



**PRESTO GEOSYSTEMS**

# **GEOWEB®**

## **SOIL STABILIZATION SYSTEM**

### **MATERIAL SPECIFICATION**



#### **PRESTO GEOSYSTEMS**

670 N PERKINS STREET, APPLETON, WISCONSIN, USA 54914

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**Perforated Geoweb® System Performance & Material Specification Summary**

	Property	Value			Test Method	
Base Material	Material Composition	Polymer – Polyethylene with density of 58.4 – 60.2 lb/ft <sup>3</sup> (0.935 – 0.965 g/cm <sup>3</sup> )			ASTM D1505 or D792	
	Color	Black - from Carbon Black	Tan, Green, Other Colors with no heavy metal content		N/A	
	Stabilizer	Carbon black content 1.5% - 2% by weight	Hindered amine light stabilizer (HALS) 1.0% by weight of carrier		N/A	
	Minimum ESCR	5000 hr			ASTM D 1693	
Strip Properties	Sheet Thickness	Prior to Texture: 50 mil, -5% +10% (1.27 mm, -5% +10%) After Texture: 60 mil, -5% +10% (1.52 mm, -5% +10%)			ASTM D 5199	
	Surface Treatment	<p><b>Performance:</b> The polyethylene strips shall be textured and perforated such that the peak friction angle between the surface of the textured / perforated plastic and #40 silica sand at 100% relative density shall be no less than 85% of the peak friction angle of the silica sand in isolation when tested by the direct shear method per ASTM D 5321.</p> <p><b>Material:</b> The polyethylene strips shall be textured with a multitude of rhomboidal (diamond shape) indentations. The rhomboidal indentations shall have a surface density of 140 – 200 per in<sup>2</sup> (22 – 31 per cm<sup>2</sup>). In addition, the strips shall be perforated with horizontal rows of 0.4 in (10 mm) diameter holes. Perforations within each row shall be 0.75 in (19 mm) on-center. Horizontal rows shall be staggered and separated 0.5 in (12 mm) relative to the hole centers. The edge of strip to the nearest edge of perforation shall be 0.3 in (8 mm) minimum and the centerline of the weld to the nearest edge of perforation shall be 0.7 in (18 mm) minimum. A slot with a dimension of 3/8 in x 1 3/8 in (10 mm x 35 mm) is standard in the center of the non-perforated areas and at the center of each weld.</p>				
Cell & Seam Properties	Cell Details	Percent Cell Wall Open Area	Nominal Dimensions ±10%		Density per yd <sup>2</sup> (m <sup>2</sup> )	Nominal Area ±1%
			Length	Width		
	GW20V	21.2% ± 1%	8.8 in (224 mm)	10.2 in (259 mm)	28.9 (34.6)	44.8 in <sup>2</sup> (289 cm <sup>2</sup> )
	GW30V	16.8% ± 1%	287 mm (11.3 in)	320 mm (12.6 in)	18.2 (21.7)	71.3 in <sup>2</sup> (460 cm <sup>2</sup> )
	GW40V	19.8% ± 1%	475 mm (18.7 in)	508 mm (20.0 in)	6.9 (8.3)	187.0 in <sup>2</sup> (1,206 cm <sup>2</sup> )
	Short-term Seam Peel Strength	Cell Depth		Minimum Certified Cell Seam Strength		
		3 in (75 mm)		240 lbf (1060 N)		
		4 in (100 mm)		320 lbf (1420 N)		
		6 in (150 mm)		480 lbf (2130 N)		
	8 in (200 mm)		640 lbf (2840 N)			
Long-term Seam Peel Strength	Long-term seam peel strength test shall be performed on all resin or pre-manufactured sheet or strips. A 4.0 in (100 mm) wide seam sample shall support a 160 lb (72.5 kg) load for a period of 168 hours (7 days) minimum in a temperature-controlled environment undergoing a temperature change on a 1-hour cycle from ambient room to 130°F (54°C). Ambient room temperature is per ASTM E 41					
10,000-hour Seam Peel Strength Certification	Presto shall provide data showing that the high-density polyethylene resin used to produce the Geoweb sections has been tested using an appropriate number of seam samples and varying loads to generate data indicating that the seam peel strength shall survive a loading of at least 209 lbf (95 kg) for a minimum of 10,000 hours.					
Section Properties	Section Dimension	Section Width	Section Length Range (Cells Long: 18, 21, 25, 29, 34)			
		Variable	Minimum	Maximum		
	GW20V	7.7 ft (2.3 m) to 9.2 ft (2.8 m)	12.0 ft (3.7 m)	27.3 ft (8.3 m)		
	GW30V		15.4 ft (4.7 m)	35.1 ft (10.7 m)		
GW40V	25.4 ft (7.7 m)		58.2 ft (17.8 m)			



### ***Manufacturing Certification***

Presto Geosystems shall have earned a certificate of registration, which demonstrates that its quality-management system for its Geoweb (geocell) cellular confinement system is currently registered to the ISO 9001:2015 quality standards. The scope of the ISO 9001:2015 registration shall be for the sale, design and manufacture of Geoweb cellular confinement system (geocell) product from incoming raw materials (resin) to finished product. Earned registration shall be verifiable by providing a copy of the current continuous registration certificate upon the customer's written request.

