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May 2013

PRODUCT SPECIFICATION (CSI FORMAT)

Specifier Note: This product guide specification is written according to the Construction Specifications Institute (CSI) Format, including *Master Format*, *Section Format,* and *Page Format,* contained in the CSI *Manual of Practice.*

The section shall be carefully reviewed and edited by the Engineer to meet specific project requirements and all applicable building codes. Coordinate with corresponding specification sections, details and drawings.

Contract Documents shall refer to the drawings and specifications prepared and approved by the Engineer.

Delete all "Specifier Notes" while editing this section.

SECTION _____

SOIL STABILIZATION SYSTEM

Specifier Note: This section covers Presto Geosystems' Geoweb® (geocell) Cellular Confinement System. The system consists of geocell material into which specific infill materials may be placed. The complete system includes Geoweb sections, infill materials, and some or all of the following components: ATRA® Stake Clips, ATRA® Anchors, tendons, ATRA® Tendon Clips, ATRA Key connection device, geotextiles, earth anchoring devices, geomembrane, geocomposite drainage materials and surface treatments.

Contact Presto Geosystems for assistance in editing this section.

PART 1 GENERAL

1.1 SUMMARY

A. Work Included: This Section includes providing all material, labor, tools and equipment for installation of Cellular Confinement System as shown in the Contract Documents and as specified in this Section.

B. The Cellular Confinement System shall be used for channel protection.

1.2 RELATED SECTIONS AND DIVISIONS

Specifier Note: Edit the following list as required for the project. List other sections with work directly related to the cellular confinement system.

A. The applicable provisions of the General Conditions shall govern the work in this Section.

B. Section 0130000 – Administrative Requirements

C. Section 0220000 – Site Preparation

D. Section 312000 – Earth Moving

E. Section 312500 - Erosion and Sedimentation Control

1.3 REFERENCES

Specifier Note: List standards referenced in the section, complete with designations and titles. This article does not require compliance with standards, but is merely a listing of those used.

A. American Association of State Highway and Transportation Officials (AASHTO)
   1. AASHTO M 218 - Steel Sheet, Zinc-Coated (Galvanized) for Corrugated Steel Pipe.
   2. AASHTO M 288 - Geotextile Specification for Highway Applications

B. American Society of Testing and Materials (ASTM)
   1. ASTM D 1505 - Density of Plastics by the Density-Gradient Technique.
   2. ASTM D 1603 – Standard Test for Carbon Black in Olefin Plastics
   3. ASTM D 1693 – Environmental Stress-Cracking of Ethylene Plastics.
   4. ASTM D 5199 – Measuring Nominal Thickness of Geotextiles and Geomembranes.
   5. ASTM E 41 – Terminology Relating to Conditioning.

1.4 SUBMITTALS

A. Submit manufacturer's shop drawings in accordance with Section 0130000, Submittals including Manufacturer's product data, samples and section layout.

B. Manufacturer's Certificate of Analysis: Manufacturer shall supply certificate of analysis containing the following test results for the cellular confinement material used for project: Base Resin Lot Number(s), Resin Density per ASTM-1505, Production Lot Number(s), Material Thickness, Short Term Seam Peel Strength, and percentage of Carbon Black.

C. Design Calculations and Drawings. Provide a complete set of design calculations including a description of the hydraulic and static analyses performed to determine overall stability.
   1. The calculations shall be submitted at the time of bid.
   2. Minimum overall design factor of safety shall be 1.4.

3. At a minimum; include channel design conditions, channel and hydraulic stability calculations, flow, velocity, roughness coefficients, water depth, tractive force, calculated factors of safety, friction angles and type of anchorage (anchors, tendons, earth anchors, etc).
4. If required, provide type (crest burial, pipe deadman, concrete deadman, earth anchors, etc) and calculations for the recommended crest anchorage system.
5. If tendons are required, a submittal shall be included for the load transfer device including third party testing showing pull through testing exceeding 420 pounds.
6. The stability calculations shall be in Microsoft Excel converted to Adobe PDF format.
7. Cross section drawings shall be in AutoCAD converted to Adobe PDF format.

Specifier Note: Delete installer qualifications if not required.

