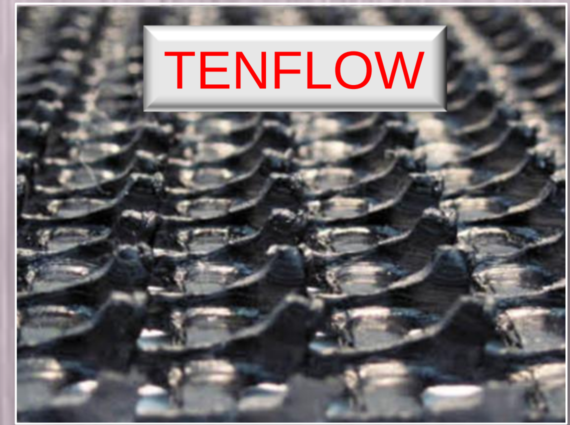
SYNTEC

GEOSYNTHETICS EVOLVED

SYNTEC

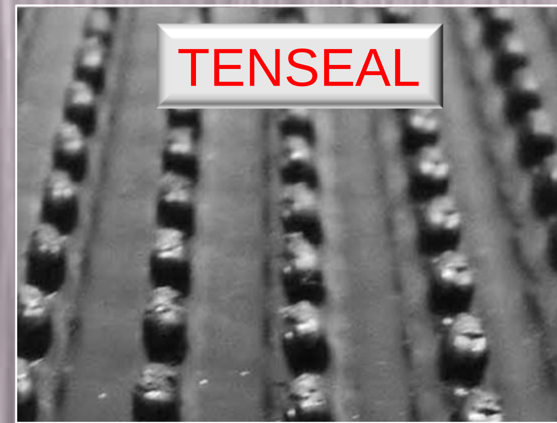
GEOSYNTHETICS EVOLVED

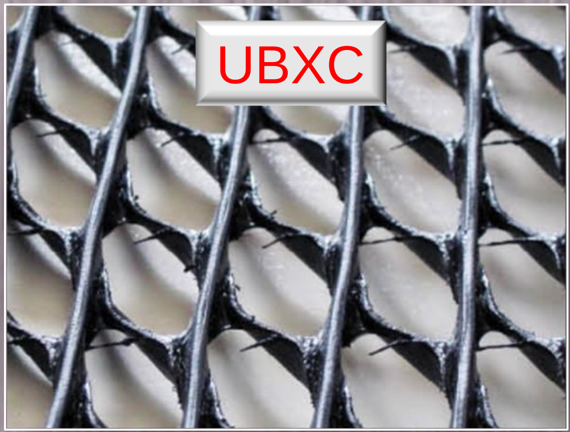
- Based in Baltimore Maryland
- Acquired Tenax Geocomposite product line in 2009
- Manufacturer of extruded Civil and Environmental geosynthetics
- Geosynthetic Engineering and Technical assistance
- Secured USA based production for Punched & Drawn Geogrids

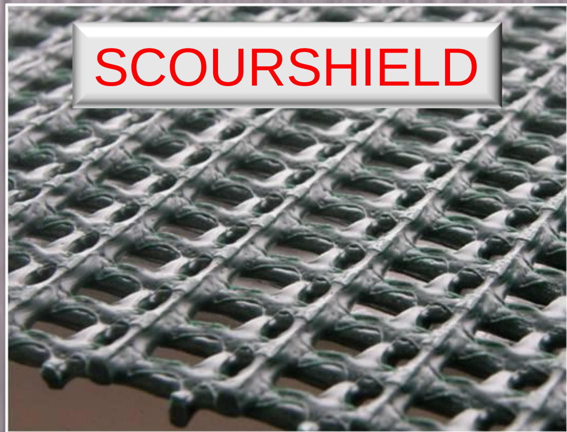


SYNTEC

GEOSYNTHETICS EVOLVED





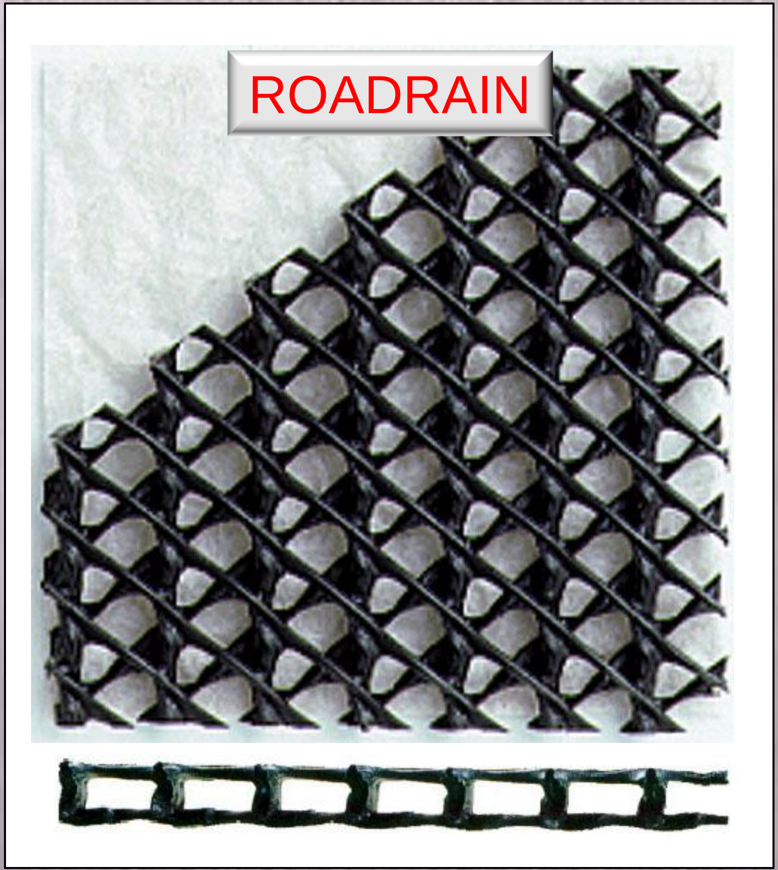


High load and high flow geocomposites for landfill expansions

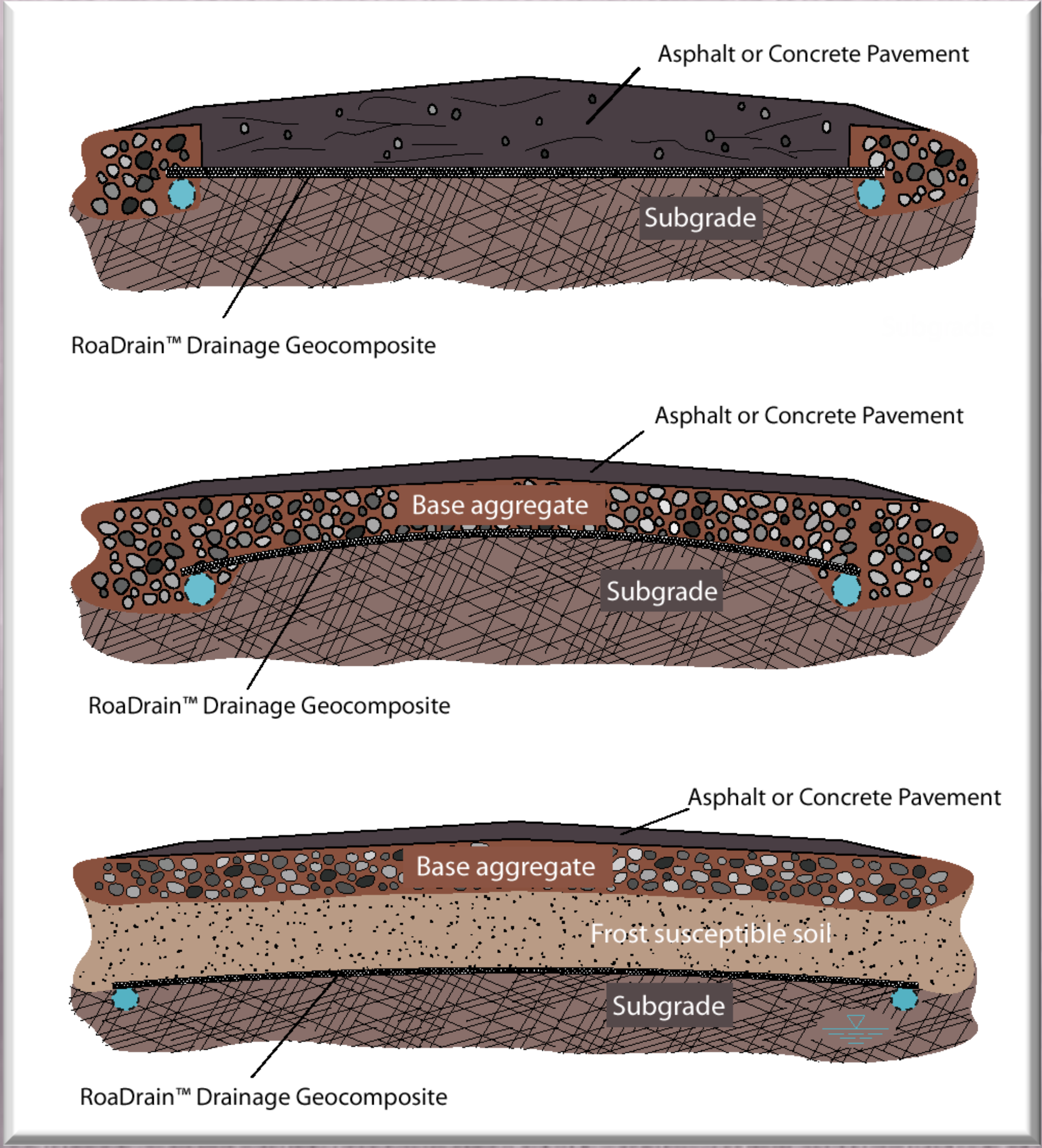
Drainage under concrete slopes for impoundments

Geotextile filter removed to show triplanar core

Synthetic subsurface drainage layer for pavement systems

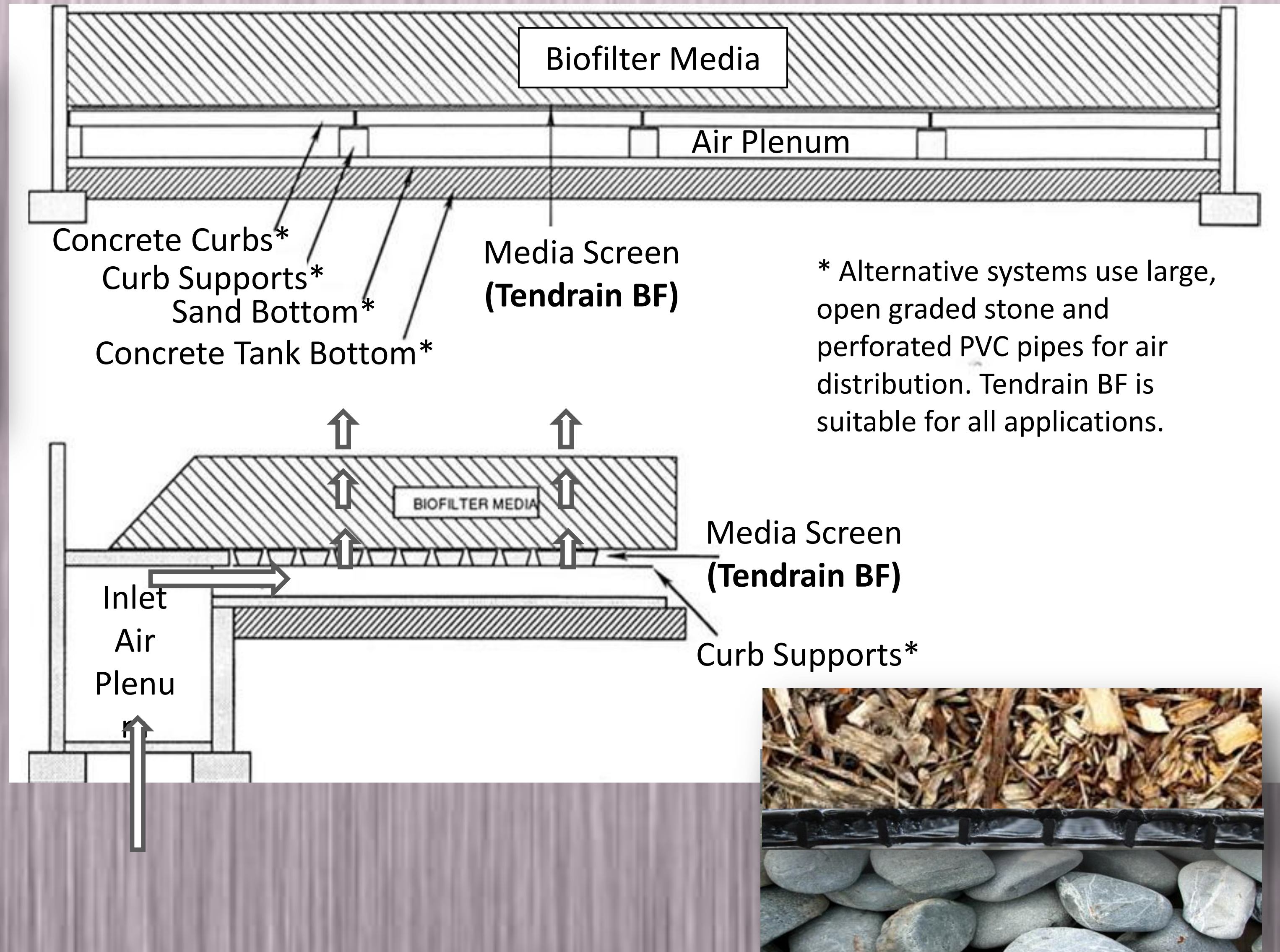


Geotextile filter removed to show triplanar core

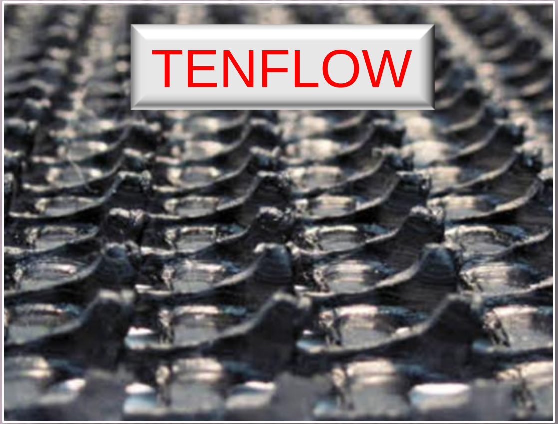


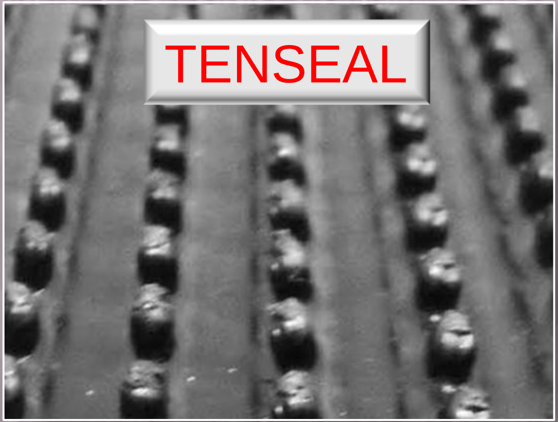
RoaDrain can be used in multiple ways to improve pavements