Under the scope of the ISO quality standard, Presto Geosystems shall compile, keep record of, and provide for any customer order or production lot, when requested at the time of order placement, actual and certified values for the following:

1. Resin Lot Number
2. Resin Density
3. Carbon Black content (where applicable)
4. High Pressure Oxidation Induction Time (HPOIT) (where applicable)
5. Sheet Thickness
6. Short-term Seam Peel Strength

Long-term Seam Peel Strength - 7-day hot box method

### ***Substitutions***

No material will be considered as an equivalent to the geocell material specified herein unless it meets all requirements of this specification, without exception. Manufacturers seeking to supply what they represent as equivalent material must submit records, data, independent test results, samples, certifications, and documentation deemed necessary by the Engineer to prove equivalency. The Engineer shall approve or disapprove other Manufacturers materials in accordance with the General Conditions after all information is submitted and reviewed.

### ***Product Certification***

Presto Geosystems shall provide certification of compliance to all applicable testing procedures and related specifications upon the customer's written request. Request for certification shall be submitted no later than the date of order placement.

### ***Specifier Choice for Certification and Warranty***

The Specifier shall determine the applicability of Manufacturing Certification, Product Certification and a Product Warranty and state which of the above is to be part of the project specifications.

### ***Product Limited Warranty***

Presto Geosystems shall warrant each Geoweb section that it ships to be free from defects in materials and workmanship at the time of manufacture. Presto's exclusive liability under this warranty or otherwise will be to furnish without charge to Presto's customer at the original f.o.b. point a replacement for any section which proves to be defective under normal use and service during the 10-year period which begins on the date of shipment-by Presto. Presto reserves the right to inspect any allegedly defective section in order to verify the defect and ascertain its cause.

This warranty shall not cover defects attributable to causes or occurrences beyond Presto's control and unrelated to the manufacturing process, including, but not limited to, abuse, misuse, mishandling, neglect, improper storage, improper installation, improper alteration or improper application.

PRESTO MAKES NO OTHER WARRANTIES, EXPRESS OR IMPLIED, WRITTEN OR ORAL, INCLUDING, BUT NOT LIMITED TO, ANY WARRANTIES OR MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE, IN CONNECTION WITH THE GEOWEB CELLULAR CONFINEMENT SYSTEM. IN NO EVENT SHALL THE PRESTO BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES FOR THE BREACH OF ANY EXPRESS OR IMPLIED WARRANTY OR FOR ANY OTHER REASON, INCLUDING NEGLIGENCE, IN CONNECTION WITH THE GEOWEB SYSTEM.



### **Geoweb Material Properties**

#### **Specifier Choice for Material Properties**

The specifier shall state the desired color. The color determines which ultraviolet light stabilizer is to be used. Polyethylene stabilized with carbon black is used for most applications. Colored polyethylene stabilized with HALS is generally used for the fascia strip for Geoweb earth retention systems.

NOTE: All measurements and colorants are subject to manufacturing tolerances unless otherwise stated.

#### **Polyethylene - Stabilized with Carbon Black**

Polyethylene used to make strips for Presto Geoweb sections shall have a density of 58.4 - 60.2 lb/ft<sup>3</sup> (0.935 - 0.965 g/cm<sup>3</sup>) in accordance with ASTM D1505 or D792.

Polyethylene used to make strips for Presto Geoweb sections shall have an Environmental Stress Crack Resistance (ESCR) of 5000 hours in accordance with ASTM D1693.

Carbon black shall be used for ultra-violet light stabilization. Carbon black content shall be 1.5% - 2% by weight through the addition of a carrier with certified carbon black content. The carbon black shall be homogeneously distributed throughout the material.

The resin manufacturer's certification of polyethylene density and ESCR shall be available upon request from Presto (the Geoweb manufacturer). Presto shall certify the percentage of carbon black.

#### **Polyethylene - Colored and Stabilized with HALS**

Polyethylene used to make strips for Presto Geoweb sections shall have a density of 58.4 - 60.2 lb/ft<sup>3</sup> (0.935 - 0.965 g/cm<sup>3</sup>) in accordance with ASTM D1505 or D792.

Polyethylene used to make strips for Presto Geoweb sections shall have an Environmental Stress Crack Resistance (ESCR) of 5000 hours in accordance with ASTM D1693.

The color(s) of the polyethylene shall be (Tan, Green, other). Colorants shall be non-heavy metal types. The colorant shall be homogeneously distributed throughout the material.

Hindered amine light stabilizer (HALS) shall be used for ultra-violet light stabilization. HALS content shall be 1.0% by weight through the addition of a carrier with a certified HALS concentrate. The HALS shall be homogeneously distributed throughout the material.

Colored polyethylene fascia panels on Geoweb sections used for earth retention systems shall have a High Pressure Oxidation Induction Time (HPOIT) of 820 minutes minimum in accordance with ASTM D5885 *Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry*.

