

**ALCOA GEOSYSTEMS**

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

	Property	Value		Test Method		
<b>Base Material</b>	<b>Material Composition</b>	Polymer – Polyethylene with density of 0.935 – 0.965 g/cm <sup>3</sup> (58.4 - 60.2 lb/ft <sup>3</sup> )		ASTM D 1505		
	<b>Color</b>	Black - from Carbon Black	Tan, Green, Other Colors with no heavy metal content		N/A	
	<b>Stabilizer</b>	Carbon black content 1.5% - 2% by weight	Hindered amine light stabilizer (HALS) 1.0% by weight of carrier		N/A	
	<b>Minimum ESCR</b>	3000 hr		ASTM D 1693		
<b>Strip Properties</b>	<b>Sheet Thickness</b>	1.27 mm -5% +10% (50 mil -5% +10%)		ASTM D 5199		
	<b>Surface Treatment</b>	<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 a #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. The quantity of perforations shall remove 16.7% ± 3.5% of the cell wall area.	<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 22 – 31 per cm <sup>2</sup> (140 – 200 per in <sup>2</sup> ). In addition, the strips shall be perforated with horizontal rows of 10 mm (0.4 in) diameter holes. Perforations within each row shall be 19 mm (0.75 in) on-center. Horizontal rows shall be staggered and separated 12 mm (0.50 in) relative to the hole centers. The edge of strip to the nearest edge of perforation shall be 8 mm (0.3 in) minimum and the centerline of the weld to the nearest edge of perforation shall be 18 mm (0.7 in) minimum. A slot with a dimension of 10 mm x 35 mm (3/8 in x 1 3/8 in) is standard in the center of the non-perforated areas and at the center of each weld.			
<b>Cell &amp; Seam Properties</b>	<b>Cell Details</b>	<b>Cell Depth</b>	<b>Nominal Dimensions ±10%</b>		<b>Density per m<sup>2</sup> (yd<sup>2</sup>)</b>	<b>Nominal Area ±1%</b>
			<b>Length</b>	<b>Width</b>		
	<b>GW20V</b>	75 mm (3 in)	224 mm (8.8 in)	259 mm (10.2 in)	34.6 (28.9)	289 cm <sup>2</sup> (44.8 in <sup>2</sup> )
	<b>GW30V</b>	100 mm (4 in)	287 mm (11.3 in)	320 mm (12.6 in)	21.7 (18.2)	460 cm <sup>2</sup> (71.3 in <sup>2</sup> )
	<b>GW40V</b>	150 mm (6 in) 200 mm (8 in)	475 mm (18.7 in)	508 mm (20.0 in)	8.3 (6.9)	1,206 cm <sup>2</sup> (187.0 in <sup>2</sup> )
	<b>Short-term Seam Peel Strength</b>	<b>Cell Depth</b>		<b>Average Certified Cell Seam Strength</b>		
		75 mm (3 in)		1060 N (240 lbf)		
		100 mm (4 in)		1420 N (320 lbf)		
		150 mm (6 in)		2130 N (480 lbf)		
	<b>Long-term Seam Peel Strength</b>	200 mm (8 in)		2840 N (640 lbf)		
Long-term seam peel strength test shall be performed on all resin or pre-manufactured sheet or strips. A 100 mm (4.0 in) wide seam sample shall support a 72.5 kg (160 lb) 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 54°C (130°F). Ambient room temperature is per ASTM E 41						
<b>10,000-hour Seam Peel Strength Certification</b>	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 95 kg (209 lbf) for a minimum of 10,000 hours.					
<b>Section Properties</b>	<b>Section Dimension</b>	<b>Section Width</b>	<b>Section Length Range (Cells Long: 18, 21, 25, 29, 34)</b>			
		<b>Variable</b>	<b>Minimum</b>		<b>Maximum</b>	
	<b>GW20V</b>	2.3 m (7.7 ft) to 2.8 m (9.2 ft)	3.7 m (12.0 ft)		8.3 m (27.3 ft)	
	<b>GW30V</b>		4.7 m (15.4 ft)		10.7 m (35.1 ft)	
<b>GW40V</b>	7.7 m (25.4 ft)		17.8 m (58.2 ft)			

### ***Manufacturing Certification***

Alcoa Geosystems (the manufacturer) 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 9001:2000 quality standards. The scope of the ISO 9001:2000 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, Alcoa Geosystems (the manufacturer) 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
7. 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 areas 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 within 60 days after all submitted information is studied and tested.