D. Submit qualifications certifying the installer is experienced in the installation of the specified products.

E. Submit qualifications of Manufacturer's field representative certifying the field representative is experienced in the installation of the specified products.

F. 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. Any substitute materials submitted shall be subject to independent lab testing at the contractor's expense.

1.5 QUALITY ASSURANCE AND CONTROL

A. The cellular confinement system material shall be provided from a single Manufacturer for the entire project.

B. The Manufacturer's Quality management system shall be certified and in accordance with ISO 9001:2008 and CE certification. Any substitute materials submitted shall provide a certification that their cellular confinement manufacturing process is part of an ISO program and a certification will be required specifically stating that their testing facility is certified and in accordance with ISO. An ISO certification for the substitute material will not be acceptable unless it is proven it pertains specifically to the geocell manufacturing operations.

C. 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. The Manufacturer shall have a minimum of 20 years experience producing cellular confinement systems.

D. Pre-Installation Meeting: Prior to installation of any materials, conduct a pre-installation meeting to discuss the scope of work and review installation requirements. The pre-installation meeting shall be attended by all parties involved in the installation of the cellular confinement system.

E. Manufacturer's Field Representative Qualifications:

1. Manufacturer shall provide a qualified field representative on site at the start of construction to ensure the system is installed in accordance with the Contract Documents.
2. Manufacturer's field representative shall have a minimum 5 years installation experience with the specified products in the specified application.

3. Manufacturer of any substitute materials to be used shall certify that a representative can meet the above criteria and will be on site for initial construction start up. Manufacturers other than Presto will be required to provide proof the representative meets these qualifications.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to site in Manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and Manufacturer.

B. The materials shall be stored in accordance with Manufacturer's instructions. The materials shall be protected from damage and out of direct sunlight.

C. The materials shall be delivered, unloaded and installed in a manner to prevent damage.

1.7 WARRANTY

A. The Manufacturer shall warrant each section that it ships to be free from defects in materials and workmanship at the time of manufacture. The Manufacturer's exclusive liability under this warranty or otherwise will be to furnish without charge to 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. The Manufacturer reserves the right to inspect any allegedly defective section in order to verify the defect and ascertain its cause.

B. This warranty shall not cover defects attributable to causes or occurrences beyond the Manufacturer'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.

C. In no event shall the Manufacturer 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 cellular confinement system.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

A. Presto Geosystems, PO Box 2399, Appleton, Wisconsin 54912-2399.
Toll Free: (800) 548-3424. Phone: (920) 738-1328. Fax: (920) 738-1222.
E-Mail info@prestogeo.com. Website www.prestogeo.com.

2.2 GEOWEB CELLULAR CONFINEMENT SYSTEM

A. Manufacturing Certification

1. Presto Geosystems (the manufacturer) shall have earned a certificate of registration, which demonstrates that its quality-management system for its Geoweb cellular confinement system is currently registered to the ISO 9001:2008 and CE quality standards.

B. Base Materials

1. Polyethylene Stabilized with Carbon Black

a. Density shall be 58.4 to 60.2 pound/ft^3 (0.935 to 0.965 g/cm^3) in accordance with ASTM D 1505.
b. Environmental Stress Crack Resistance (ESCR) shall be 5000 hours in accordance with ASTM D 1693.
c. Ultra-Violet light stabilization with carbon black.
d. Carbon Black content shall be 1.5 to 2 percent by weight, through addition of a carrier with certified carbon black content.
e. Carbon black shall be homogeneously distributed throughout material.
f. The manufacturer must have an in-place quality control to prevent irregularities in strip.

C. Cell Properties
1. Individual cells shall be uniform in shape and size when expanded.
2. Individual cell dimensions (nominal) shall be dimensions ± 10%.

Specifier Note: Select GW20V-Cell, GW30V-Cell, or GW40V-Cell type and nominal depth and delete the others. Contact Presto Geosystems for assistance.