The resin manufacturer's certification of polyethylene density, ESCR and HPOIT shall be available upon request from Presto (the Geoweb manufacturer). Presto shall certify the percentage of HALS.

### **Strip Properties and Assembly**

#### **Specifier Choice for Strip Properties and Assembly**

The specifier shall state the desired strip/cell type: Perforated Textured or Non-Perforated Textured. Perforated and textured strips are recommended for all applications except for the front face of walls.

NOTE: All measurements are subject to manufacturing tolerances unless otherwise stated.

#### **Perforated Textured Strip/Cell (Recommended)**

Polyethylene sheet used to make strips for Presto Geoweb sections shall have a thickness of 50 mil -5% +10% (1.27 mm -5% +10%) prior to any surface disruption. The strips shall have a perforated, textured surface. **Performance:** The peak friction angle between the surface of the perforated, textured plastic and #40 silica sand at 100% relative density shall be no less than 85% of the peak friction angle of the silica sand in isolation when tested by the direct shear method in accordance with ASTM D 5321. The quantity of perforations removed from the cell wall area shall be 21.2% ± 1% for GW20V, 16.8% ± 1% for GW30V and 19.89% ± 1% for GW40V. **Material:** The surface texturing shall be a multitude of rhomboidal (diamond shape) indentations. The rhomboidal indentations shall have a surface density of 140 - 200 per in<sup>2</sup> (22 - 31 per cm<sup>2</sup>). The thickness of the textured sheet shall be 60 mil ±6 mil (1.52 mm ±0.15 mm) determined in



accordance with ASTM D5199. The perforations shall be horizontal rows of 0.4 in (10 mm) diameter holes. Perforations within each row shall be 0.75 in (19 mm) on-center. Horizontal rows shall be staggered and separated 0.5 in (12 mm) relative to the hole centers. The edge of strip to the nearest edge of perforation shall be 0.3 in (8 mm) minimum and the centerline of the weld to the nearest edge of perforation shall be 0.7 in (18 mm) minimum. A slot with a dimension of 3/8 in x 1-3/8 in (10 mm x 35 mm) is standard in the center of the non-perforated areas and at the center of each weld.

### **Non-perforated Textured Strip/Cell**

Polyethylene sheet used to make strips for Presto Geoweb sections shall have a thickness of 50 mil, -5% +10% (1.27 mm -5% +10%) prior to any surface disruption. The strips shall have a textured surface. **Performance:** The peak friction angle between the surface of the textured plastic and #40 silica sand at 100% relative density shall be no less than 85% of the peak friction angle of the silica sand in isolation when tested by the direct shear method in accordance with ASTM D 5321. **Material:** The surface texturing shall be a multitude of rhomboidal (diamond shape) indentations. The rhomboidal indentations shall have a surface density of 140 – 200 per in<sup>2</sup> (22 - 31 per cm<sup>2</sup>). The thickness of the textured sheet shall be 60 mil ±6 mil (1.52 mm ±0.15 mm) determined in accordance with ASTM D5199. A slot with a dimension of 3/8 in x 1 3/8 in (10 mm x 35 mm) may be punched in the center of the non-perforated areas and at the center of each weld.

### **Assembly**

Presto Geoweb sections shall be fabricated using strips of sheet polyethylene each having a length as shown in Table 1 and a width equal to the cell depth. Polyethylene strips shall be connected using full-depth, ultrasonic spot-welds aligned perpendicular to the longitudinal axis of the strip. Weld spacing shall be as shown in Table 1. The ultrasonic weld melt-pool width shall not exceed 1.0 in (25 mm).

**Table 1 Strip Lengths & Weld Spacing for Cell Types**

Cell Type	GW20V	GW30V	GW40V
<b>Strip Length</b>	142 in (3.61 m)	142 in (3.61 m)	142 in (3.61 m)
<b>Weld Spacing</b>	14.0 in ± 0.10 in (356 mm ± 2.5 mm)	17.5 in ± 0.10 in (445 mm ± 2.5 mm)	28.0 in ± 0.10 in (711 mm ± 2.5 mm)
NOTE: All measurements are subject to manufacturing tolerances unless otherwise stated.			

### **Geoweb Cell and Seam Properties**

#### **Specifier Choice for Cell and Seam Properties**

The specifier shall state the desired cell size and depth. The specifier shall also state the Short-Term Seam Peel-Strength Test and the Long-Term Seam Peel-Strength Test. There are three possibilities for seams for a Geoweb section:

