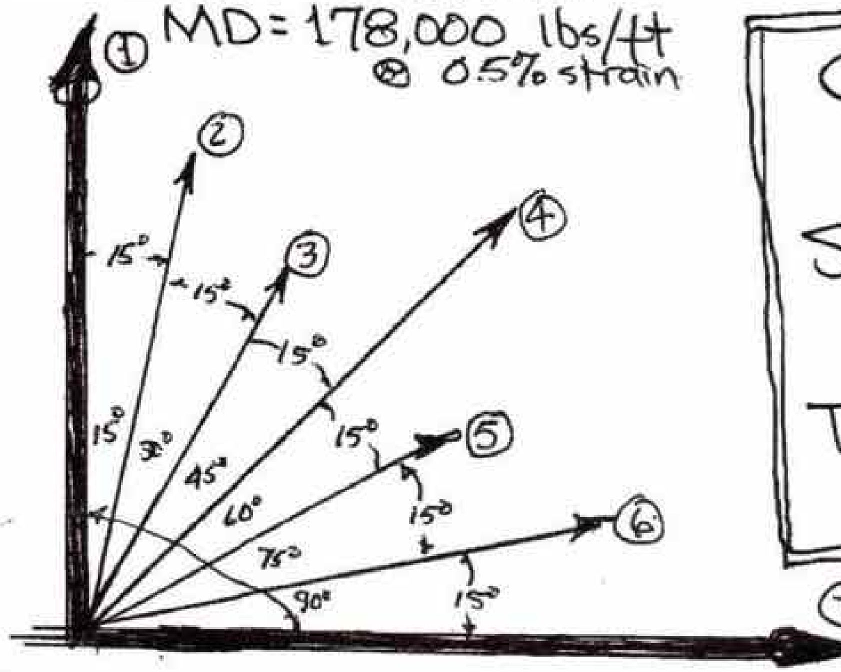
M.R. SIMAC 22-MARCH-2012

CALCULATE RADIAL STIFFNESS SYNTEEN TF-120 Type 2 GEOGRID.



NOTE: RADIAL STIFFNESS USES MODULUS @ 0.5% strain

POSITION:

Min. ① @ 0° = 178,000 (cos 0°) + 235,000 (sin 0°) = 178,000 lbs/ft.
② @ 15° = 178,000 (cos 15°) + 235,000 (sin 15°) = 232,757 lbs/ft
③ @ 30° = 178,000 (cos 30°) + 235,000 (sin 30°) = 271,652 lbs/ft
④ @ 45° = 178,000 (cos 45°) + 235,000 (sin 45°) = 292,035 lbs/ft
MAX. ⑤ @ 60° = 178,000 (cos 60°) + 235,000 (sin 60°) = 292,515 lbs/ft
⑥ @ 75° = 178,000 (cos 75°) + 235,000 (sin 75°) = 273,062 lbs/ft
⑦ @ 90° = 178,000 (cos 90°) + 235,000 (sin 90°) = 235,000 lbs/ft.

MINIMUM RADIAL Stiffness = 178,000 lbs/ft @ 0.5% strain
or 2,598 kN/m @ 0.5% strain.

MAXIMUM RADIAL Stiffness = 292,515 lbs/ft @ 0.5% strain
or 4,270 kN/m @ 0.5% strain

NOTE: to convert to kN/m, divide by 68.5