Grave replacement layer for concrete slabs

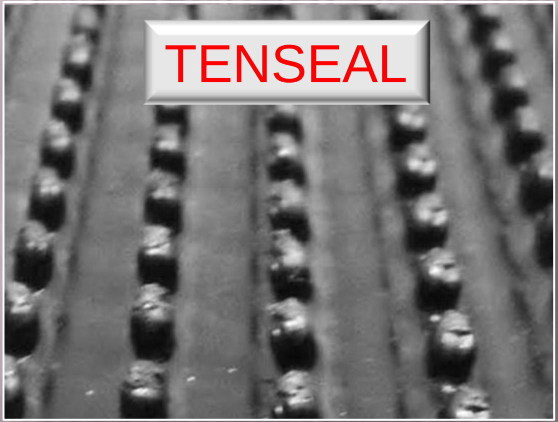


Odor control biofilter media screen Tendrain BF

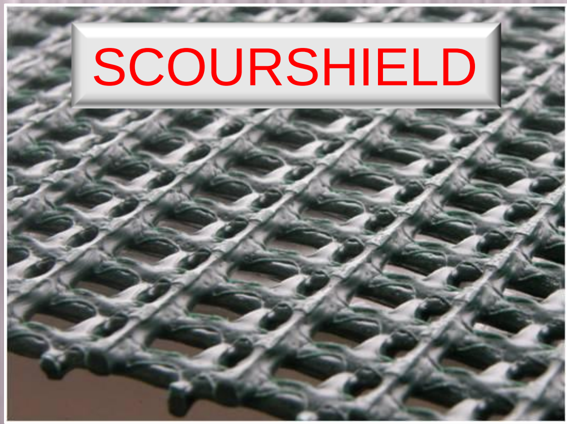




High flow drainage geocomposites



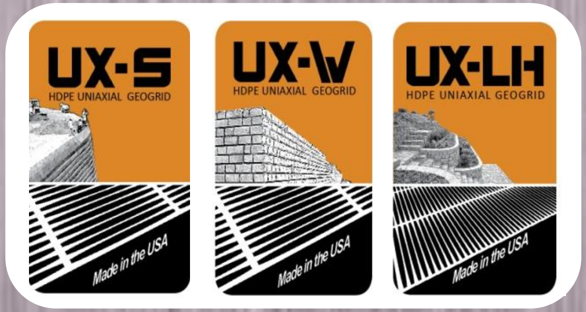
Innovative products for combined drainage and waterproofing



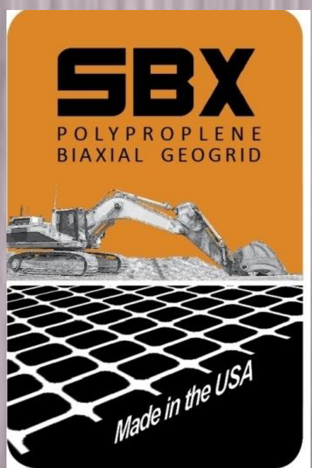
The flexible solution to scour protection

October 11, 2011 Syntec announced the launch of our own line of punched and drawn geogrids manufactured in the USA:

SBX biaxial geogrids & UX Series uniaxial geogrids



Uniaxial geogrids for mechanically stabilized earth structures

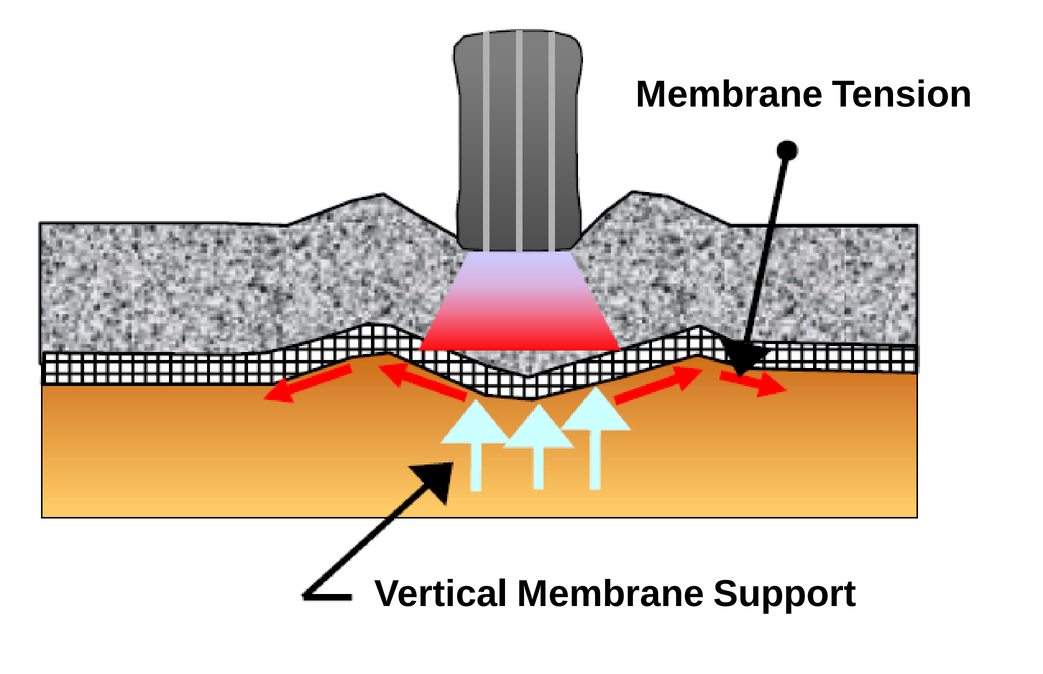


Subgrade stabilization (CBR <4)

Base Reinforcement (CBR >4)

Geogrid Reinforcement Mechanisms:

1) Tensile Membrane Effect
2) Improved Bearing Capacity
3) Lateral Restraint

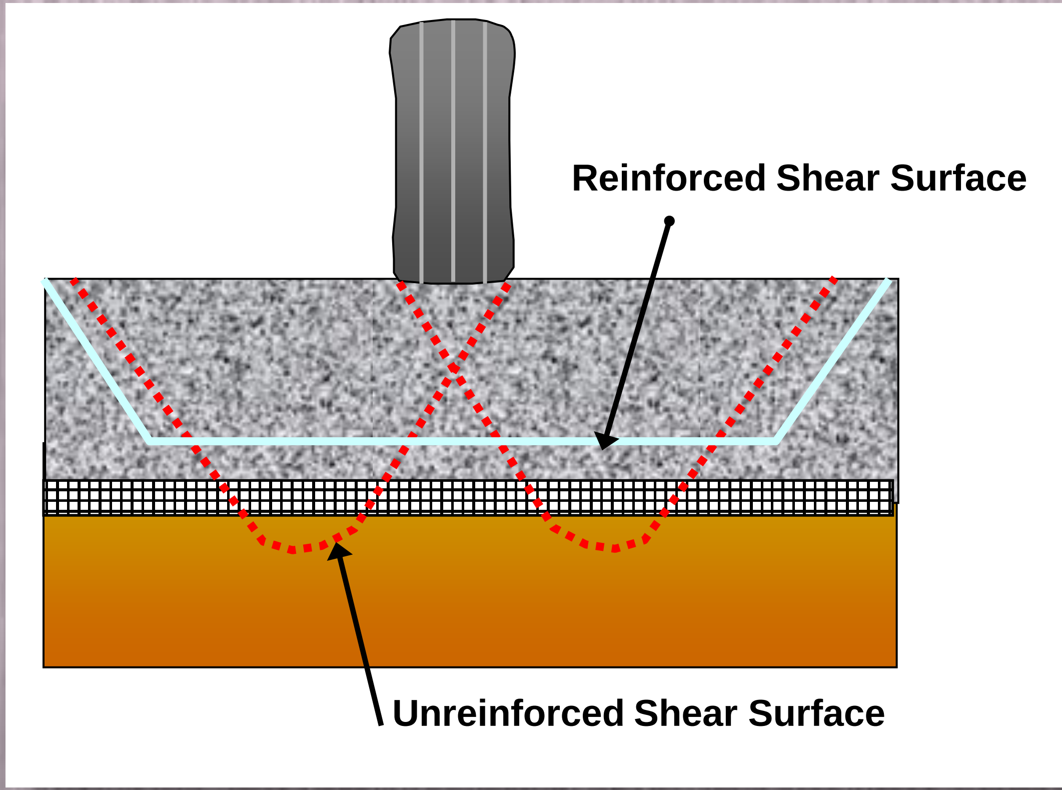


- Primary reinforcement mechanism found in geotextiles
- Thought to be the primary reinforcement mechanism for geogrids prior to extensive research
- Considered now to be minimal in relation to lateral restraint mechanism, particularly in subgrade improvement

Source: USACOE ETL 1110-1-189

Geogrid Reinforcement Mechanisms:

1) Tensile Membrane Effect
2) Improved Bearing Capacity
3) Lateral Restraint

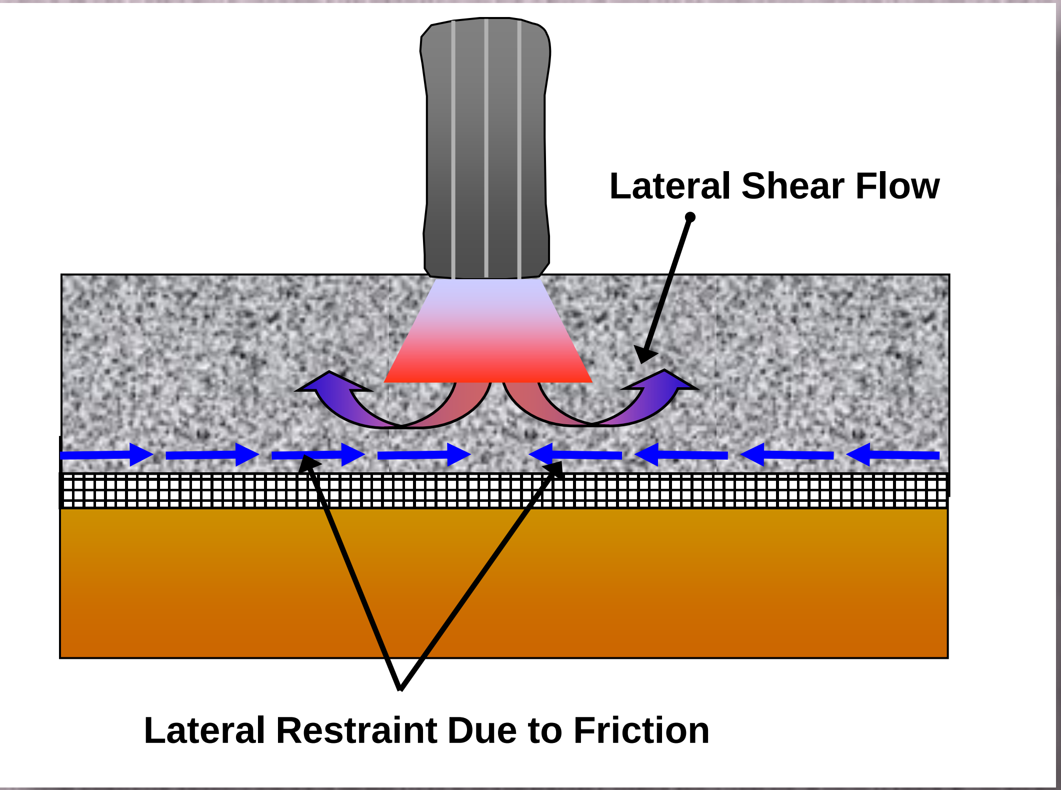


- Shifting failure envelope from the weak subgrade to the stronger base material
- Results in enhanced bearing capacity of the subgrade without soil treatment or undercutting