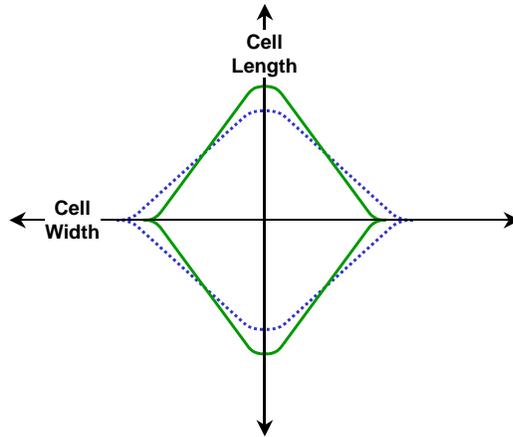
- 1) Two carbon black stabilized strips welded together. *This is most typical for Geoweb sections used in all application areas.*
- 2) A carbon black strip welded to a HALS stabilized strip. *This is typically used when a colored fascia is desired on the Geoweb earth retention system.*
- 3) Two HALS stabilized strips welded together. *However, this is uncommon and would apply only to fully colored Geoweb sections. Presto Geosystems should be consulted before specifying fully colored Geoweb sections. In the Long Term Seam Peel-Strength Test, the load capacity is given for seams made of two carbon-black stabilized strips welded together and a carbon black stabilized strip welded to a HALS stabilized strip.*

NOTE: All measurements are nominal and subject to manufacturing tolerances unless otherwise stated.



**Cell Expansion**

The Geoweb cell expansion is variable and defined by cell width and cell length as shown in Figure 1.



**Figure 1 Variable Expansion of the Geoweb Cell**

**Cell Size, Density, and Area**

The individual cells of the GW(TT)V Geoweb section shall have variable dimensions depending on expansion. The nominal cell dimensions, density and nominal area are provided in Table 2.

**Table 2 Cell Size, Density and Area**

Type (TT)	Nominal Cell Dimensions ±10%		Density per yd <sup>2</sup> (m <sup>2</sup> )	Nominal Area ±1%
	Length	Width		
<b>GW20V</b>	8.8 in (224 mm)	10.2 in (259 mm)	28.9 (34.6)	44.8 in <sup>2</sup> (289 cm <sup>2</sup> )
<b>GW30V</b>	11.3 in (287 mm)	12.6 in (320 mm)	18.2 (21.7)	71.3 in <sup>2</sup> (460 cm <sup>2</sup> )
<b>GW40V</b>	18.7 in (475 mm)	20.0 in (508 mm)	6.9 (8.3)	187.0 in <sup>2</sup> (1206 cm <sup>2</sup> )

**Cell Depth**

The Geoweb section shall have a nominal cell depth of (D).

Depth (D) =	8.0 in (200 mm)	6.0 in (150 mm)	4.0 in (100 mm)	3.0 in (75 mm)
-------------	-----------------	-----------------	-----------------	----------------

NOTE: All measurements are subject to manufacturing tolerances unless otherwise stated.

**Short-Term Seam Peel-Strength Test**

Short-term cell seam peel-strength shall be uniform over the full depth of the cell. Minimum short-term seam peel-strengths shall be:

- 640 lbf (2840 N).....for the 8 in (200 mm) depth cell.
- 480 lbf (2130 N).....for the 6 in (150 mm) depth cell.
- 320 lbf (1420 N).....for the 4 in (100 mm) depth cell.
- 240 lbf (1060 N).....for the 3 in (75 mm) depth cell.

Short-term seam peel strength shall be tested in accordance with Appendix A.

**Long-Term Seam Peel-Strength Test**

Long-term seam peel-strength test shall be performed on all resin or pre-manufactured sheet or strips. A 4.0 in (100 mm) wide seam sample shall support a 160 lb (72.5 kg) load for a period of **168 hours** (7 days) **minimum** in a temperature-controlled environment that undergoes change on a 1-hour cycle from room temperature to 130°F (54°C). Room temperature is defined in accordance with ASTM E41.

Long-term seam peel strength shall be tested in accordance with Appendix B.

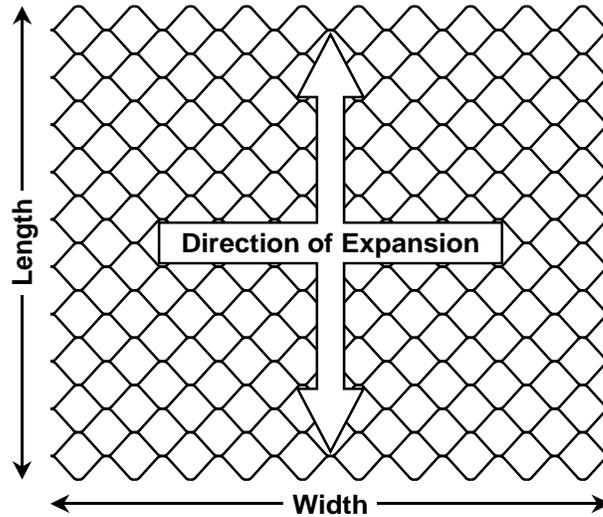


**10,000-hour Seam Peel Strength Certification**

Presto Geosystems shall provide data showing that the high-density polyethylene resin used to produce the Geoweb sections has been tested using an appropriate number of seam samples and varying loads to generate data indicating that the seam peel strength shall survive a loading of at least 209 lbf (95 kg) for a minimum of 10,000 hours.