### ***Product Certification***

Alcoa Geosystems (the manufacturer) 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.

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

Alcoa Geosystems (the manufacturer) shall warrant each Geoweb section that it ships to be free from defects in materials and workmanship at the time of manufacture. Alcoa's exclusive liability under this warranty or otherwise will be to furnish without charge to Alcoa'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 Alcoa. Alcoa 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 Alcoa'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.

ALCOA 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 Alcoa 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.

### ***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.

### ***Geoweb Base Material***

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

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

Polyethylene used to make strips for Alcoa Geoweb sections shall have a density of 0.935 - 0.965 g/cm<sup>3</sup> (58.4 - 60.2 lb/ft<sup>3</sup>) tested per ASTM D1505.

Polyethylene used to make strips for Alcoa Geoweb sections shall have an Environmental Stress Crack Resistance (ESCR) of 3000 hour tested per 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 a 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 Alcoa (the Geoweb manufacturer). Alcoa shall certify the percentage of carbon black.

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

Polyethylene used to make strips for Alcoa Geoweb sections shall have a density of 0.935 - 0.965 g/cm<sup>3</sup> (58.4 - 60.2 lb/ft<sup>3</sup>) tested per ASTM D1505.

Polyethylene used to make strips for Alcoa Geoweb sections shall have an Environmental Stress Crack Resistance (ESCR) of 3000 hour tested per 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 facia panels on Geoweb sections used for earth retention systems shall have a High Pressure Oxidation Induction Time (HPOIT) of 820 minutes minimum per 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 Alcoa (the Geoweb manufacturer). Alcoa shall certify the percentage of HALS.

#### ***Specifier Choice for Base Material***

The polyethylene used for all Geoweb material meets the same standards. 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 facia strip for Geoweb earth retention systems.

#### ***Strip Properties and Assembly***

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

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

Polyethylene sheet used to make strips for Alcoa Geoweb sections shall have a thickness of 1.27 mm -5% +10% (50 mil -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 a #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. The quantity of perforations shall remove 16.7% ± 3.5% of the cell wall area. **Material:** The surface texturing shall be a multitude of rhomboidal (diamond shape) indentations. The rhomboidal indentations shall have a surface density of 22 - 31 per cm<sup>2</sup> (140 - 200 per in<sup>2</sup>). The thickness of the textured sheet shall be 1.52 mm ±0.15 mm (60 mil ±6 mil) determined per ASTM D5199. The perforations shall be horizontal rows of 10 mm (0.4 in) diameter holes. Perforations within each row shall be 19 mm (0.75 in) on-center. Horizontal rows shall be staggered and separated 12 mm (0.50 in) relative to the hole centers. The edge of strip to the nearest edge of perforation shall be 8 mm (0.3 in) minimum and the centerline of the weld to the nearest edge of perforation shall be 18 mm (0.7 in) minimum. A slot with a dimension of 10 mm x 35 mm (3/8 in x 1 3/8 in) 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 Alcoa Geoweb sections shall have a thickness of 1.27 mm -5% +10% (50 mil -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 a #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. **Material:** The surface texturing shall be a multitude of rhomboidal (diamond shape) indentations. The rhomboidal indentations shall have a surface density of 22 - 31 per cm<sup>2</sup> (140 - 200 per in<sup>2</sup>). The thickness of the textured sheet shall be 1.52 mm ±0.15 mm (60 mil ±6 mil) determined per ASTM D5199. A slot with a dimension of 10 mm x 35 mm (3/8 in x 1 3/8 in) may be punched in the center of the non-perforated areas and at the center of each weld.