Source: USACOE ETL 1110-1-189

Geogrid Reinforcement Mechanisms:

1) Tensile Membrane Effect
2) Improved Bearing Capacity
3) Lateral Restraint

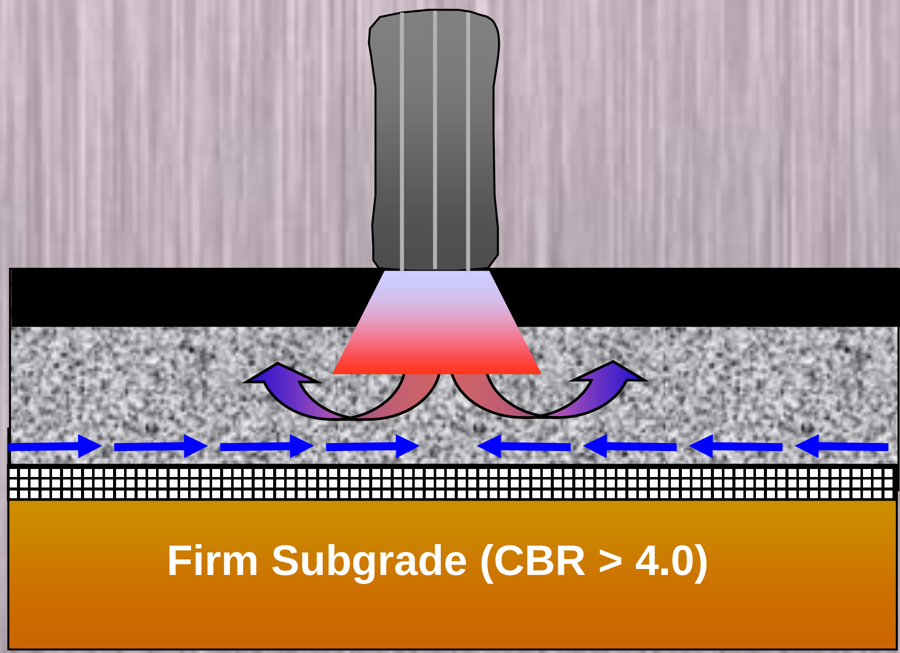


- Confinement of the aggregate base during loading
- Results in increased modulus of the base material (**Residual Stress**)
- Improved/reduced vertical stress distribution applied to pavement subgrade

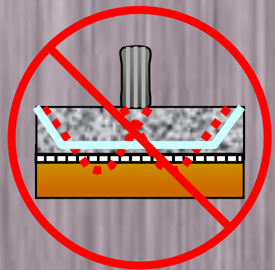
Source: USACOE ETL 1110-1-189

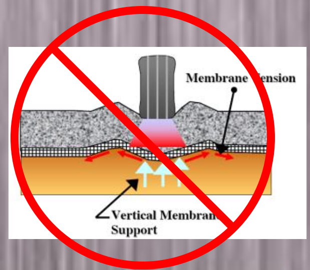
SBX Biaxial Geogrids:
Base Reinforcement vs. Subgrade Improvement

Base Reinforcement

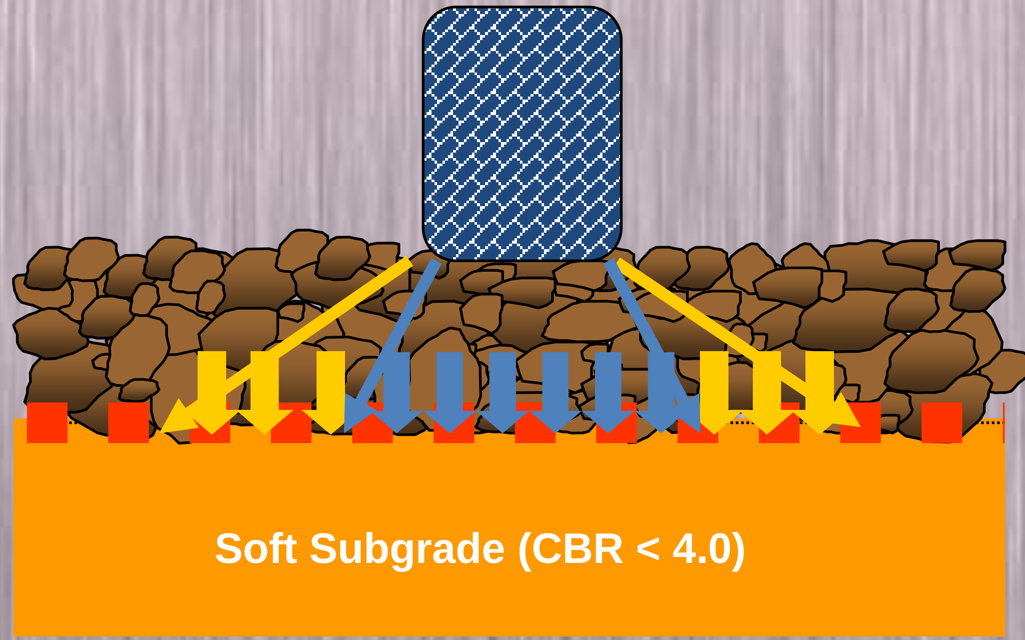


- Lateral Restraint



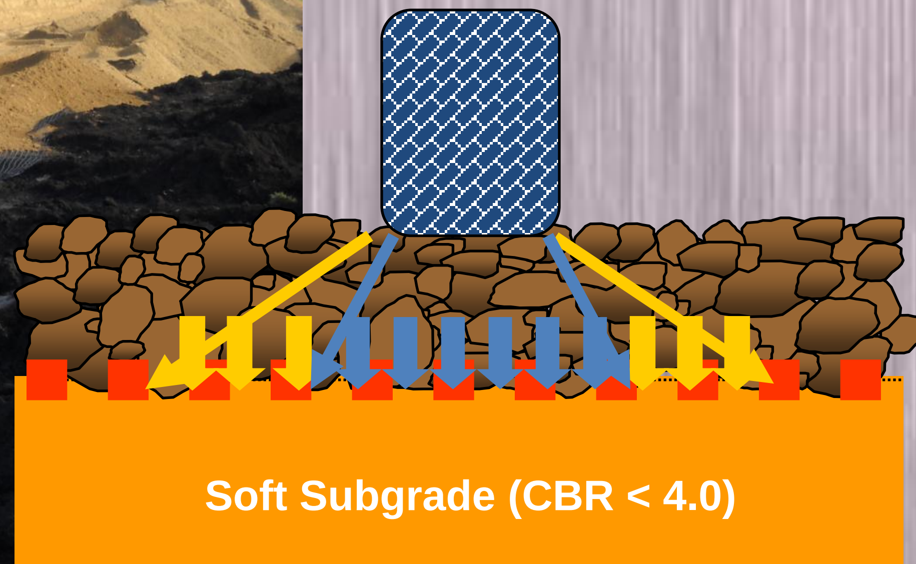


Subgrade Improvement



- Improved Bearing Capacity
- Tensile Membrane Effect
- Lateral Restraint

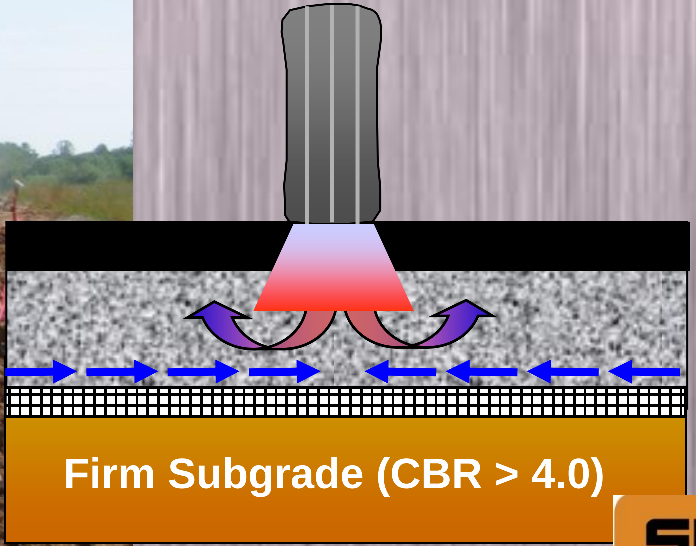
SBX Biaxial Geogrids:
Base Reinforcement vs. Subgrade Improvement



Facilitate construction over soft soils (CBR <4)

SBX Biaxial Geogrids:
Base Reinforcement vs. Subgrade Improvement

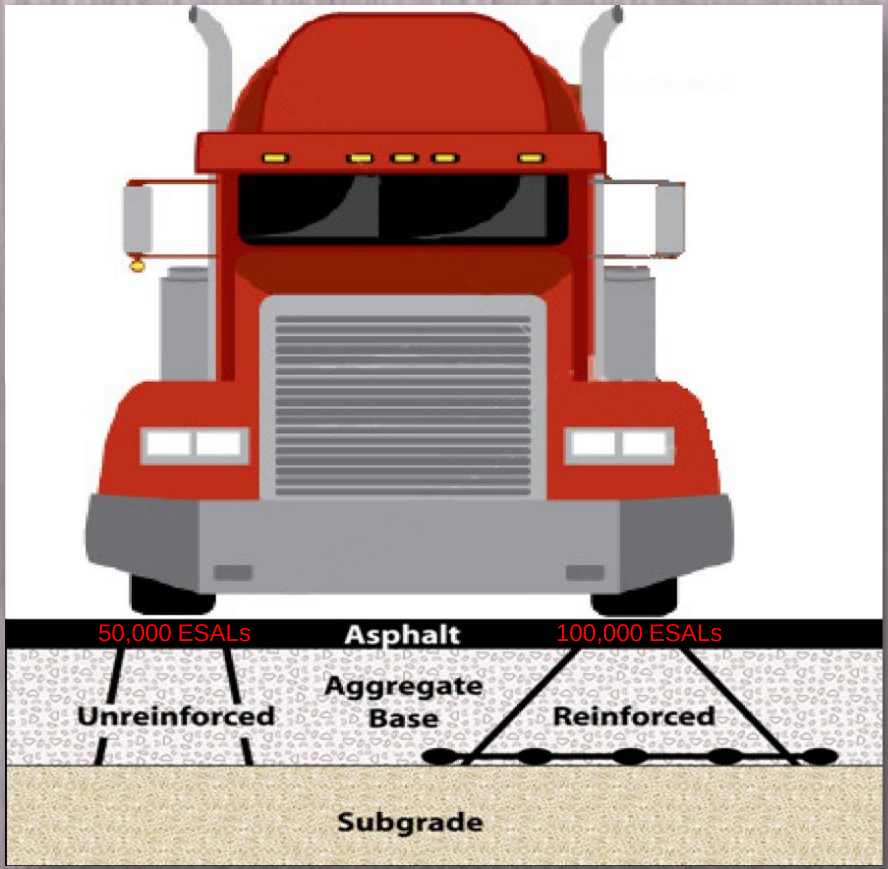
Base Reinforcement



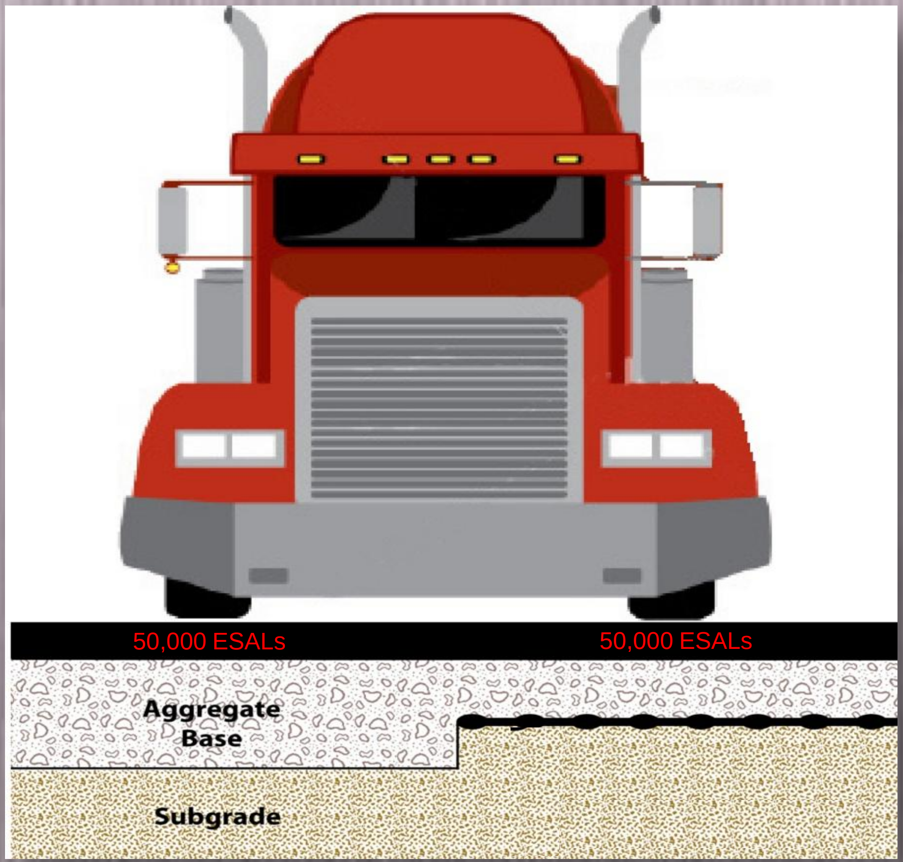
Reduce cost by major component (aggregate base) reduction.