**Geoweb Section Properties**

**Section Expansion**



**Figure 2 Geoweb Expansion**

**GW20V Geoweb Section Dimensions**

Presto Geoweb GW20V section dimensions shall be as indicated in Table 3. Sections shall have a nomenclature of “GW20VDWWLL” where “GW20V” indicates the cell size, “D” indicates the cell depth in inches, “WW” indicates the number of cells wide, and “LL” indicates the number of cells long. Sections shall have expanded dimensions as shown in Table 3. An example of the GW20V Geoweb section nomenclature is GW20V81029 where the section cell depth is 8 in (200 mm) and the section is 10 cells wide and 29 cells in length.

**Table 3 Available GW20V Geoweb Section Dimensions - 10 Cells Wide**

Cells Long	Minimum Expansion				Maximum Expansion				Nominal Area	
	Length		Width		Length		Width		m <sup>2</sup>	ft <sup>2</sup>
	M	Ft	m	Ft	m	Ft	M	ft		
18	3.7	12.0	2.8	9.2	4.4	14.5	2.3	7.7	10.4	112
21	4.3	14.0			5.1	16.9			12.1	131
25	5.1	16.7			6.1	20.1			14.5	156
29	5.9	19.4			7.1	23.3			16.8	181
34	6.9	22.7			8.3	27.3			19.7	212

**GW30V Geoweb Section Dimensions**

Presto Geoweb GW30V section dimensions shall be as indicated in Table 4. Sections shall have a nomenclature of “GW30VDWWLL” where “GW30V” indicates the cell size, “D” indicates the cell depth in inches, “WW” indicates the number of cells wide, and “LL” indicates the number of cells long. Sections shall have expanded dimensions as shown in Table 4. An example of the GW30V Geoweb section nomenclature is GW30V60829 where the section cell depth is 6 in (150 mm) and the section is 8 cells wide and 29 cells in length.

**Table 4 Available GW30V Geoweb Section Dimensions – 8 Cells Wide**

Cells Long	Minimum Expansion				Maximum Expansion				Nominal Area	
	Length		Width		Length		Width		M <sup>2</sup>	ft <sup>2</sup>
	m	Ft	m	Ft	m	Ft	M	ft		
18	4.7	15.4	2.8	9.2	5.7	18.6	2.3	7.6	13.3	143
21	5.5	18.0			6.6	21.7			15.5	167
25	6.5	21.4			7.9	25.8			18.4	198
29	7.6	24.8			9.1	30.0			21.4	230
34	8.9	29.1			10.7	35.1			25.0	270

### GW40V Geoweb Section Dimensions

Presto Geoweb GW40V section dimensions shall be as indicated in Table 5. Sections shall have a nomenclature of “GW40VDWWLL” where “GW40V” indicates the cell size, “D” indicates the cell depth in inches, “WW” indicates the number of cells wide, and “LL” indicates the number of cells long. Sections shall have expanded dimensions as shown in Table 5. An example of the GW40V Geoweb section nomenclature is GW40V40525 where the section cell depth is 4 in (100 mm) and the section is 5 cells wide and 25 cells in length.

**Table 5 Available GW40V Geoweb Section Dimensions - 5 Cells Wide**

Cells Long	Minimum Expansion				Maximum Expansion				Nominal Area	
	Length		Width		Length		Width		M <sup>2</sup>	ft <sup>2</sup>
	m	Ft	m	Ft	M	Ft	M	ft		
18	7.7	25.4	2.8	9.1	9.4	30.8	2.3	7.5	21.7	234
21	9.0	29.6			11.0	36.0			25.3	273
25	10.7	35.2			13.1	42.8			30.2	325
29	12.5	40.9			15.1	49.7			35.0	377
34	14.6	47.9			17.8	58.2			41.0	441

### Geoweb Accessories and Integral Components

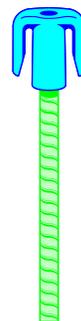
#### The ATRA® Stake Clip and ATRA® Stake

As shown in Figure 3, the ATRA Stake Clip is a molded, high-strength polyethylene device available in standard (0.5 inch) and metric (10-12mm) versions. The ATRA Stake Clip can be used for the following purposes:



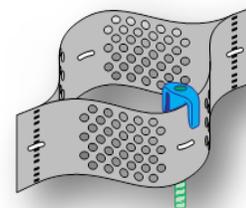
**Figure 3 ATRA® Stake Clip**

ATRA Stake Clips installed as an end cap on No. 4 rebar stakes or 10-12 mm rods forms ATRA Stakes as shown in Figure 4.



**Figure 4 ATRA® Stake**

The ATRA Stake provides anchorage by engaging the arm of the ATRA Stake Clip over the top of the cell wall as shown in Figure 5.



**Figure 5 ATRA® Stake Connected Over the Cell Wall**



To provide additional anchorage, ATRA Stakes may be used in conjunction with tendons. The arm of the ATRA Stake Clip is engaged with the tendon and the ATRA Stake is driven flush with the base of the cell as shown in Figure 6.

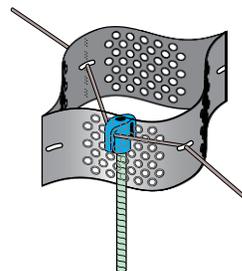


Figure 6 ATRA® Stake over Tendon

### **ATRA® Speed Stake**

The ATRA Speed Stake provides additional anchorage and resistance to sliding and/or uplift forces to GEOWEB sections with or without tendons for crest, toe and internal anchoring.