3. GW20V-Cell
a. Length shall be 8.8 inches (224 mm).
b. Width shall be 10.2 inches (259 mm).
c. Nominal area shall be 44.8 in^2 (289 cm^2) plus or minus 1%.
d. Nominal depth shall be [8 inches (200 mm)] [6 inches (150 mm)] [4 inches (100 mm)] [3 inches (75 mm)].
4. GW30V-Cell
a. Length shall be 11.3 inches (287 mm).
b. Width shall be 12.6 inches (320 mm).
c. Nominal area shall be 71.3 in^2 (460 cm^2) plus or minus 1%.
d. Nominal depth shall be [8 inches (200 mm)] [6 inches (150 mm)] [4 inches (100 mm)] [3 inches (75 mm)].
5. GW40V-Cell
a. Length shall be 18.7 inches (475 mm).
b. Width shall be 20.0 inches (508 mm).
c. Nominal area shall be 187.0 in^2 (1206 cm^2) plus or minus 1%.
d. Nominal depth shall be [8 inches (200 mm)] [6 inches (150 mm)] [4 inches (100 mm)] [3 inches (75 mm)].

D. Strip Properties and Assembly
1. Perforated Textured Strip/Cell
a. Strip sheet thickness shall be 50 mil (1.27 mm), minus 5 percent, plus 10 percent in accordance with ASTM D 5199. Determine thickness flat, before surface disruption.
b. Polyethylene strips shall be textured surface with a multitude of rhomboidal (diamond shape) indentations.

c. Textured sheet thickness shall be 60 mil plus or minus 6 mil (1.52 mm plus or minus 0.15 mm).
d. Indentation surface density shall be 140 to 200 per in2 (22 to 31 per cm2).
e. Perforated with horizontal rows of 0.4 inch (10 mm) diameter holes.
f. Perforations within each row shall be 0.75 inches (19 mm) on-center.
g. Horizontal rows shall be staggered and separated 0.50 inches (12 mm) relative to hole centers.
h. Edge of strip to nearest edge of perforation shall be a minimum of 0.3 inches (8 mm).
i. Centerline of spot weld to nearest edge of perforation shall be a minimum of 0.7 inches (18 mm).
j. A slot with a dimension of 3/8 inch x 1-3/8 inch (10 mm x 35 mm) is standard in the center of the non-perforated areas and at the center of each weld.

2. Assembly of Cell Sections
a. Fabricate using strips of sheet polyethylene each with a length of 142 inches (3.61 m) and a width equal to cell depth.
b. Connect strips using full depth ultrasonic spot-welds aligned perpendicular to longitudinal axis of strip.
c. Ultrasonic weld melt-pool width shall be 1.0 inch (25 mm) maximum.

Specifier Note: Select GW20V Cell, GW30V Cell, or GW40V Cell type and delete others.

d. Weld spacing for GW20V-cell sections shall be 14.0 inches plus or minus 0.10 inch (356 mm plus or minus 2.5 mm).
e. Weld spacing for GW30V-cell sections shall be 17.5 inches plus or minus 0.10 inch (445 mm plus or minus 2.5 mm).
f. Weld spacing for GW40V-cell sections shall be: 28.0 inches plus or minus 0.10 inch (771 mm plus or minus 2.5 mm).

E. Cell Seam Strength Tests
1. Minimum seam strengths are required by design and shall be reported in test results. Materials submitted with average or typical values will not be accepted. Written certification of minimum strengths must be supplied to the engineer at the time of submittals.
2. Short-Term Seam Peel-Strength Test
a. Cell seam strength shall be uniform over full depth of cell.

Specifier Note: Select the minimum seam peel strength for the specified cell size and delete the others. Contact Presto Geosystems for assistance.

b. Minimum seam peel strength shall be [640 lbf (2,840 N) for 8 inch (200 mm) depth] [480 lbf (2,130 N) for 6 inch (150 mm) depth] [320 lbf (1,420 N) for 4 inch (100 mm) depth] [240 lbf (1060 N) for 3 inch (75 mm) depth].
3. Long-Term Seam Peel-Strength Test
a. Conditions: Minimum of 7 days in a temperature-controlled environment that undergoes change on a 1-hour cycle from room temperature to 130 degrees F (54 degrees C).

b. Room temperature shall be in accordance with ASTM E41.
c. Test samples shall consist of two, 4 inch (100 mm) wide strips welded together.
d. Test sample consisting of 2 carbon black stabilized strips shall support a 160 pound (72.5 kg) load for test period.