SBX Biaxial Geogrids: Base Reinforcement

- Life Cycle Cost Savings
  - Service Life Extension



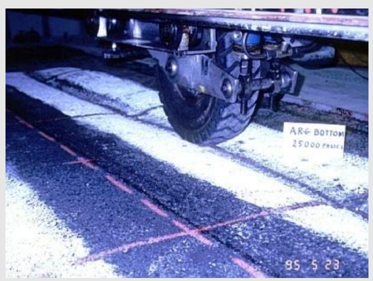
- Reduced Initial Cost
  - Pavement Component Reduction



Punched & Drawn PP Biaxial Geogrids:

Almost 3 decades of research to:

1) Identify key properties
2) Quantify contribution

Plate loading	Moving wheels	Full scale	Composite
Gourc et al (1983) **U of Waterloo (1984)** **Milligan et al (1986)** **Haas et al (1988)** Alenowicz et al (1996) **Beretta et al (1994)** Abdulijauwal et al (1994) Palmeira & Ferreira (1994) Ho (1996) **Collin et al (1996)** **Gabr 2001** 	Brown et al (1982) **Barker (1987)** **Barksdale et al (1989)** **Collin et al (1996)** **Moghaddas et al (1996)** **Watts et al (2004)** **Perkins (2004)** 	Ruddock et al (1982) Halliday & Potter (1984) **Milligan et al (1986)** Delmas et al (1986) Chaddock (1988) **Anderson & Killeavy (1989)** **Yarger et al (1991)** **Webster (1991)** **Webster (1992)** **Dawson et al (1994)** Freeman & Ahlrich (1996) **Austin & Knapton (1996)** Brandon et al (1996) **Huntington & Ksaibati (1999)** **Morvant & Holm (1999)** **Pavement Management Services (2000)** **Beland & Konrad (2002)** **Tingle & Webster (2003)**	**Kennephol et al (1985)** Cancelli et al (1996) Al-Qadi et al (1998) **Miura et al (1990)** **Perkins (1998 -)** 

Punched & Drawn PP Biaxial Geogrids:

Almost 3 decades of research to:

1) Identify key properties
2) Quantify contribution

- "We have attempted to capture the physical properties a geogrid must possess in order to enhance flexible pavement performance."
- Aperture Stability index property developed

Ribs	Thickness	Thicker is better
	Stiffness	High stiffness is better
	Shape	**Rectangular is better**
Aperture	Size	Depends on fill used
	Shape	**Round or square is better**
	Stiffness	**High stiffness is better**
Joint	**Strength**	**High compared to ribs (>90%)**
Overall	**Torsional Stiffness**	**High is better**
	Stability	**Very high**

Source: USACOE Webster, 1992

Punched & Drawn PP Biaxial Geogrids:

Patented in the USA since 1995

US005419659A

United States Patent [19]

Mercer

[11] **Patent Number:** 5,419,659

[45] **Date of Patent:** May 30, 1995

[54] PLASTIC MATERIAL MESH STRUCTURE

[75] Inventor: Frank B. Mercer, Lancashire, England

[73] Assignee: P.L.G. Research Limited, Blackburn, England

[21] Appl. No.: 291,044

[22] Filed: Aug. 15, 1994

3,137,746	6/1964	Seymour .
3,142,109	7/1964	Stoll et al. .
3,252,181	5/1966	Hureau .
3,253,072	5/1966	Scragg .

(List continued on next page.)

FOREIGN PATENT DOCUMENTS

873556	7/1979	Belgium .
954261	9/1974	Canada .

Punched & Drawn PP Biaxial Geogrids:

Patented in the USA since 1995,

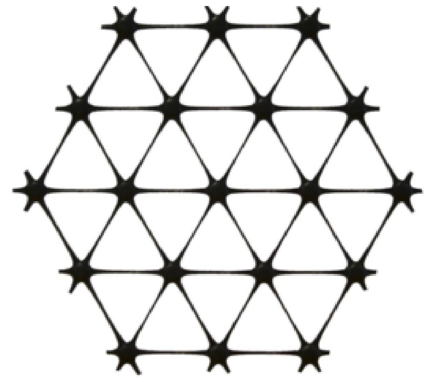
Patent expires May 30th 2012

Tensar INTERNATIONAL

Product Specification - TriAx™ TX160 Geogrid

Tensar International Corporation reserves the right to change its product specifications at any time. It is the responsibility of the person specifying the use of this product and the purchaser to ensure that product specifications relied upon for design or procurement purposes are current and that the product is suitable for its intended use in each instance.

Tensar TriAx™ Geogrid



General

1. The geogrid is manufactured from a punched polypropylene sheet, which is then oriented in three substantially equilateral directions so that the resulting ribs shall have a high degree of molecular orientation, which continues at least in part through the mass of the integral node.
2. The properties contributing to the performance of a mechanically stabilized layer include the following:

Punched & Drawn Geogrids: Biaxial vs. Triaxial

To whom it may concern.

Rationalization of Tensar BX Type 2 Geogrid

Effective June 24th 2010, Tensar will discontinue regular production runs of Type2 (BX1200) and will remove it from the standard list of products.
This decision follows the very positive response from the market to the introduction of TriAx in April 2009 and it marks the next stage in our strategy to transition all of our BX markets to TriAx.

Customers seeking to purchase BX Type 2 should be asked to utilize TX160 as a better performing and lower cost alternative. The letter from Tensar dated August 1st 2009 will assist in this conversion process.

Where it is not practical for customers to switch their order to TriAx, we will do our best to accommodate the request. This will however be subject to manufacturing scheduling constraints as we will have limited supply of Type 2. Also note that Type 2 will be priced at a premium compared to TriAx as we manage smaller inventories and production quantities. Any requests for production of BX Type 2 to meet a specific order will first be referred by customer Services to Dean Ditmar – VP of Sales for approval.

Yours sincerely

Tim Oliver
VP for Global Marketing
Tensar International
+1 404 214 5350
www.tensar-international.com

Punched & Drawn Geogrids:
Biaxial vs. Triaxial

1) Almost 3 decades of successful Design, Installations and Proven Performance worldwide and in the USA.

2) Approved by FHWA and AASHTO.

3) Often the preferred geogrid by, USACE, State DOT’s, Counties, Municipalities and Private Enterprise. (Walmart)

4) Due to the patent they are often specified without equal. Geogrids demonstrating similar strength are often rejected because due to a single property.

5) What was once the Gold Standard is now claimed obsolete by the maker?

Punched & Drawn Geogrids: Biaxial vs. Triaxial

Tensar

Tensar Earth Technologies, Inc.
5883 Glenridge Drive, Suite 200
Atlanta, Georgia 30328-5363
Phone: (800) 836-7271
www.tensarcorp.com

Product Specification - Biaxial Geogrid BX1200

Tensar Earth Technologies, Inc. reserves the right to change its product specifications at any time. It is the responsibility of the specifier and purchaser to ensure that product specifications used for design and procurement purposes are current and consistent with the products used in each instance. Please contact Tensar Earth Technologies, Inc. at 800-836-7271 for assistance

Product Type:	**Integrally Formed Biaxial Geogrid**
Polymer:	**Polypropylene**
Load Transfer Mechanism:	**Positive Mechanical Interlock**
Primary Applications:	**Spectra System (Base Reinforcement, Subgrade Improvement)**

Product Properties

Index Properties	Units	MD Values[1]	XMD Values[1]
▪ Aperture Dimensions[2]	mm (in)	25 (1.0)	33 (1.3)
▪ Minimum Rib Thickness[2]	mm (in)	1.27 (0.05)	1.27 (0.05)
▪ Tensile Strength @ 2% Strain[3]	kN/m (lb/ft)	6.0 (410)	9.0 (620)
▪ Tensile Strength @ 5% Strain[3]	kN/m (lb/ft)	11.8 (810)	19.6 (1,340)
▪ Ultimate Tensile Strength[3]	kN/m (lb/ft)	19.2 (1,310)	28.8 (1,970)
Structural Integrity			
▪ Junction Efficiency[4]	%	93	
▪ Flexural Stiffness[5]	mg-cm	750,000	
▪ Aperture Stability[6]	m-N/deg	0.65	
Durability			
▪ Resistance to Installation Damage[7]	%SC / %SW / %GP	95 / 93 / 90	
▪ Resistance to Long Term Degradation[8]	%	100	
▪ Resistance to UV Degradation[9]	%	100	

Dimensions and Delivery

The biaxial geogrid shall be delivered to the jobsite in roll form with each roll individually identified and nominally measuring 3.0 meters (9.8 feet) or 4.0 meters (13.1 feet) in width and 50.0 meters (164 feet) in length. A typical truckload quantity is 160 to 210 rolls.

Notes

1. Unless indicated otherwise, values shown are minimum average roll values (MARV) determined in accordance with ASTM D4759. The column labeled MD Values represents results from testing the product in the Machine Direction. The column labeled XMD Values represents results from testing the product in the Cross-Machine (Transverse) Direction.
2. Nominal dimensions.
3. True resistance to elongation when initially subjected to a load determined in accordance with ASTM D6637 without deforming test materials under load before measuring such resistance or employing "secant" or "offset" tangent methods of measurement so as to overstate tensile properties.
4. Load transfer capability determined in accordance with GRI-GG2-87 and expressed as a percentage of ultimate tensile strength.
5. Resistance to bending force determined in accordance with ASTM D5732-95, using specimens of width two ribs wide, with transverse ribs cut flush with exterior edges of longitudinal ribs (as a "ladder"), and of length sufficiently long to enable measurement of the overhang dimension. . The overall Flexural Stiffness is calculated as the square root of the product of MD and XMD Flexural Stiffness values.
6. Resistance to in-plane rotational movement measured by applying a 20 kg-cm (2 m-N) moment to the central junction of a 9 inch x 9 inch specimen restrained at its perimeter in accordance with U.S. Army Corps of Engineers Methodology for measurement of Torsional Rigidity.
7. Resistance to loss of load capacity or structural integrity when subjected to mechanical installation stress in clayey sand (SC), well graded sand (SW), and crushed stone classified as poorly graded gravel (GP). The geogrid shall be sampled in accordance with ASTM D5818 and load capacity shall be determined in accordance with ASTM D6637.
8. Resistance to loss of load capacity or structural integrity when subjected to chemically aggressive environments in accordance with EPA 9090 immersion testing.
9. Resistance to loss of load capacity or structural integrity when subjected to 500 hours of ultraviolet light and aggressive weathering in accordance with ASTM D4355.

Tensar Earth Technologies, Inc. warrants that at the time of delivery the geogrid furnished hereunder shall be of the quality and specification stated herein. If the geogrid does not meet the specifications on this page and Tensar is notified prior to installation, Tensar will replace the geogrid at no cost to the customer.

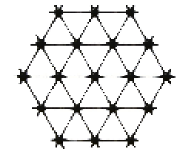
This product specification supersedes all prior specifications for the product described above and is not applicable to any products shipped prior to August 1, 2005

Tensar
INTERNATIONAL

Product Specification - TriAx™ TX160 Geogrid

Tensar International Corporation reserves the right to change its product specifications at any time. It is the responsibility of the person specifying the use of this product and of the purchaser to ensure that product specifications relied upon for design or procurement purposes are current and that the product is suitable for its intended use in each instance.

Tensar TriAx™ Geogrid



General

1. The geogrid is manufactured from a punched polypropylene sheet, which is then oriented in three substantially equilateral directions so that the resulting ribs shall have a high degree of molecular orientation, which continues at least in part through the mass of the integral node.
2. The properties contributing to the performance of a mechanically stabilized layer include the following:

Index Properties	Longitudinal	Diagonal	Transverse	General
▪ Rib pitch(2), mm (in)	40 (1.60)	40 (1.60)	–	
▪ Mid-rib depth(2), mm (in)	–	1.8 (0.07)	1.5 (0.06)	
▪ Mid-rib width(2), mm (in)	–	1.1 (0.04)	1.3 (0.05)	
▪ Nodal thickness(2), mm (in)				3.1 (0.12)
▪ Rib shape				rectangular
▪ Aperture shape				triangular

Structural Integrity	
▪ Junction efficiency(3), %	93
▪ Aperture stability(4), kg-cm/deg @ 5.0kg-cm (2)	3.6
▪ Radial stiffness at low strain(5), kN/m @ 0.5% strain	300
(lb/ft @ 0.5% strain)	(20,580)

Durability	
▪ Resistance to chemical degradation(6)	100%
▪ Resistance to ultra-violet light and weathering(7)	100%

Dimensions and Delivery

The TX geogrid shall be delivered to the jobsite in roll form with each roll individually identified and nominally measuring 4.0 meters (13.1feet) in width and 75 meters (246 feet) in length.

Notes

1. Unless indicated otherwise, values shown are minimum average roll values determined in accordance with ASTM D4759-02. Brief descriptions of test procedures are given in the following notes.
2. Nominal dimensions.
3. Load transfer capability determined in accordance with GRI-GG2-87 and GRI-GG1-87 and expressed as a percentage 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, (Kinney, T.C. Aperture stability Modulus ref 3, 3.1.2000).
5. Radial stiffness is determined from tensile stiffness measured in any in-plane axis from testing in accordance with ASTM D6637-01.
6. Resistance to loss of load capacity or structural integrity when subjected to chemically aggressive environments in accordance with EPA 9090 immersion testing.
7. Resistance to loss of load capacity or structural integrity when subjected to 500 hours of ultraviolet light and aggressive weathering in accordance with ASTM D4355-05.