ATRA Speed stakes are a one-piece non-metallic molded anchor used instead of traditional rebar or steel rods for durability in wet or corrosive environments. ATRA Speed Stakes make a secure connection with GEOWEB cell walls and allow for driving of anchors with powered ATRA Drivers with ATRA Gad attachment.

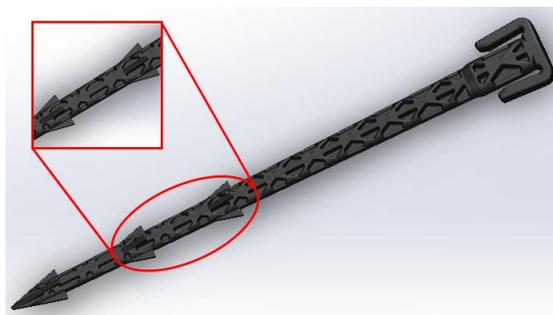


Figure 7 ATRA® Anchor over Tendon

### **The ATRA® Tendon Clip**

As shown in Figure 8, the ATRA Tendon Clip is a molded, high-strength polyethylene device with a locking member and post for tendon anchorage.

The ATRA tendon clip is the recommended anchorage connection method for securing Geoweb sections and tendons.

As shown in Figure 9, the ATRA Tendon Clip is attached to the cell wall and tendon to provide load transfer from the infilled Geoweb sections to the tendons and associated crest anchorage system.



Figure 8 ATRA® Tendon Clip

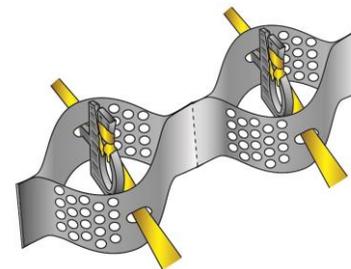


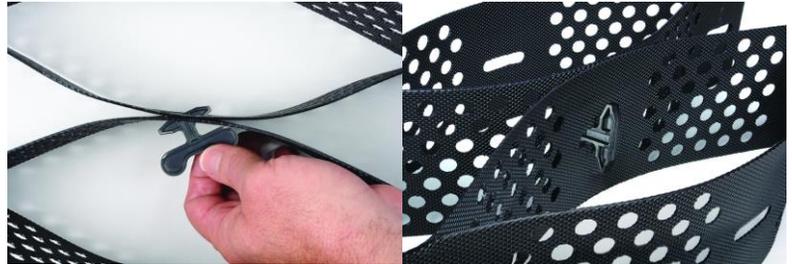
Figure 9 ATRA® Tendon Clips with  
Tendons through the Geoweb Cell  
Wall.



***ATRA® Keys for Panel Connection***

Geoweb panels shall be connected together with ATRA Keys at each interleaf and end to end connection through the slots in the cell wall. For the front fascia wall panels, slit the I-slot opening with a utility razor knife to allow installation of the ATRA key. The ATRA Key is constructed of polyethylene and provides a high strength connection.

The ATRA Key has a wide top for handling and a narrow bottom for inserting through the slot in the cell wall. ATRA Keys are installed through the slots in the adjacent Geoweb cell walls and turned 90 degrees to “lock” the sections together as shown in Figure 10.



**Figure 10 ATRA® Key Geoweb Panel Connection**

***Staples for Wall Fascia Connection***

Staples may be used for connecting the front face of walls. ATRA keys are the preferred connection device. Staples shall be ½ inch, Stanley Bostitch, SL5035, or equal.

***Integral Tendons***

***Specifier Choice for Tendons***

If required, the specifier shall state which tendon is to be used to anchor the Geoweb sections. The tendon strength must meet the design requirements for the application. The specifier shall also include ATRA® Tendon Clips for load transfer.

***Woven Polypropylene Tendons***

The polypropylene tendon shall be manufactured from bright yellow, high-tenacity, industrial-continuous filament polypropylene yarn woven into a braided strap. The tendon reference name, diameter/width and minimum break strength shall be as shown in Table 6.

**Table 6 Woven Polypropylene Tendon**

Reference Name	Tendon Diameter / Width		Tendon Minimum Break-strength	
	mm	In	kN	lbf
<b>TPP-55</b>	6.4 mm	0.25	5.56	1250

***Woven Polyester Tendons***

The polyester tendons shall be manufactured from bright, high-tenacity, industrial-continuous filament polyester yarn woven into a braided strap. Elongation shall be 9 – 15% at break. The tendon reference name, diameter/width and minimum break strength shall be as shown in Table 7.

**Table 7 Woven Polyester Tendons**

Reference Name	Tendon Diameter / Width		Tendon Minimum Break-strength	
	mm	In	kN	lbf
<b>TP-67</b>	19	0.75	7.04	1585
<b>TP-93</b>	19	0.75	9.77	2200
<b>TP-225</b>	32	1.250	22.7	5100



**Kevlar® Aramid Tendons**

The Kevlar aramid tendons shall be woven strap having the reference name, width and minimum break-strength as shown in Table 8.