***Assembly***

Alcoa Geoweb [*Cell Type*] sections shall be fabricated using strips of sheet polyethylene each having a length of ... (per 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 ... (per Table 1). The ultrasonic weld melt-pool width shall not exceed 25 mm (1.0 in).

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

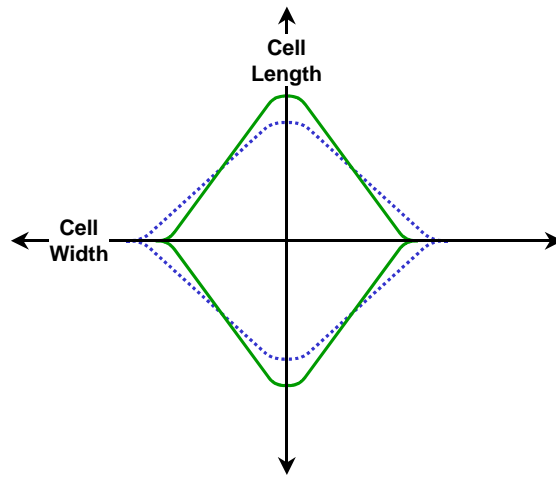
Cell Type	GW20V	GW30V	GW40V
Strip Length	3.61 m (142 in)	3.61 m (142 in)	3.61 m (142 in)
Weld Spacing	356 mm ± 2.5 mm (14.0 in ± 0.10 in)	445 mm ± 2.5 mm (17.5 in ± 0.10 in)	711 mm ± 2.5 mm (28.0 in ± 0.10 in)

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

The specifier shall state the desired strip/cell type: Perforated Textured or Non-Perforated Textured and use either the **Performance** or **Material** language. Refer to *THE GEOWEB SYSTEM TECHNICAL OVERVIEW* documents for recommendations.

***Cell and Seam Properties***

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



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

**Cell Nominal Length & Width, Density, and Nominal Area**

The individual cells of the GW(TT)V Geoweb section shall have a variable dimensions depending on expansion. The nominal cell dimensions, density and nominal area are illustrated in Figure 1.

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

**Nominal Cell Depth**

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

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

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:

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

Short-term seam peel strength shall be tested per 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 100 mm (4.0 in) wide seam sample shall support a 72.5 kg (160 lb) 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 54°C (130°F). Room temperature is defined in ASTM E41.

Long-term seam peel strength shall be tested per Appendix B.

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

Alcoa 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 95 kg (209 lbf) for a minimum of 10,000 hours.

**Specifier Choice for Seam and Cell Properties**

The specifier shall state the desired cell size: either the GW20V, GW30V or GW40V Geoweb section and the cell depth. Refer to *THE GEOWEB SYSTEM TECHNICAL OVERVIEW* documents for recommendations.

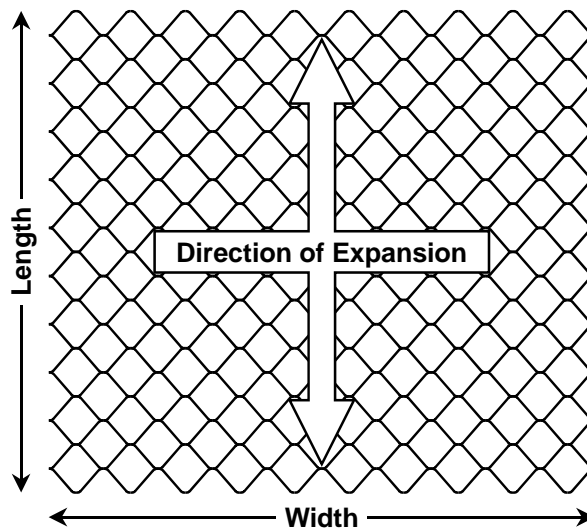
The specifier shall also state the Short-Term Seam Peel-Strength Test and the Long-Term Seam Peel-Strength Test. There are three possibilities for seams for a Geoweb section:

- 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 facia 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. Alcoa 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.*

**Geoweb Section Properties – GW20V Cell**

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

**GW20V Geoweb Section**



**Figure 2 GW20V Geoweb Section**

Alcoa Geoweb GW20V section dimensions shall be as indicated in Figure 2. 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 per Table 2. An example of the GW20V Geoweb section nomenclature is GW20V81029 where the section cell depth is 8 in or 200 mm and the section is 10 cells wide and 29 cells in length.