Tensar International Corporation
5883 Glenridge Drive, Suite 200
Atlanta, Georgia 30328-5363
Phone: 800-TENSAR-1
www.tensar-international.com

This specification supersedes any and all prior specifications for the product designated above and is not applicable to any product shipped prior to August 15, 2009.Tensar and TriAx are trademarks of Tensar International Corporation or its affiliates in the US and many other countries. TriAx® geogrid and the use thereof are protected by U.S. Patent No. 7,001,112. Patents or patent applications also exist in other countries. Final determination of the suitability of the above-mentioned information or product for the use contemplated, and its manner of use are the sole responsibility of the user. Tensar International Corporation disclaims any and all express, implied or statutory warranties, including but not limited to, any warranty of merchantability or fitness for a particular purpose regarding this product or the Company's other products, technologies or services. The information contained herein does not constitute engineering advice.

Tensar BX1200 (Biaxial geogrid)

Product Properties

Index Properties	Units	MD Values[1]	XMD Values[1]
▪ Aperture Dimensions[2]	mm (in)	25 (1.0)	33 (1.3)
▪ Minimum Rib Thickness[2]	mm (in)	1.27 (0.05)	1.27 (0.05)
▪ Tensile Strength @ 2% Strain[3]	kN/m (lb/ft)	6.0 (410)	9.0 (620)
▪ Tensile Strength @ 5% Strain[3]	kN/m (lb/ft)	11.8 (810)	19.6 (1,340)
▪ Ultimate Tensile Strength[3]	kN/m (lb/ft)	19.2 (1,310)	28.8 (1,970)
Structural Integrity			
▪ Junction Efficiency[4]	%	93	
▪ Flexural Stiffness[5]	mg-cm	750,000	
▪ Aperture Stability[6]	m-N/deg	0.65	
Durability			
▪ Resistance to Installation Damage[7]	%SC / %SW / %GP	95 / 93 / 90	
▪ Resistance to Long Term Degradation[8]	%	100	
▪ Resistance to UV Degradation[9]	%	100	

Dimensions and Delivery

The biaxial geogrid shall be delivered to the jobsite in roll form with each roll individually identified and nominally measuring 3.0 meters (9.8 feet) or 4.0 meters (13.1 feet) in width and 50.0 meters (164 feet) in length. A typical truckload quantity is 160 to 210 rolls.

Notes

1. Unless indicated otherwise, values shown are minimum average roll values (MARV) determined in accordance with ASTM D4759. The column labeled MD Values represents results from testing the product in the Machine Direction. The column labeled XMD Values represents results from testing the product in the Cross-Machine (Transverse) Direction.
2. Nominal dimensions.
3. True resistance to elongation when initially subjected to a load determined in accordance with ASTM D6637 without deforming test materials under load before measuring such resistance or employing "secant" or "offset" tangent methods of measurement so as to overstate tensile properties.
4. Load transfer capability determined in accordance with GRI-GG2-87 and expressed as a percentage of ultimate tensile strength.
5. Resistance to bending force determined in accordance with ASTM D5732-95, using specimens of width two ribs wide, with transverse ribs cut flush with exterior edges of longitudinal ribs (as a "ladder"), and of length sufficiently long to enable measurement of the overhang dimension. . The overall Flexural Stiffness is calculated as the square root of the product of MD and XMD Flexural Stiffness values.
6. Resistance to in-plane rotational movement measured by applying a 20 kg-cm (2 m-N) moment to the central junction of a 9 inch x 9 inch specimen restrained at its perimeter in accordance with U.S. Army Corps of Engineers Methodology for measurement of Torsional Rigidity.

Tensar TX160 (Triaxial geogrid)

Structural Integrity

▪ Junction efficiency[3], %	93
▪ Aperture stability[4], kg-cm/deg @ 5.0kg-cm [2]	3.6
▪ Radial stiffness at low strain[5], kN/m @ 0.5% strain	300
(lb/ft @ 0.5% strain)	(20,580)

Durability

▪ Resistance to chemical degradation[6]	100%
▪ Resistance to ultra-violet light and weathering[7]	100%

Dimensions and Delivery

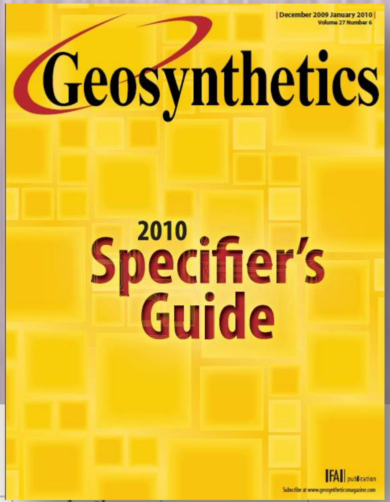
The TX geogrid shall be delivered to the jobsite in roll form with each roll individually identified and nominally measuring 4.0 meters (13.1feet) in width and 75 meters (246 feet) in length.

Notes

1. Unless indicated otherwise, values shown are minimum average roll values determined in accordance with ASTM D4759-02. Brief descriptions of test procedures are given in the following notes.
2. Nominal dimensions.
3. Load transfer capability determined in accordance with GRI-GG2-87 and GRI-GG1-87 and expressed as a percentage 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, (Kinney, T.C. Aperture stability Modulus ref 3, 3.1.2000).
5. Radial stiffness is determined from tensile stiffness measured in any in-plane axis from testing in accordance with ASTM D6637-01.
6. Resistance to loss of load capacity or structural integrity when subjected to chemically aggressive environments in accordance with EPA 9090 immersion testing.

Punched & Drawn Geogrids: Biaxial vs. Triaxial

Manufacturer provided no tensile data for TriAx in 2010 or 2011 Geosynthetics Specifier's Guides



Product Name	Manufacturing Process	Polymer Type [1]	Coating Type [1]	Mass/Unit Area ASTM D 5261 g/m2 (oz/yd2)	Dimensional Properties [2] Aperture Size mm (in) MD	Dimensional Properties [2] Aperture Size mm (in) XD	Tensile Strength/[Elongation] ASTM D 6637 [2] kN/m (lb/ft)/% Strength @ 5% Strain MD	Strength @ 5% Strain XD	Ultimate Strength/% (Tult) MD	Ultimate Strength/% (Tult) XD	Creep Limited Strength- ASTM D 5262 kN/m (lb/f[illegible]	LTDS GRI GG4-MD [4] kN/m (lb/ft) (in sand)	Manufacturer's Suggested Applications [5]
Tensar International Corp. | www.tensar-international.com													
BX Type 1	integrally formed	PP	NA	NA	25 [A] (1.0) [A]	33 [A] (1.3) [A]	8.5 (580)	13.4 (920)	NA	NA	NA	NA	SI, B
BX Type 2	integrally formed	PP	NA	NA	25 [A] (1.0) [A]	33 [A] (1.3) [A]	11.8 (810)	19.6 (1340)	NA	NA	NA	NA	SI, B
BX1300	integrally formed	PP	NA	NA	46 [A] (1.8) [A]	64 [A] (2.5) [A]	10.5 (720)	17.5 (1200)	NA	NA	NA	NA	SI, B
BX1500	integrally formed	PP	NA	NA	25 [A] (1.0) [A]	31 [A] (1.2) [A]	17.5 (1200)	20.0 (1370)	NA	NA	NA	NA	SI, B
TX160	integrally formed	PP	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	SI, B
TX5	integrally formed	PP	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	SI, B
TX7	integrally formed	PP	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	SI, B

WHAT IS RADIAL STIFFNESS?

ASTM D4439

Standard terminology for geosynthetics

ASTM D6637

Standard test method of geogrid tensile properties

Designation: D4439 – 04

Standard Terminology for Geosynthetics[1]

This standard is issued under the fixed designation D4439; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

absorption, *n*—the process by which a liquid is drawn into and tends to fill permeable pores in a porous solid body, also, the increase in mass of a porous solid body resulting from penetration of a liquid into its permeable pores. **C125**

aerobic, *n*—a condition in which a measurable volume of air is present in the incubation chamber or system. **D1987**

anaerobic, *n*—a condition in which no measurable volume of air is present in the incubation chamber or system. **D1987**

apparent opening size (AOS), O_{95}, *n—for a geotextile,* a property which indicates the approximate largest particle that would effectively pass through the geotextile. **D4751**

atmosphere for testing geosynthetics, *n*—air maintained at a relative humidity between 50 to 70 % and a temperature of 21 ± 2°C (70° ± 4°F). **D4439, D4751, D5494**

back flushing, *n*—a process by which liquid is forced in the reverse direction to the flow direction. **D1987**

basis weight—deprecated term (do not use in the sense of mass per unit area). **D4439**

bend, *vt—in mechanics*, to force an object from its natural or manufactured shape into a curve or into increased curvature. **D4439**

blinding, *n—for geotextiles*, the condition where soil particles block the surface openings of the fabric, thereby reducing the hydraulic conductivity of the system. **D4439**

biocide, *n*—a chemical used to kill bacteria and other micro-organisms. **D1987**

breaking force, *(F), J, n*—the force at failure. **D4885**

breaking load, *n*—the maximum force applied to a specimen in a tensile test carried to rupture. **D4632**

breaking toughness, *T,* (FL^{-1}), Jm^{-2}, *n—for geotextiles*, the actual work-to-break per unit surface area of material. **D4595, D4885**

chemical resistance, *n*—the ability to resist chemical attack. **D5322**

clogging, *n—for geotextiles,* the condition where soil particles move into and are retained in the openings of the fabric, thereby reducing the hydraulic conductivity. **D4439**

clogging potential, *n—in geotextiles*, the tendency for a given geotextile to decrease permeability due to soil particles that have either lodged in the geotextile openings or have built up a restrictive layer on the surface of the geotextile. **D5101**

compressed thickness (t, (L), mm), *n*—thickness under a specified stress applied normal to the material. **D4439**

constant-rate-of-load tensile testing machine (CRL), *n*—a testing machine in which the rate of increase of the load being applied to the specimen is uniform with time after the first 3 s. **D4439**

corresponding force, *n*—synonym for force at specified elongation. **D4885**

coupon, *n*—a portion of a material or laboratory sample from which multiple specimens can be taken for testing. **D5747**

creep, *n*—the time-dependent increase in accumulative strain in a material resulting from an applied constant force. **D5262**

critical height *(ch)*, *n*—the maximum exposed height of a cone or pyramid that will not cause a puncture failure of a geosynthetic at a specified hydrostatic pressure for a given period of time. **D5514**

cross-machine direction, *n*—the direction in the plane of the fabric perpendicular to the direction of manufacture. **D4632**

density (ρ, (ML^{-3}), kg/m^3), *n*—mass per unit volume. **D4439**

design load—the load at which the geosynthetic is required to operate in order to perform its intended function. **D5262**

elastic limit, *n—in mechanics*, the stress intensity at which stress and deformation of a material subjected to an increasing force cease to be proportional; the limit of stress within which a material will return to its original size and shape when the force is removed, and hence, not a permanent set. **D4885**

elongation at break, *n*—the elongation corresponding to the breaking load, that is, the maximum load. **D4632**

failure, *n*—an arbitrary point beyond which a material ceases to be functionally capable of its intended use. **D4885, D5262**

failure, *n—in testing geosynthetics,* water or air pressure in the test vessel at failure of the geosynthetic. **D5514**

flexible polypropylene, *n*—a material having a 2 % secant modulus of less than 300 MPa (40,000 psi) as determined by

[1] This terminology is under the jurisdiction of D35 on Geosynthetics and is the direct responsibility of Subcommittee D35.93 on Editorial and Terminology.

Current edition approved June 1, 2004. PublishedJuly 2004. Originally approved in 1984. Last previous edition approved in 2002 as D4439 – 02. DOI: 10.1520/D4439-04.

Designation: D 6637 – 01 (Reapproved 2009)

Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method[1]

This standard is issued under the fixed designation D 6637; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the determination of the tensile strength properties of geogrids by subjecting strips of varying width to tensile loading.

1.2 Three alternative procedures are provided to determine the tensile strength, as follows:

1.2.1 *Method A*—Testing a single geogrid rib in tension (N or lbf).

1.2.2 *Method B*—Testing multiple geogrid ribs in tension (kN/m or lbf/ft).

1.2.3 *Method C*—Testing multiple layers of multiple geogrid ribs in tension (kN/m or lbf/ft)

1.3 This test method is intended for quality control and conformance testing of geogrids.

1.4 The values stated in SI units are to be regarded as the standard. The inch-pound values stated in parentheses are provided for information only.

1.5 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D 76 Specification for Tensile Testing Machines for Textiles
D 123 Terminology Relating to Textiles
D 1909 Standard Table of Commercial Moisture Regains for Textile Fibers
D 4354 Practice for Sampling of Geosynthetics for Testing
D 4439 Terminology for Geosynthetics
D 5262 Test Method for Evaluating the Unconfined Tension Creep and Creep Rupture Behavior of Geosynthetics

3. Terminology

3.1 *Definitions:*

3.1.1 *atmosphere for testing geosynthetics*, *n*—air maintained at a relative humidity of 50 to 70 % and a temperature of 21 ± 2°C (70 ± 4°F).

3.1.2 *breaking force, (F), n*—the force at failure.

3.1.3 *corresponding force*, *n*—synonym for force at specified elongation.

3.1.4 *force at specified elongation, FASE, n*—a force associated with a specific elongation on the force-elongation curve. (synonym for corresponding force.)

3.1.5 *force-elongation curve*, *n*—in a tensile test, a graphical representation of the relationship between the magnitude of an externally applied force and the change in length of the specimen in the direction of the applied force. (synonym for stress-strain curve.)