**Table 8 Kevlar® Aramid Tendon**

Reference Name	Tendon Diameter / Width		Tendon Minimum Break-strength	
	mm	In	kN	Lbf
TK-178	19	0.750	17.80	4000

**Anchoring Requirements**

**Specifier Choice for Anchoring Systems**

The specifier shall determine which anchoring methods is required for the application. NOTE: ATRA Stake Clips, ATRA Speed Stakes, ATRA Tendon Clips, Tendons, ATRA Keys and ATRA GFRP Anchors are available from Presto Geosystems.

Geoweb sections shall be anchored in accordance with the Construction Drawings. The size, type and distribution of anchors shall be in accordance with the Construction Drawings.

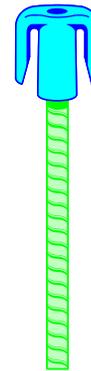
**ATRA® Stake`**

The ATRA Stake shall be a No. 4 (0.5 inch) steel reinforcing rod or 10-12 mm rod with an ATRA® Stake Clip attached as an end cap as shown in Figure 11.

The ATRA Stake shall be assembled in the field by inserting the ATRA Stake Clip onto the rod so that the end of the rod is flush with the top of the ATRA Stake Clip. Prior to inserting the ATRA Stake Clip on the end of the stake, the stake end shall be ground or filed so it has a bevel edge and is free from all burrs.

The length of the ATRA Stake shall be as shown on the Construction Drawings.

If required, the steel reinforcing rod shall be hot dipped galvanized in accordance with AASHTO M-218, Hot Dip Galvanized Carbon Steel.



**Figure 11 ATRA® Stake**

**ATRA® Speed Stake**

The ATRA Speed Stake shall be a one-piece injection, non-metallic molded anchor with integral flanged arms and barbs for durability of use in wet or corrosive environments as shown in Figure 12.

The ATRA Speed Stake makes a secure connection with GEOWEB cell walls and allows for driving of anchors with powered ATRA Drivers with ATRA Gad attachment. The ATRA Speed Stake provides additional anchorage and resistance to sliding and/or uplift forces to GEOWEB sections with or without tendons for crest, toe and internal anchoring.

The length of the ATRA Speed Stake shall be 16 in (407 mm) or 20 in (508 mm) as shown on the Construction Drawings.



**Figure 12 ATRA® Speed Stake**



### ***Other Anchors***

#### **ATRA® Glass Fiber Reinforced Polymer (GFRP) Anchor**

The ATRA GFRP Anchor shall be a pre-assembled unit consisting of the ATRA Stake Clip inserted onto the ATRA GFRP stake so that the end of the stake is flush with the top of the ATRA Stake Clip.

The ATRA® GFRP stake shall be composed of glass fiber-reinforced polymer with the outer surface of the stake sand coated and deformed by a helical wrap of glass. Glass reinforcement content shall be 75% minimum by weight and shall be continuous longitudinal filament. Polymer shall be vinyl ester, isophthalic polyester, or other matrix material. The outer surface of the stake shall be sand coated and deformed by a helical wrap of glass. The ATRA GFRP stake shall have a minimum tensile strength of 95 kips (655 MPa) in accordance with ASTM D638. The stake shall be non-magnetic, non-conducting and corrosion resistant. The length shall be as shown on the Construction Drawings.

The pre-assembled ATRA GFRP Anchors are available in several lengths from Presto Geosystems.

#### **Straight Steel Stakes**

Straight steel stakes shall be fabricated from mild steel or reinforcing steel rod. Rod diameter shall be 0.3125 in (8 mm), 0.375 in (10 mm), 0.50 in (12 mm), 0.625 in (16 mm) or .75 in (20 mm). Stake length shall be per the Construction Drawings.

If required, galvanizing shall be in accordance with AASHTO M-218, Hot Dip Galvanized Carbon Steel.

#### **Wood Stakes**

Wood stakes shall be \_\_\_\_\_ (state wood type) and free from knots that may reduce the strength of the stake. The stakes shall be \_\_\_\_\_ inches wide by \_\_\_\_\_ inches thick. The stake length shall be as shown on the Construction Drawings

#### ***Disclaimer***

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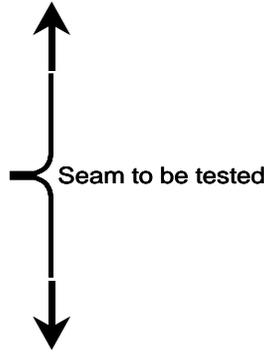


### Appendix A

#### Short-Term Seam Strength Procedure

##### Frequency of Test

The short-term seam peel strength test (referred to as the 'test' in this section) shall be performed on a geocell section randomly taken directly from the production line each two hours.



#### Test Sample Preparation

Randomly choose 10 welds within the selected section and cut those welds from the section such that 4 in (10 cm) of material exist on each side of the weld. The test sample shall have a general appearance as illustrated in Figure A1. Prior to testing, the test samples shall have air cool for a minimum of 30 minutes from the time the selected geocell section was manufactured.