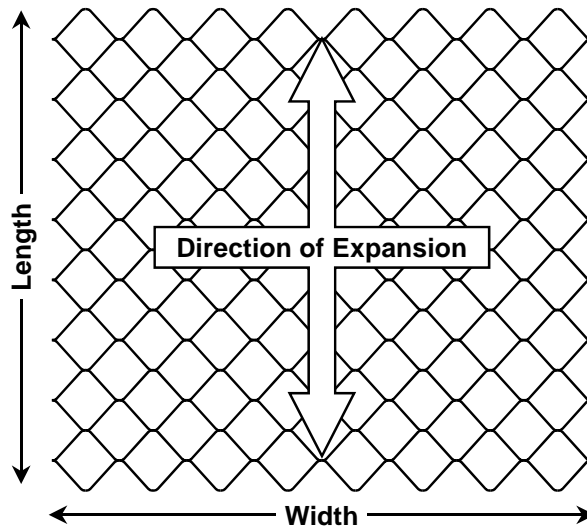
**Table 2 Available GW20V Geoweb Section Dimensions - 10 Cells Wide**

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

**Geoweb Section Properties – GW30V Cell**

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

**GW30V Geoweb Section**



**Figure 3 GW30V Geoweb Section**

Alcoa Geoweb GW30V section dimensions shall be as indicated in Figure 3. 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 per Table 3. An example of the GW30V Geoweb section nomenclature is GW30V60829 where the section cell depth is 6 in or 150 mm and the section is 8 cells wide and 29 cells in length.

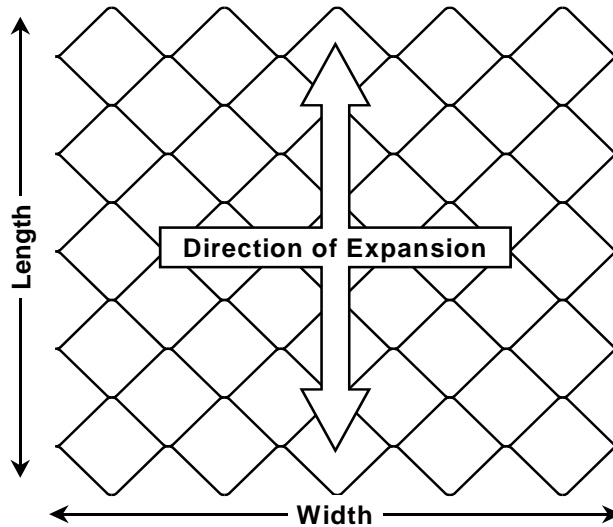
**Table 3 Available GW30V Geoweb Section Dimensions - 8 Cells Wide**

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

**Geoweb Section Properties – GW40V Cell**

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

**GW40V Geoweb Section**



**Figure 4 GW40V Geoweb Section**

Alcoa Geoweb GW40V section dimensions shall be as indicated in Figure 4. 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 per Table 4. An example of the GW40V Geoweb section nomenclature is GW40V40525 where the section cell depth is 4 in or 100 mm and the section is 5 cells wide and 25 cells in length.