3.1.6 *geogrid*, *n*—a geosynthetic formed by a regular network of integrally connected elements with aperetures greater than 6.35 mm (¼ inch) to allow interlocking with surrounding soil, rock, earth, and other surrounding materials to primarily function as reinforcement. **(D 5262)**

3.1.7 *integral*, *adj*—in geosynthetics, forming a necessary part of the whole; a constituent.

3.1.8 *geosynthetic*, *n*—a product manufactured from polymeric material used with soil, rock, earth, or other geotechnical engineering related material as an integral part of a man made project, structure, or system.

3.1.9 *index test*, *n*—a test procedure which may contain known bias, but which may be used to establish an order for a set of specimens with respect to the property of interest.

3.1.10 *junction*, *n*—the point where geogrid ribs are interconnected to provide structure and dimensional stability.

3.1.11 *rib* , *n*—for geogrids, the continuous elements of a geogrid which are either in the machine or cross-machine direction as manufactured.

3.1.12 *rupture*, *n*—for geogrids, the breaking or tearing apart of ribs.

3.1.13 *tensile*, *adj*—capable of tensions, or relating to tension of a material.

[1] This test method is under the jurisdiction of ASTM Committee D35 on Geosynthetics and is the direct responsibility of Subcommittee D35.01 on Mechanical Properties.

Current edition approved June 1, 2009. Published July 2009. Originally approved in 2001. Last previous edition approved in 2001 as D 6637 – 01.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

WHAT IS RADIAL STIFFNESS?

D4439 – 04

that purpose. (*Syn.* test specimen)

s. **stiffness,** *n*—resistance to bending.

WHAT IS RADIAL STIFFNESS?

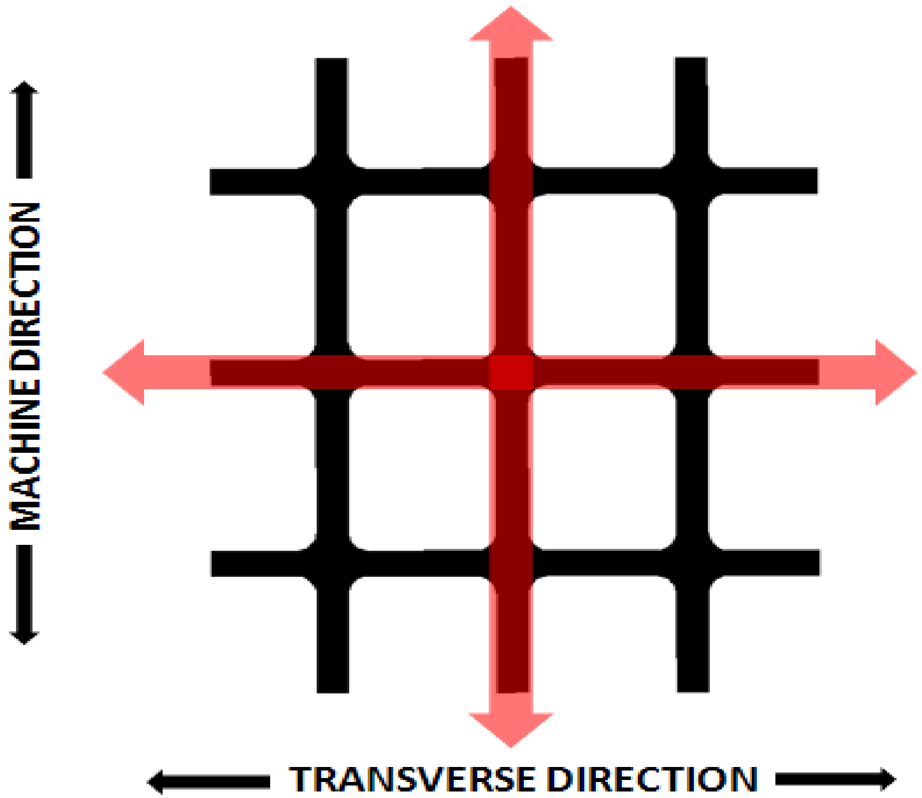
ASTM D6637 does not define radial stiffness or taking of samples in any other direction than MD or TD.

8. Test Specimen

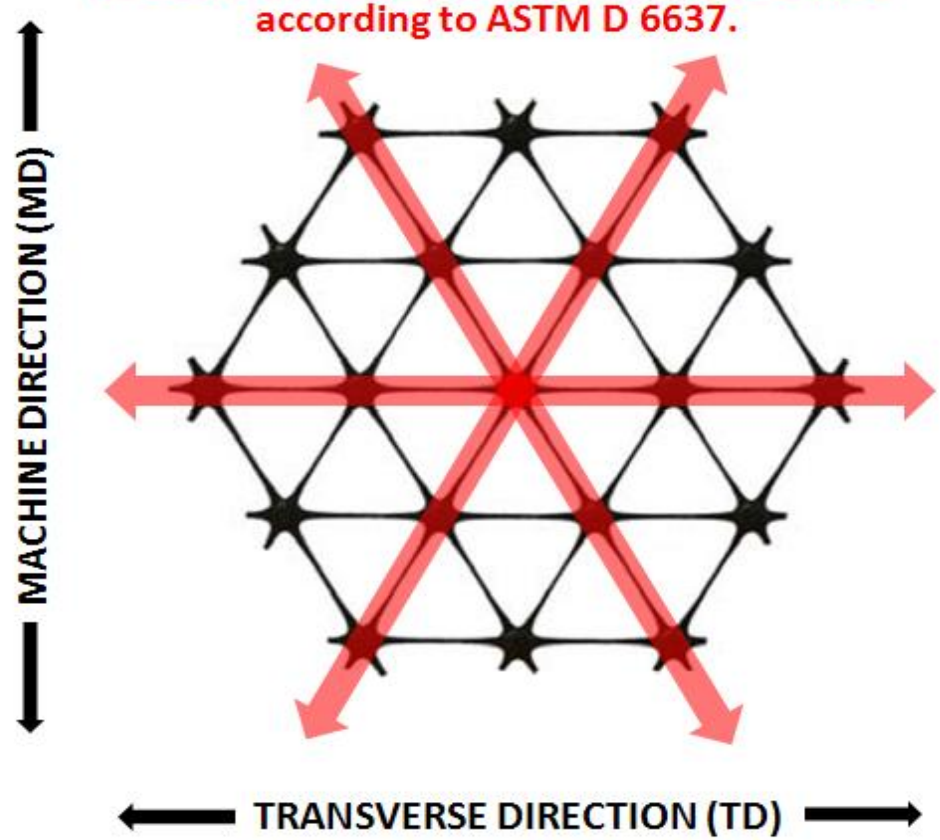
8.1 The specimens shall consist of three (3) junctions or 300 mm in length (12 in.), in order to establish a minimum specimen length in the direction of the test (either the machine or cross-machine direction). All specimens should be free of surface defects, etc., not typical of the laboratory sample. Take no specimens nearer the selvage edge along the geogrid than $\frac{1}{10}$ the width of the sample.

WHAT IS RADIAL STIFFNESS?

ASTM D 6637 measures tensile properties of conventional biaxial geogrids in the TD and MD with the highest strength typically in the TD.



Radial Stiffness describes tensile properties measured in the TD and 45° and 135° off TD according to ASTM D 6637.



Punched & Drawn Geogrids: Biaxial vs. Triaxial

PER ASTM D 6637		LOAD @ 2% STRAIN		LOAD @ 5% STRAIN		LOAD @ PEAK	
		kN/m	Lbs/ft	kN/m	Lbs/ft	kN/m	lbs/ft
TriAx 140	**TD**	**3.95**	**270**	**8.99**	**616**	**14.73**	**1,009**
BX1100 (Type 1)	**TD**	**6.6**	**450**	**13.4**	**920**	**19**	**1,300**
	MD	4.1	280	8.5	580	12.4	850
TriAx 160	**TD**	**4.6**	**314**	**10.64**	**726**	**18.924**	**1,291**
BX1200 (Type 2)	**TD**	**8.6**	**590**	**19.6**	**1,343**	**28.8**	**1,970**
	MD	6	410	11.8	810	19.2	1,310

TRIAXIAL GEOGRID STUDIES:

LOUISIANNA TRANSPORTATION RESEARCH CENTER

Laboratory Evaluation of Geogrid Base Reinforcement

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And

Mingjiang Tao, Ph.D., P.E.
Assistant Professor,
Department of Civil and Environmental Engineering
Worcester Polytechnic Institute
Worcester, MA 01609, taomj@wpi.edu

Submitted to:

88th Transportation Research Board Annual Meeting
January 11–15, 2009
Washington, D.C.

TRIAXIAL GEOGRID STUDIES:

LOUISIANNA TRASPORTATION RESEARCH CENTER

Research funded in part by Tensar

2 Geogrids Tested (tensile modulus)
GG1 = 450 kN/m @ 2% (BX1200)
GG2 = 475 kN/m @ 2% (TriAx 170)

Currently Available (tensile modulus)
TriAX 140 = 198 kN/m @ 2%
TriAX 160 = 230 kN/m @ 2%

From the report:
"…the triaxial geogrid GG2 performed a little better than the biaxial geogrid GG1. However, the difference is considered insignificant and lies within the test variations."

TRIAXIAL GEOGRID STUDIES:
The Confinement Effect of Different Geogrids

9th International Conference on Geosynthetics, Brazil, 2010

The confinement effect of different geogrids

Wrigley, N.E.
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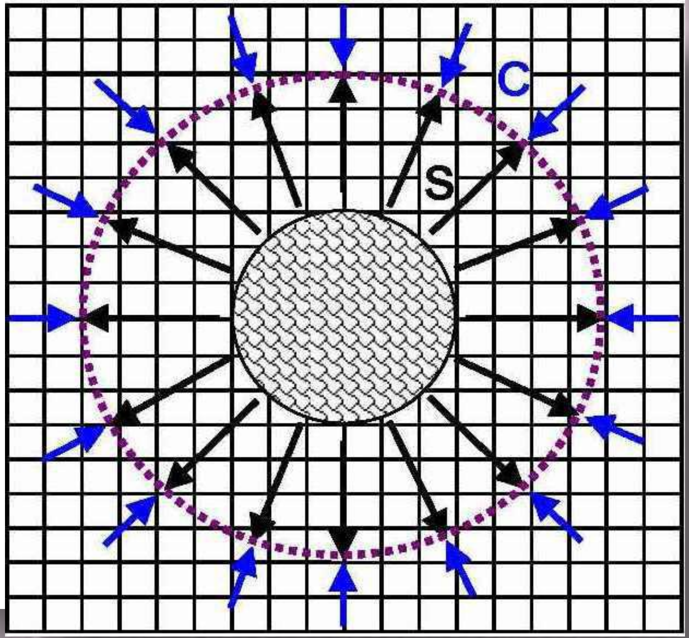
Zheng, H.
BOSTD Geosynthetics Qingdao Ltd., Qingdao, China

Liu, X.J.
Bostd Geosynthetics Qingdao Ltd., Qingdao, China

Sama, S.R.
SKZ, Würzburg, Germany



Discussion of the results:

"…there ***does not seem to be any significant difference*** *in performance between square and triangular shaped apertures."*

"…. confinement load at ***2% strain*** *should be adopted…"*

TRIAXIAL GEOGRID STUDIES: Western Transportation Institute

Quarterly Progress Report *7/1/08 – 9/30/08*

Progress Report #2

For the project entitled:

Field Investigation of Geosynthetics
Used for Subgrade Stabilization

Reporting Period: July 1 - September 30, 2008
(First Quarter of State Fiscal Year 2009)

Submitted by:

Eli Cuelho, P.E.
Research Engineer
Western Transportation Institute
College of Engineering
Montana State University – Bozeman

Steven Perkins, Ph.D., P.E.
Professor
Department of Civil Engineering
College of Engineering
Montana State University – Bozeman

Submitted to:

Montana Department of Transportation
Research Programs
2701 Prospect Avenue
Helena, Montana 59620

and

NAUE GmbH & Co. KG
Gewerbestraße 2
D-32339 Espelkamp-Fiestel
Germany

October 2008

Montana Department of Transportation **August 2009**
R E S E A R C H P R O G R A M S

Project Summary Report 8193

Authors: Eli Cuelho and Steve Perkins
Western Transportation Institute, College of Engineering
Montana State University - Bozeman

Field Investigation of Geosynthetics used for Subgrade Stabilization

http://www.mdt.mt.gov/research/projects/geotech/subgrade.shtml

Introduction

Roadways are commonly constructed on weak native soil deposits. When excavation and replacement of these soils is not cost effective, soil stabilization may be necessary to provide a working platform so that the base course gravel layer can be properly constructed and overall rutting reduced. Geosynthetics are planar polymeric materials that have been extensively used in these situations (i.e., subgrade stabilization) to reinforce and/ or separate the surrounding soils. Subgrade stabilization is typically applicable for unpaved temporary roads such as haul roads or construction platforms to support permanent roads. The Montana Department of Transportation (MDT) has used both geotextiles and geogrids for subgrade stabilization and supported this research because currently there is a lack of: 1) a universally accepted standard design technique that incorporates non-proprietary material properties of geosynthetics when used as subgrade stabilization, and 2) agreement as to which geosynthetic properties are most relevant in these cases for purposes of specification development. Therefore, this research was initiated to provide an understanding of which properties are most relevant as MDT seeks to update its specifications to more broadly encompass materials with which it has had good experience, as well as open up the application to other suitable materials. This is particularly important since new geosynthetics and manufacturing processes are regularly introduced into the market.