#### Short-term Seam Peel Strength Test

The apparatus used for testing the short-term seam peel strength shall be of such configuration that the jaws of the clamp shall not over stress the sample during the test period. Load shall be applied at a rate of 12 in (300 mm) per minute and be applied for adequate time to determine the maximum load. The date, time and load shall be recorded.

Short-term seam peel strength shall be defined as the maximum load applied to the test sample. Minimum required short-term seam peel strength shall be:

- 640 lbf (2840 N) for the 8 in (200 mm) depth cell
- 480 lbf (2130 N) for the 6 in (150 mm) depth cell
- 320 lbf (1420 N) for the 4 in (100 mm) depth cell
- 240 lbf (1060 N) for the 3 in (75 mm) depth cell.

#### Definition of Pass / Failure

Two methods shall be used to determine acceptability of the manufactured geocell sections. The successful passing of the short-term seam peel test shall not be used to determine acceptable of the polyethylene for use in manufacturing of the geocell sections. Acceptability of the polyethylene shall be determined through tests conducted in Appendix B.

#### The Tested Value

If more than one of the tested seam samples fails to meet the minimum peel strength, all sections manufactured after the previously successful test shall be rejected.

If all tested seam samples meet the minimum peel strength, all geocell sections manufactured since the last successful test shall be considered to have passed the test.

When one of the tested seam samples fails to meet the minimum peel strength, another 10 samples shall be randomly selected and cut from the previously selected section. If more than one of these samples fails, all sections manufactured after the previously successful test shall be rejected. Otherwise, all geocell sections manufactured since the last successful test shall be considered to have passed the test.

#### Visual Failure Mode

After each sample is tested, the seam shall be examined to determine the failure mode. Two failure modes are possible.

- Material failure within and adjacent to the weld indicated by material strain and
- Weld failure resulting in complete separation of the seam and shows little or no material strain.

Upon examination, when the failure mode results in complete separation of the seam and indicates little or no material strain, product manufactured shall be rejected.

Figure A1



**Appendix B**

**Long-Term Seam-Strength Test Procedure**

**Frequency of Test**

The long-term seam peel strength test (referred to as the 'test' in this section) shall be performed:

1. on each new resin lot number if the geocell manufacturer extrudes the sheet or strip used to produce the geocell material.
2. on each new order of sheet and/or strip if the geocell manufacturer does not extrude the sheet and/or strip used to produce the geocell material.

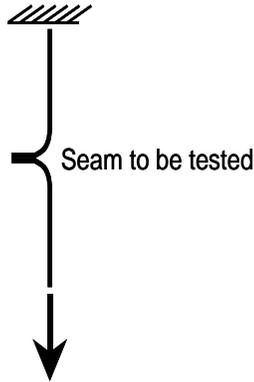


Figure B1

**Test Sample Preparation**

A test sample shall be made using two sets of two strips meeting all aspects of the material portion of this specification. Testing shall be done on non-perforated samples to obtain the true seam strength of the bond. One set of two strips are to be welded in welder position "A" and the other set of two strips are to be welded in welder position "B" producing two 1-cell long sections of geocell product. Welding should be done using a warm welder. The welded samples shall be labeled "A" and "B" and the weld seams of each sample shall be numbered consecutively from left to right starting with the number 1 (one) and corresponding to the welding head number.

The samples shall air cool for a minimum of 30 minutes. Randomly choose 10 welds from samples "A" and "B" and cut those welds from the geocell samples such that 4 in (10 cm) of material exist on each side of the weld. These samples shall be cut to a width of 4 in (10 cm). Properly identify each weld using the sample letter and weld seam number.

These samples are now ready to be tested.

**Long-term Seam Peel Strength Test**

The long-term seam peel strength test shall take place within an environmentally controlled chamber that undergoes temperature change on a 1-hour cycle from room temperature to 130°F (54°C). Room temperature shall be in accordance with ASTM E41.

Within the environmentally controlled chamber, one of the ends of the samples (10 samples in total) shall be secured to a stationary upper clamp. The jaws of the clamp shall be of such configuration that the grip does not over stress the sample during the test period. The sample shall be secured so that its axis is vertical and the welds being tested are horizontal as the sample hangs within the environmentally controlled chamber.

A weight of 160 lb (72.5 kg) shall be lifted via a hoist or lift platform and attached to the free lower end, of the sample. The weight shall be lowered in a way so that no impact load occurs on the sample being tested. The weight shall be sufficient distance from the floor of the chamber so that the weight will not touch the floor of the chamber as the sample undergoes creep during the test period. The date and hour the weight is applied shall be recorded.

The temperature cycle shall commence immediately within the environmentally controlled chamber. The test period for the applied load shall be 168 hours.

**Definition of Pass / Failure**

If any of the 10 seams fail prior to the end of the 168-hour (7-day) period, the date and hour of the failure shall be recorded and the polyethylene resin and strip material shall be considered unsuitable for geocell manufacturing.