2.3 INTEGRAL COMPONENTS

A. A TRA® Tendon Clip
1. The ATRA Tendon Clip is a molded, high-strength polyethylene device with a locking member and post.
2. The ATRA Tendon Clip is the recommended anchorage connection method for securing sections with tendons and transferring the driving gravity forces to the cell wall.

B. ATRA® Stake Clip
1. The ATRA Stake Clip is a molded, high-strength polyethylene device available in standard (0.5 inch) and metric (10–12 mm) versions.
2. ATRA Stake Clips can be installed as an end cap on standard (0.5 inch) and metric (10–12 mm) steel reinforcing rods to form ATRA Anchors.

C. ATRA® Key
1. ATRA keys shall be constructed of polyethylene and provide a high strength connection.
2. ATRA keys shall be used to connect sections together at each interleaf and end to end connection.

2.4 STAKE ANCHORAGE

Specifier Note: Select the desired stake anchorage and delete the others. No stake anchorage may be necessary. Contact Presto Geosystems for assistance.

A. ATRA® Anchors
1. ATRA Anchors shall consist of standard (0.5 inch) or metric (10–12 mm) steel reinforcing rod with an ATRA® Clip attached as an end cap.
2. ATRA anchors shall be assembled by inserting the ATRA Stake Clip onto the reinforcing rod so that the end is flush with the top of the ATRA Stake Clip. Prior to attaching the ATRA Stake Clip, the reinforcing rod shall be beveled and free from all burrs.
3. The anchor length shall be as shown in the Contract Documents.

B. ATRA® Glass Fiber Reinforced Polymer (GFRP) Anchors
1. ATRA GFRP Anchors shall be pre-assembled units consisting of the ATRA Stake Clip inserted onto a GFRP stake.
2. The glass reinforcement content shall be 75% minimum by weight and shall be continuous longitudinal filament.
3. Polymer shall be vinyl ester, isophthalic polyester or other matrix material.
4. The outer surface shall be sand coated and deformed by a helical wrap of glass.

5. The minimum compressive strength shall be 95 kips (655 MPa) in accordance with ASTM D 638.
6. The anchor shall be non-magnetic, non-conducting and corrosion resistant.
7. The anchor length shall be as shown in the Contract Documents.

2.5 TENDON ANCHORAGE

Specifier Note: If required, select the desired tendon and corresponding break-strength and delete the others. Contact Presto Geosystems for assistance.

A. Tendon Type
   1. Woven Polyester - [TP-31] [TP-67] [TP-93]
      a. Material shall be bright, high-tenacity, industrial-continuous-filament, polyester yarn woven into a braided strap.
      b. Elongation shall be 9 to 15 percent at break.
      c. Minimum break strength shall be [700 lbf (3.11 KN) for TP-31] [1506 lbf (6.70 KN) for TP-67] [2090 lbf (9.30 KN) for TP-93].
   2. Woven Kevlar - [TK-89] [TK-133] [TK-178]
      a. Material shall be Kevlar® Aramid material woven into a strap.
      b. Minimum break strength shall be [2000 lbf (8.90 KN) for TK-89] [3000 lbf (13.34 KN) for TK-133] [4000 lbf (17.8 KN) for TK-178].

B. Type of Tendon Anchorage

Specifier Note: Select the anchorage system being used with the tendons and delete the others. If no tendon anchorage system is required, delete the section. Contact Presto Geosystems for assistance.

1. Tendons, ATRA Tendon Clips and Geoweb Buried at Crest.
2. Tendons, ATRA Tendon Clips and ATRA Anchors.
3. Tendons, ATRA Tendon Clips and ATRA GFRP Anchors.
4. Tendons, ATRA Tendon Clips and Deadman Pipe Anchorage.
5. Tendons, ATRA Tendon Clips and Earth Anchors.

2.6 CELL INFILL MATERIALS

Specifier Note: Specify infill material type and delete the others. Coordinate infill materials with associated Soils and Concrete specifications. Engineered infill is typically used to provide structural strength in areas exposed to vehicle loads. Contact Presto Geosystems for assistance.

A. Cell infill material shall be topsoil for vegetated surfaces and shall have an SCS texture of loam, sandy loam or silty loam. Topsoil shall be neither excessively acidic nor alkaline.