What we did

To achieve these objectives, a full-scale field test section was constructed, trafficked, and monitored at TRANSCEND, a full-scale transportation research facility managed by the Western Transportation Institute, to compare the relative performance of 12 test sections – ten with geosynthetics and two without geosynthetics (Figure 1). Existing pavement and base materials were excavated from the site to create a trench where an artificial subgrade (A-2-6 material) was placed in a weak condition. In-field measurements of vane shear, moisture content and DCP were primarily used to monitor subgrade strength during construction and after trafficking. Results from these tests showed that the subgrade soil was indeed weak and generally similar between test sections, especially for the upper layers which were primarily responsible for carrying the vehicle loads. After installation of the geosynthetics on top of the subgrade, displacement and pore water pressure sensors were installed at a single location along the length of each of the test sections. Approximately 20 centimeters of crushed base course aggregate (A-1-a material) was placed in a single lift as a structural layer and driving surface. The depth of the base course was determined using the FHWA U.S. Forest Service method (FHWA, 1995). Once the subgrade material was placed, all construction equipment was prevented from driving on the test area, and the base course layer was placed, leveled and graded from the side of the test area.

TRIAXIAL GEOGRID STUDIES: Western Transportation Institute

Progress Report #2

- July 1, 2008 – Sep 30, 2008
- 13 Sections Constructed
- 13 Sections Tested

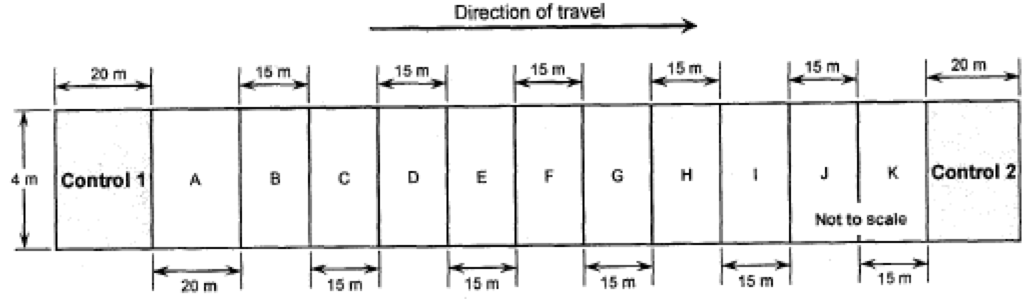


Figure 1. Layout of test sections.

Table 1. Summary of Geosynthetic Properties

Test Section	Structure	Polymer[a]	Roll Width (m)	Mass per unit area (g/m²)	Aperture Size (mm)	Strength[c] @ 2% (kN/m)	Strength[c] @ 5% (kN/m)	Ultimate[c] Strength (kN/m)
A	biaxial welded geogrid	PP	5.00	240	44 x 40	11 [NP]	22 [NP]	30
B	vibratory-welded geogrid	PP	4.75	155	32 x 32	8 [8]	16 [16]	20 [20]
C	integrally-formed biaxial geogrid	PP	4.88	NP	25 x 33	6.0 [9.0]	11.8 [19.6]	19.2 [28.8]
D[†]	composite vibratory-welded geogrid with integrated non-woven geotextile	PP	4.75	200	32 x 32	12 [12]	24 [24]	30 [30]
				150	N/A	N/A	N/A	6 [10]
E	integrally-formed biaxial geogrid	PP	4.00	NP	25 x 33	4.1 [6.6]	8.5 [13.4]	12.4 [19.0]
F	vibratory-welded geogrid	PP	4.75	200	32 x 32	12 [12]	24 [24]	30 [30]
G	integrally-formed triaxial geogrid	PP	3.81	NP	NP	NP	NP	NP
H	PVC coated woven geogrid	PMY	4.00	308.5	25.4 x 25.4	7.3 [7.3]	13.4 [13.4]	29.2 [29.2]
I	polymer coated woven geogrid	PMY	3.66	NP	25.4 x 25.4	7.7 [8.4]	11.5 [15.2]	34.9 [56.5]
J	woven geotextile	PPY	3.81	342	0.425[b]	8.8 [8.8]	21.9 [21.9]	52.5 [47.3]
K	non-woven needle-punched geotextile	PP	4.57	NP	0.18[b]	NP	NP	912[d]

[†] Material D is a composite; the top row of values is for the grid component and the bottom row is for the non-woven textile
[a] PP = polypropylene, PMY = polyester multifilament yarn, PPY = polypropylene yarn
[b] Apparent Opening Size (AOS), ASTM D 4751
[c] Machine direction [cross-machine direction]
[d] Grab strength in Newtons

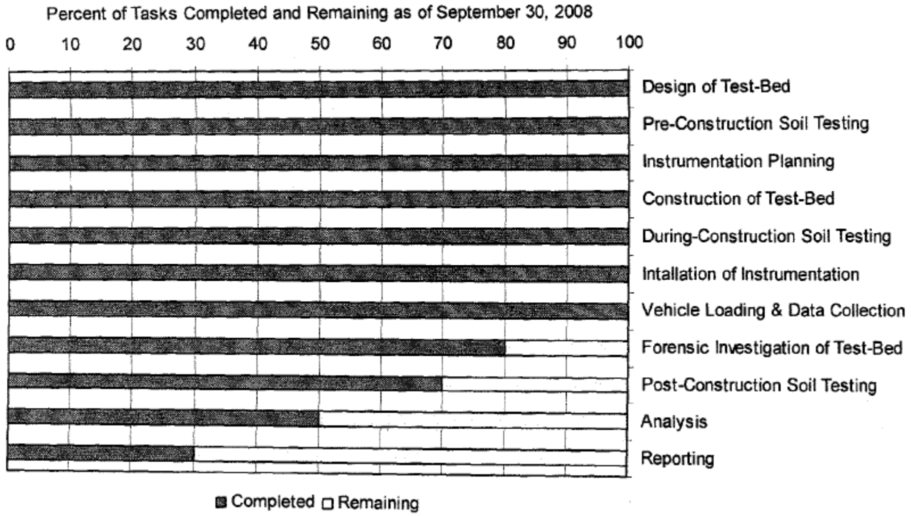
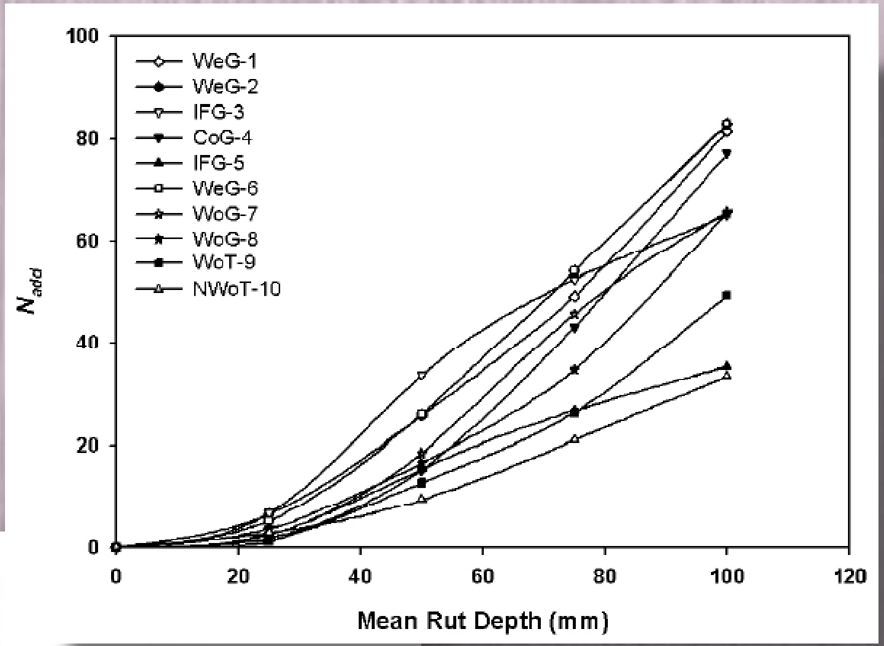


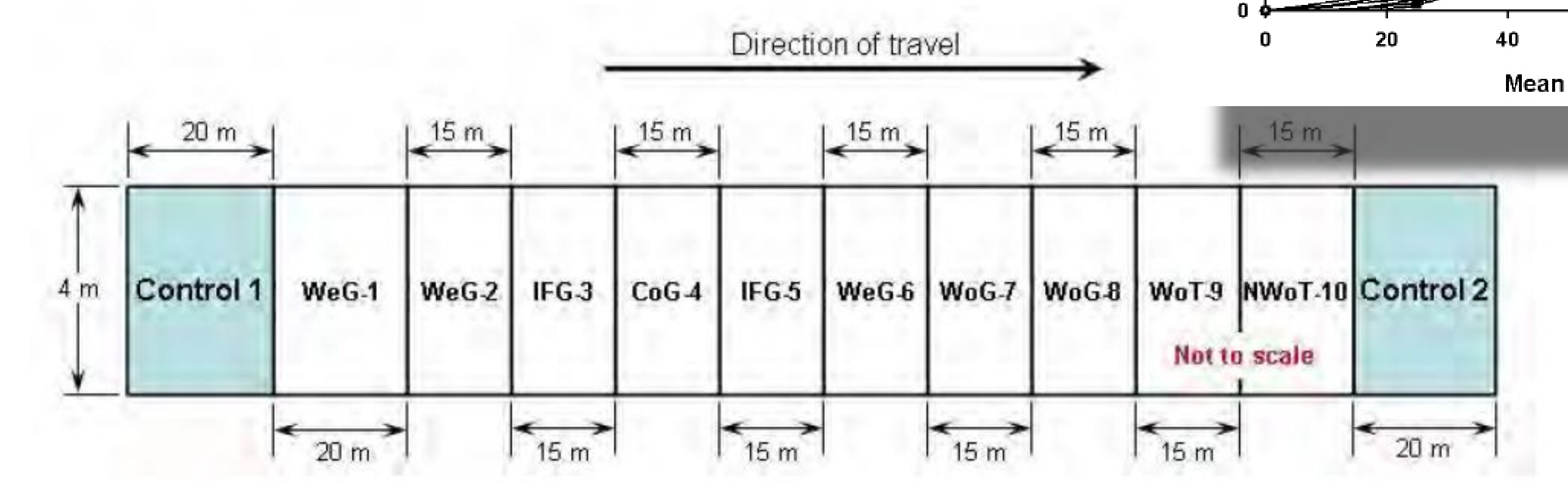
Figure 2. Project schedule

TRIAXIAL GEOGRID STUDIES: Western Transportation Institute

Project Summary Report

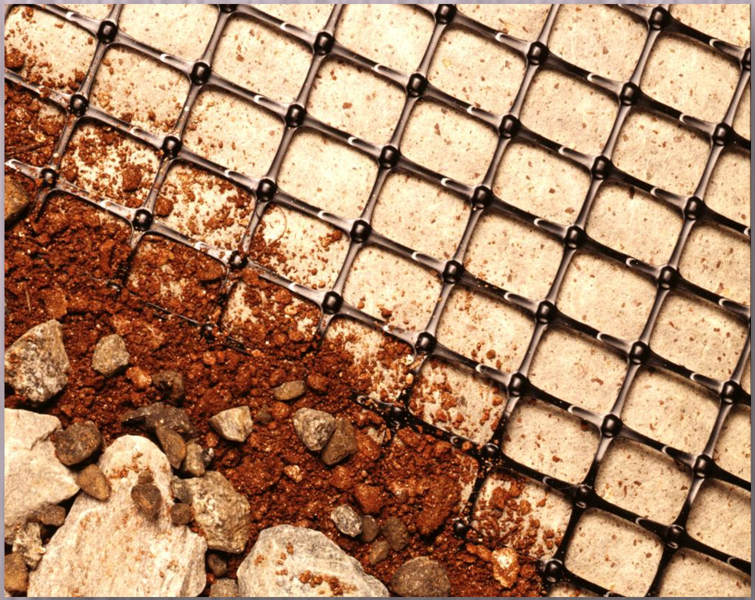
- August 2009
- Only 12 Sections
- TriAx Section Stricken! Why?