**Table 4 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

**Specifier Choice for Section Properties**

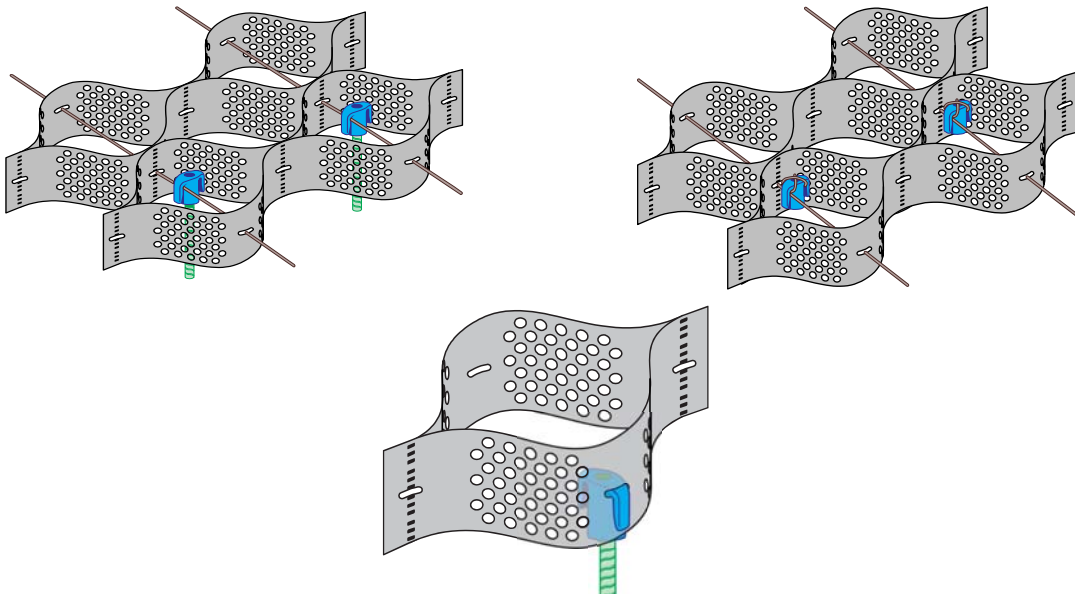
The specifier shall state the desired Geoweb section type(s) and size(s). Refer to *THE GEOWEB SYSTEM TECHNICAL OVERVIEW* documents for recommendations.

**Geoweb Section Features / Components**

**Slotted Geoweb Sections**

Geoweb sections may be provided with a series of punched slots through the cell walls at each weld point. The slots are used for:

1. Inserting tendons at predetermined spacing. Tendons are inserted in the field such that they pass through the Geoweb section in the direction of expansion. Tendons may be used with ATRA® anchors or ATRA® restraint clips.
2. Connecting ATRA anchors so that the top of the ATRA anchors are below surface. See Figure 5.



**Figure 5 Slotted Geoweb Section Applications**

**Integral Tendons**

**Polyester Tendons**

The polyester tendon 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 per Table 5.

**Table 5 Polyester Tendons**

Reference Name	Tendon Diameter / Width		Tendon Minimum Break-strength	
	mm	in	kN	lbf
TP-31	13	0.500	3.11	700
TP-67	19	0.750	6.70	1506
TP-93	19	0.750	9.30	2090

***Kevlar® Aramid Tendons***

The Kevlar® aramid tendon shall be a woven strap having the reference name, width and minimum break-strength per Table 6.

**Table 6 Kevlar® Aramid Tendon**

Reference Name	Tendon Diameter / Width		Tendon Minimum Break-strength	
	mm	in	kN	Lbf
TK-89	10	0.375	8.90	2000
TK-133	16	0.625	13.34	3000

***Polypropylene Tendons***

The polypropylene tendon shall be 3-strand twisted rope having the reference name, diameter and minimum break-strength per Table 7.

**Table 7 Polypropylene Tendon**

Reference Name	Tendon Diameter / Width		Tendon Minimum Break-strength	
	mm	in	kN	Lbf
TPP-44	6 dia	0.25 dia	4.40	990

***The ATRA® Clip Restraint Pin***

The ATRA® Clip shall be used as a load transfer pin within Geoweb® sections. The ATRA® Clip Restraint Pin shall transfer load from the infilled Geoweb cells to the tendon. The ATRA® Clip shall be molded from high-strength polyethylene.



**Figure 6 ATRA® Clip**

***Specifier Choice for Tendons and Restraint Pins***

If a requirement of the design, the specifier shall state which tendon is to be used. Tendon strength must meet design requirements for the application. The specifier shall also state if the ATRA® Clip restraint pin is needed. Refer to *THE GEOWEB SYSTEM TECHNICAL OVERVIEW* documents for recommendations.