B. Cell infill material shall be gravel, crushed aggregate or stone with a maximum particle size of 3 inches (75 mm).

C. Cell infill material shall be concrete with a minimum strength of 3000 psi and air content of 2 to 4% in accordance with ACI and ASTM standards.

D. Cell infill material shall be an engineered fill consisting of topsoil and aggregate mixture for vegetated surfaces.

1. Engineered infill shall be a mix of topsoil and aggregate having a homogeneous mixture of a clear crushed aggregate having an AASHTO #5 or similar designation blended with pulverized topsoil and a minimum 30% void space for air and/or water.
2. The mixture will promote vegetation growth and provide structural support.
3. The aggregate portion shall have a particle range from 0.375 to 1.0 inches (9.5 to 25 mm) with a D50 of 0.5 inches (13 mm).
4. The percentage void space of the aggregate portion when compacted shall be at least 30%.
5. The pulverized topsoil portion shall equal 25% of the total volume. The topsoil shall be blended with the aggregate to produce a homogeneous mixture.
6. Once placed, the mixture shall be compacted to a 95% Standard Proctor.

E. Infill material shall be free of any foreign material.

F. Clays and silts are not acceptable infill material.

G. Infill material shall be free-flowing and not frozen when placed in the sections.

2.7 ADDITIONAL COMPONENTS

Specifier Note: Edit the following for specific project requirements and delete those items that do not apply. Surface protection with an erosion control blanket or turf reinforcement mat is typically provided if there is a chance of wash-out prior to establishing vegetation. A geotextile separation layer may be required to separate the sub grade from infill materials, or when a geomembrane separation layer is used. A geotextile separation layer is typically not required with topsoil infill.

A. Vegetation

1. Vegetation shall be as specified in the Contract Documents.

B. Surface Protection

1. Surface protection shall consist of [erosion control blanket] [turf reinforcement mat] as specified in the Contract Documents.

C. Geotextile

1. The geotextile separation layer shall be as specified in the Contract Documents.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify site conditions are as indicated on the drawings. Notify the Engineer if site conditions are not acceptable. Do not begin preparation or installation until unacceptable conditions have been corrected.

B. Verify layout of structure is as indicated on the drawings. Notify the Engineer if layout of structure is not acceptable. Do not begin preparation or installation until unacceptable conditions have been corrected.

Specifier Note: Edit the installation requirements as required. Contact Presto Geosystems for assistance.

3.2 INSTALLATION OF THE CHANNEL PROTECTION SYSTEM

A. Prepare sub grade and install channel protection system in accordance with Manufacturer's recommendations.

Specifier Note: Specify days required for manufacturer's field representative to be on site. Delete if manufacturer's field representative is not required.

B. On-site time for installation assistance by the Manufacturer's field representative shall be ____ day(s) with one trip. All travel and expense costs for Manufacturer's field representative installation assistance shall be included in the base bid price.

C. Sub Grade Preparation:

1. Excavate or fill foundation soils so top of installed section is flush with or slightly lower than adjacent terrain or final grade as indicated on the drawings or as directed by the Engineer.

Specifier Note: Delete geotextile and/or geomembrane section below if not required. Contact Presto Geosystems for assistance.

2. Install geotextile separation layer on prepared surfaces ensuring required overlaps are maintained and outer edges of geotextile are buried in accordance with the Manufacturer's recommendations.

3. Install geomembrane separation layer on prepared surfaces ensuring seams are welded and outer edges of geomembrane are buried in accordance with the Manufacturer's recommendations.

D. Section Anchorage

1. Anchorage requirements for the sections shall be as shown on the Contract Documents and as directed by the Engineer.

Specifier Note: Specifier shall select the preferred anchorage method from section 2-8 below and delete the others. Contact Presto Geosystems for assistance.

2. Anchorage with ATRA Anchors

a. Position collapsed sections at the crest of the channel slope.

b. If required, excavate the anchor trench at the top of the slope to the depth as shown on the Contract Documents.

c. Drive ATRA anchors at the crest of the slope to secure the sections in place and allow expansion of the sections into position.

d. After the sections are expanded as desired, drive ATRA Anchors so the arm of the ATRA Stake Clip engages with the top of the cell wall.

e. Anchorage pattern and stake length shall be as indicated on the Contract Documents.

f. Fill the anchorage trench with the specified material and compact as required by the Contract Documents.