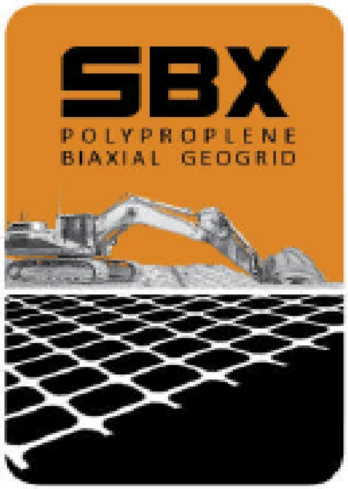


Acronym meanings: WeG = welded grid, IFG = integrally-formed grid, CoG = composite grid, WoG = woven grid, WoT = woven textile, NWoT = non-woven textile; numbers represent position along length of test site

Punched & Drawn Geogrids: Biaxial vs. Triaxial



1) Many designers still desire the proven BX geogrids
2) Many BX specifications still remain in use, Tensar is often able to switch to Triax
3) A few designers simply want Tensar geogrids
4) Syntec SBX geogrids are direct replacements to Tensar BX geogrids



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SYNTEC PRODUCT COMPARISON

SYNTEC SBX vs. TENSAR BX GEOGRIDS

	Polymer Type	*Aperture Size MD/TD (in x in)*	*Peak Tensile Strength MD/TD (lb/ft)*	*Tensile Strength @ 2% Strain MD/TD (lb/ft)*	*Tensile Strength @ 5% Strain MD/TD (lb/ft)*	*Junction Efficiency (%)*	*Aperture Stability (mg-N/deg)*	*Suggested Equivalent SYNTEC SBX Geogrid*
SYNTEC SBX								
SBX 11	PP	1.0x1.3	850/1,300	280/450	580/920	93	3.2	
SBX 12	PP	1.0x1.3	1,310/1,970	410/620	810/1,340	93	6.5	
SBX 13	PP	1.8x2.5	1,100/1,920	380/650	720/1,200	93	5.8	
SBX 15	PP	1.0x1.2	1,850/2,050	580/690	1,200/1,370	93	7.5	
SBX 41	PP	1.3x1.3	880/920	270/380	550/720	93	2.8	
SBX 42	PP	1.3x1.3	1,400/1,610	380/510	720/1,000	93	4.8	
TENSAR BX								
BX 1100	PP	1.0x1.3	850/1,300	280/450	580/920	93	3.2	SBX 11
BX 1200	PP	1.0x1.3	1,310/1,970	410/620	810/1,340	93	6.5	SBX 12
BX 1300	PP	1.8x2.5	1,100/1,920	380/650	720/1,200	93	5.8	SBX 13
BX 1500	PP	1.0x1.2	1,850/2,050	580/690	1,200/1,370	93	7.5	SBX 15
BX 4100	PP	1.3x1.3	880/920	270/380	550/720	93	2.8	SBX 41
BX 4200	PP	1.3x1.3	1,400/1,610	380/510	720/1,000	93	4.8	SBX 42

Notes: 1. Information for Geogrid products is obtained from the manufacturer's website. This chart is for comparison purpose only. Consult your local Syntec representative for current design assistance.

SYNTEC SBX vs. TENSAR BX

SYNTEC Product Specification: Biaxial Geogrid SBX 12 (Type 2)

SYNTEC
4800 Pulaski Highway
Baltimore, MD 21224-USA
Toll Free: 1-800-USGRIDS
Tel: 410-327-1070
Fax: 410-327-1078
www.synteccorp.com

Product Type:	**Integrally Formed Biaxial Geogrid**
Polymer:	**Polypropylene**
Load Transfer Mechanism:	**Positive Mechanical Interlock**
Primary Applications:	**Base Reinforcement, Subgrade Improvement**

SYNTEC reserves the right to change its product specifications at any time. It is the responsibility of the specifier and purchaser to ensure that product specifications used for design and procurement purposes are current and consistent with the products used in each instance.

Product Properties

Index Properties	**Units**	**MD Values**[1]	**XMD Values**[1]
▪ Aperture Dimensions[2]	mm (in)	25 (1.0)	33 (1.3)
▪ Minimum Rib Thickness[2]	mm (in)	1.27 (0.05)	1.27 (0.05)
▪ Tensile Strength @ 2% Strain[3]	kN/m (lb/ft)	6.0 (410)	9.0 (620)
▪ Tensile Strength @ 5% Strain[3]	kN/m (lb/ft)	11.8 (810)	19.6 (1,340)
▪ Ultimate Tensile Strength[3]	kN/m (lb/ft)	19.2 (1,310)	28.8 (1,970)
Structural Integrity			
▪ Junction Efficiency[4]	%	93	
▪ Flexural Stiffness[5]	mg-cm	750,000	
▪ Aperture Stability[6]	m-N/deg	0.65	
Durability			
▪ Resistance to Installation Damage[7]	%SC / %SW / %GP	95 / 93 / 90	
▪ Resistance to Long Term Degradation[8]	%	100	
▪ Resistance to UV Degradation[9]	%	100	

Dimensions and Delivery

The biaxial geogrid shall be delivered to the jobsite in roll form with each roll individually identified and nominally measuring 3.0 meters (9.8 feet) or 4.0 meters (13.1 feet) in width and 50.0 meters (164 feet) in length. A typical truckload quantity is 160 to 210 rolls.

Notes:
1. Unless indicated otherwise, values shown are minimum average roll values determined in accordance with ASTM D4759-02. Brief descriptions of test procedures are given in the following notes.
2. Nominal dimensions.
3. True resistance to elongation when initially subjected to a load determined in accordance with ASTM D6637-01 without deforming test materials under load before measuring such resistance or employing "secant" or "offset" tangent methods of measurement so as to overstate tensile properties.
4. Load transfer capability determined in accordance with GRI-GG2-05 and expressed as a percentage of ultimate tensile strength.
5. Resistance to bending force determined in accordance with ASTM D5732-01, using specimens of width two ribs wide, with transverse ribs cut flush with exterior edges of longitudinal ribs (as a "ladder"), and of length sufficiently long to enable measurement of the overhang dimension. The overall Flexural Stiffness is calculated as the square root of the product of MD and XMD Flexural Stiffness values.
6. Resistance to in-plane rotational movement measured by applying a 20 kg-cm (2 m-N) moment to the central junction of a 9 inch x 9 inch specimen restrained at its perimeter in accordance with U.S. Army Corps of Engineers Methodology for measurement of Torsional Rigidity.
7. Resistance to loss of load capacity or structural integrity when subjected to mechanical installation stress in clayey sand (SC), well graded sand (SW), and crushed stone classified as poorly graded gravel (GP). The geogrid shall be sampled in accordance with ASTM D5818-06 and load capacity shall be determined in accordance with ASTM D6637-01.
8. Resistance to loss of load capacity or structural integrity when subjected to chemically aggressive environments in accordance with EPA 9090 immersion testing.
9. Resistance to loss of load capacity or structural integrity when subjected to 500 hours of ultraviolet light and aggressive weathering in accordance with ASTM D4355-05.

SYNTEC warrants that at the time of delivery the geogrid furnished hereunder shall conform to the specification stated herein. Any other warranty including merchantability and fitness for a particular purpose, are hereby excluded. If the geogrid does not meet the specifications on this page and Syntec is notified prior to installation, SYNTEC will replace the geogrid at no cost to the customer.

This product specification supersedes all prior specifications for the product described above and is not applicable to any products shipped prior to October, 2011.

Tensar
INTERNATIONAL

Tensar International Corporation
5883 Glenridge Drive, Suite 200
Atlanta, Georgia 30328-5363
Phone: 800-TENSAR-1
www.tensar-international.com

Product Specification - Biaxial Geogrid BX1200

Tensar International Corporation reserves the right to change its product specifications at any time. It is the responsibility of the specifier and purchaser to ensure that product specifications used for design and procurement purposes are current and consistent with the products used in each instance.

Product Type:	**Integrally Formed Biaxial Geogrid**
Polymer:	**Polypropylene**
Load Transfer Mechanism:	**Positive Mechanical Interlock**
Primary Applications:	**Spectra System (Base Reinforcement, Subgrade Improvement)**

Product Properties

Index Properties	**Units**	**MD Values**[1]	**XMD Values**[1]
▪ Aperture Dimensions[2]	mm (in)	25 (1.0)	33 (1.3)
▪ Minimum Rib Thickness[2]	mm (in)	1.27 (0.05)	1.27 (0.05)
▪ Tensile Strength @ 2% Strain[3]	kN/m (lb/ft)	6.0 (410)	9.0 (620)
▪ Tensile Strength @ 5% Strain[3]	kN/m (lb/ft)	11.8 (810)	19.6 (1,340)
▪ Ultimate Tensile Strength[3]	kN/m (lb/ft)	19.2 (1,310)	28.8 (1,970)
Structural Integrity			
▪ Junction Efficiency[4]	%	93	
▪ Flexural Stiffness[5]	mg-cm	750,000	
▪ Aperture Stability[6]	m-N/deg	0.65	
Durability			
▪ Resistance to Installation Damage[7]	%SC / %SW / %GP	95 / 93 / 90	
▪ Resistance to Long Term Degradation[8]	%	100	
▪ Resistance to UV Degradation[9]	%	100	

Dimensions and Delivery

The biaxial geogrid shall be delivered to the jobsite in roll form with each roll individually identified and nominally measuring 3.0 meters (9.8 feet) or 4.0 meters (13.1 feet) in width and 50.0 meters (164 feet) in length. A typical truckload quantity is 160 to 210 rolls.

Notes
1. Unless indicated otherwise, values shown are minimum average roll values determined in accordance with ASTM D4759-02. Brief descriptions of test procedures are given in the following notes.
2. Nominal dimensions.
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4. Load transfer capability determined in accordance with GRI-GG2-05 and expressed as a percentage of ultimate tensile strength.
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7. Resistance to loss of load capacity or structural integrity when subjected to mechanical installation stress in clayey sand (SC), well graded sand (SW), and crushed stone classified as poorly graded gravel (GP). The geogrid shall be sampled in accordance with ASTM D5818-06 and load capacity shall be determined in accordance with ASTM D6637-01.
8. Resistance to loss of load capacity or structural integrity when subjected to chemically aggressive environments in accordance with EPA 9090 immersion testing.
9. Resistance to loss of load capacity or structural integrity when subjected to 500 hours of ultraviolet light and aggressive weathering in accordance with ASTM D4355-05.

Tensar International Corporation warrants that at the time of delivery the geogrid furnished hereunder shall conform to the specification stated herein. Any other warranty including merchantability and fitness for a particular purpose, are hereby excluded. If the geogrid does not meet the specifications on this page and Tensar is notified prior to installation, Tensar will replace the geogrid at no cost to the customer.

This product specification supersedes all prior specifications for the product described above and is not applicable to any products shipped prior to June 1, 2007

SYNTEC SBX vs. TENSAR BX
Streamlining the DOT approval process, when needed.

Dear

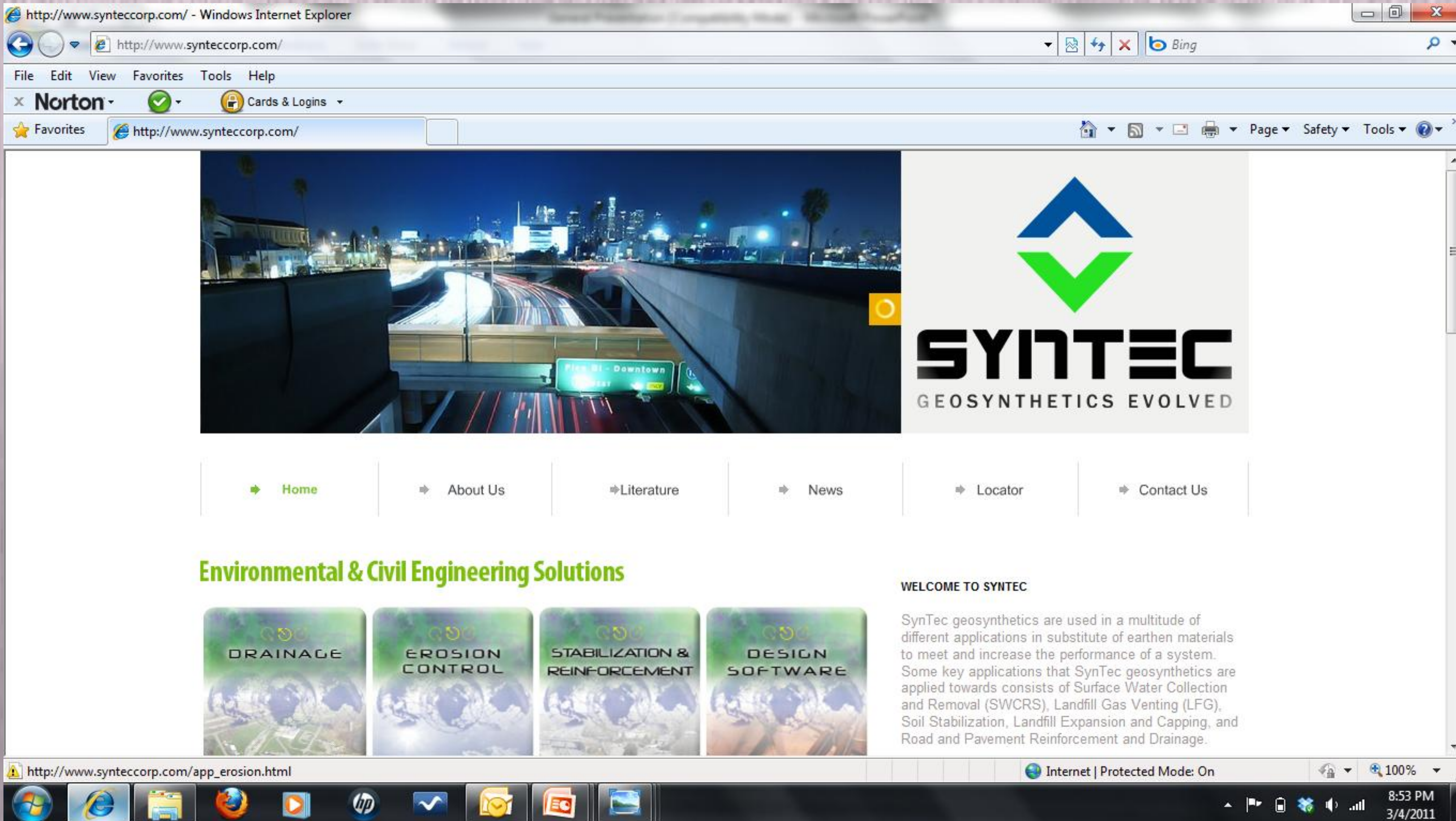
The product marketed and distributed by SynTec, LLC under the SynTec brand name "SBX "are manufactured by Tensar. The following attached table presents the list of which SynTec-branded product aligns with which Tensar-branded product, along with test data from an independent laboratory for SBX11 and SBX12.

If you need any additional information, please feel free to contact me,

Respectively

Giovanni Capra

President



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