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

***Anchoring Requirements***

Geoweb sections shall be anchored in accordance with construction drawings. Rows of ATRA® Anchors or stake anchors shall engage and bear against the cell walls, or engage and hold the integral tendons against the foundation soil. The size, type and distribution of ATRA® Anchor (stake anchors) shall be in accordance with the construction drawings.

**Anchor Systems**

**ATRA® GFRP Anchor – Pre-Assembled Unit**

The ATRA® GFRP Anchor shall be a pre-assembled unit consisting of the ATRA® Clip inserted onto the ATRA® GFRP stake so that the end of the stake is flush with or 3 mm (1/8 in) maximum above the top of the ATRA® Clip. Prior to inserting the ATRA® Clip on the end of the stake, the stake end shall be ground or filed so it has a bevel and is free from all burrs.

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 655 MPa (95 ksi) per ASTM D638. The stake shall be non-magnetic, non-conducting and corrosion resistant. The stake diameter shall be 12-13 mm (1/2 in). The length shall be per construction drawings.

The pre-assembled ATRA® GFRP Anchors are available from Alcoa Geosystems. Contact Alcoa Geosystems or their authorized representative for available lengths.

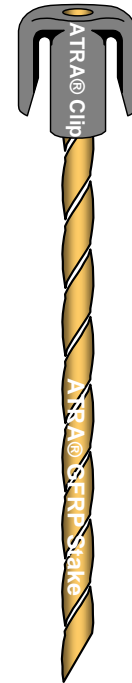


Figure 7 ATRA® GFRP Anchor

**Other ATRA® Anchors**

**ATRA® GFRP Anchor**

The ATRA® GFRP Anchor shall be made by properly inserting the ATRA® Clip onto a straight stake so that the end of the stake is flush with or 3 mm (1/8 in) maximum above the top of the ATRA® Clip. Prior to inserting the ATRA® Clip on the end of the stake, the stake end shall be ground or filed so it has a bevel and is free from all burrs. The stake shall be composed of glass fiber-reinforced polymer (GFRP) 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. The use of non-continuous filament is strictly prohibited. Polymer shall be vinyl ester, isophthalic polyester, or other matrix material. The stake shall have a minimum tensile strength of 655 MPa (95 ksi) per ASTM D638. The stake shall be non-magnetic, non-conducting and corrosion resistant. The stake length shall be per construction drawings.

**Steel ATRA® Anchor**

The Steel ATRA® Anchor shall be made by properly inserting the ATRA® Clip onto a straight stake so that the end of the stake is flush with or 3 mm (1/8 in) maximum above the top of the ATRA® Clip. Prior to inserting the ATRA® Clip on the end of the stake, the stake end shall be ground or filed so it has a bevel and is free from all burrs. The stake shall consist of straight 12-13 mm (#4) steel reinforcing rod. The stake length shall be per construction drawings.

#### Galvanized Steel ATRA® Anchor

The Galvanized Steel ATRA® Anchor shall be made by properly inserting the ATRA® Clip onto a straight stake so that the end of the stake is flush with or 3 mm (1/8 in) maximum above the top of the ATRA® Clip. Prior to inserting the ATRA® Clip on the end of the stake, the stake end shall be ground or filed so it has a bevel and is free from all burrs. The stake shall consist of straight 12-13 mm (#4) steel reinforcing rod hot dipped galvanized per AASHTO M-218. The stake length shall be per construction drawings.

#### Metal ATRA® Anchor

The ATRA® Anchor shall be made by properly inserting the ATRA® Clip onto a straight stake so that the end of the stake is flush with or 3 mm (1/8 in) maximum above the top of the ATRA® Clip. Prior to inserting the ATRA® Clip on the end of the stake, the stake end shall be ground or filed so it has a bevel and is free from all burrs. The stake shall consist of straight 12-13 mm (½ in) \_\_\_\_\_ (state metal type) rod. The stake length shall be per construction drawings.

### Stake Types

#### GFRP Stakes

The GFRP Stake shall be composed of glass fiber-reinforced polymer with a sand coating. Glass reinforcement content shall be 75% minimum by weight and shall be continuous longitudinal filament. The use of non-continuous filament is strictly prohibited. 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 stake shall have a minimum tensile strength of 655 MPa (95 ksi) per ASTM D638. The stake shall be non-magnetic, non-conducting and corrosion resistant. The stake diameter and length shall be per construction drawings.

#### Steel J-pin Stakes

Steel J-pin stakes shall be fabricated from mild steel or reinforcing steel rod. Each stake shall have a minimum-radius, 180-degree return at one end. Rod diameter shall be 8 mm (0.3125 in), 10 mm (0.375 in), 12 mm (0.50 in), 16 mm (0.625 in) or 20 mm (0.75 in). Stake length shall be per the construction drawings. When specified, galvanizing shall be per AASHTO M-218.

#### Straight Steel Stakes

Straight steel stakes shall be fabricated from mild steel or reinforcing steel rod. Rod diameter shall be 8 mm (0.3125 in), 10 mm (0.375 in), 12 mm (0.50 in), 16 mm (0.625 in) or 20 mm (0.75 in). Stake length shall be per the construction drawings. When specified, galvanizing shall be per AASHTO M-218.

#### Straight Metal Stakes

Straight metal shall be fabricated from \_\_\_\_\_ (state metal type) rod. Rod diameter shall be 8 mm (0.3125 in), 10 mm (0.375 in), 12 mm (0.50 in), 16 mm (0.625 in) or 20 mm (0.75 in). Stake length shall be per the construction drawings.

#### Wood Stakes

Wood stakes shall be made from \_\_\_\_\_ (state wood type) and shall be free from knots that affect the strength of the stake. The stakes shall have a cross section of \_\_\_\_\_ by \_\_\_\_\_ and be \_\_\_\_\_ long.

### Specifier Choice for Anchoring Systems

The specifier shall state which of the anchoring methods are required for the application and choose from the stated options. Refer to *THE GEOWEB SLOPE PROTECTION SYSTEM* and/or *CHANNEL PROTECTION SYSTEM TECHNICAL OVERVIEW* for recommendations. Note, the pre-assembled glass fiber-reinforced polymer ATRA® GFRP Anchors are available from Alcoa Geosystems. Other ATRA® Anchors are not available from Alcoa Geosystems.



## **GEOWEB<sup>®</sup> SYSTEM MATERIAL SPECIFICATION**

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### ***Disclaimer***

This document has been prepared for the benefit of customers interested in the Alcoa Geosystems Geoweb Cellular Confinement System. It was reviewed carefully prior to publication. Alcoa Geosystems assumes no liability and makes no guarantee or warranty as to its accuracy or completeness. Final determination of the suitability of any information or material for the use contemplated, or for its manner of use, is the sole responsibility of the user. Geoweb<sup>®</sup> and ATRA<sup>®</sup> are registered trademarks of Presto Products Company, a business of Alcoa.

**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 10 cm (4 in) 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 300 mm (12 in) 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:

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

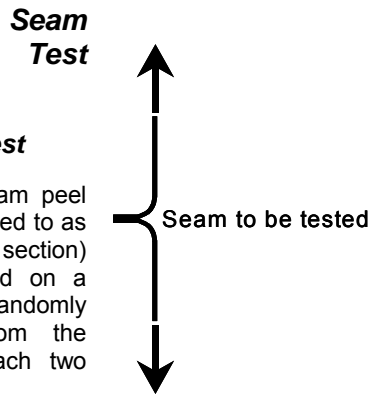


Figure A1

**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.

**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.

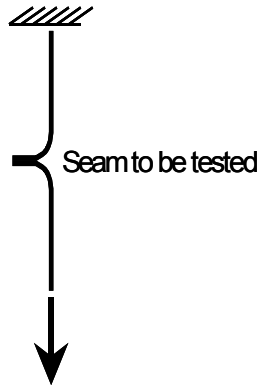


Figure B1

**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 10 cm (4 in) of material exist on each side of the weld. These samples shall be cut to a width of 10 cm (4 in). 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 54°C (130°F). Room temperature shall be defined per 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 72.5 kg (160 lb) 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.