3. Anchorage with ATRA GFRP Anchors
   a. Position collapsed sections at the crest of the channel slope.
   b. If required, excavate the anchor trench at the top of the slope to the depth as shown on the Contract Documents.
   c. Drive ATRA GFRP anchors at the crest of the slope to secure the sections in place and allow expansion of the sections into position.
   d. After the sections are expanded as desired, drive ATRA GFRP Anchors so the arm of the ATRA Stake Clip engages with the top of the cell wall.
   e. Anchorage pattern and stake length shall be as indicated on the Contract Documents.
   f. Fill the anchorage trench with the specified material and compact as required by the Contract Documents.
4. Anchorage with Tendons, ATRA Tendon Clips and Buried at Crest

   Preferred Method – Top of Channel Slope Installation
   a. Excavate the anchor trench at the top of the channel slope to the depth as shown on the Contract Documents.
   b. Position the collapsed sections at the crest of the slope.
   c. Measure and cut the tendon run lengths for each tendon location.
   d. Mark the tendons with a black permanent marker per the ATRA Tendon Clip Location Chart.
   e. Starting from the first cell, count the number of cells to the next ATRA Tendon Clip location and repeat along that cell row.
   f. Repeat this procedure for each additional cell row Tendon/ATRA Tendon Clip run.
   g. With all the ATRA Tendon Clips placed in the section, thread the tendons through the cell wall I-slots in the unexpanded section.
   h. Locate the corresponding mark on the tendon and position it in front of the cell wall. Hold the tendon and connect to the ATRA Tendon Clip. Refer to the Channel Installation Manual for ATRA Tendon Clip tie-off instructions.
   i. Leave the trailing length of the tendon on the upslope side of the section to allow connection to ATRA Tendon Clip.
   j. Repeat this process on each cell row Tendon/ATRA Tendon Clip run.
   k. Place the collapsed section in the anchor trench, secure with temporary stakes or ATRA Anchors and expand down the slope.
   l. Adjust the section (i.e. a shake or two of the expanded section works well for this) so that the section and tendons are uniformly taut.
   m. Terminate the bottom of the tendons with ATRA Tendon Clips.
   n. Fill the anchorage trench with the specified material and compact as required by the Contract Documents.

   Alternate Method – On Channel Slope Installation
   a. Excavate the anchor trench at the top of the channel slope to the depth as shown on the Contract Documents.
   b. Position collapsed sections at the crest of the slope.

c. Feed precut lengths of specified tendon material through the I-slots in cell walls before expanding individual sections into position. Number of tendons per section shall be per the Contract Documents. Leave the trailing length of the tendon on the upslope side of the section to allow for connection of the ATRA Tendon Clips.

d. Place the collapsed section in the anchor trench, secure with temporary stakes or ATRA Anchors and expand down the slope.

e. Install the ATRA Tendon Clips at the locations indicated on the Contract Documents.

f. Hold the tendon and connect to each ATRA Tendon Clip. Refer to the Channel Installation Manual for ATRA Tendon Clip tie-off instructions.

g. Adjust the section (i.e. a shake or two of the expanded section works well for this) so that the section and tendons are uniformly taut.

h. Terminate the bottom of the tendons with ATRA Tendon Clips.

i. Fill the anchorage trench with the specified material and compact as required by the Contract Documents.

5. Anchorage with Tendons, ATRA Tendon Clips and ATRA Anchors

Preferred Method – Top of Channel Slope Installation

a. Excavate the anchor trench at the top of the channel slope to the depth as shown on the Contract Documents.

b. Position the collapsed sections at the crest of the slope.

c. Measure and cut the tendon run lengths for each tendon location.

d. Mark the tendons with a black permanent marker per the ATRA Tendon Clip Location Chart.

e. Thread the tendons through the unexpanded section.

f. Starting from the first cell, count the number of cells to the next ATRA Tendon Clip location and repeat along that cell row.

g. Repeat this procedure for each additional cell row Tendon/ATRA Tendon Clip run.

h. With all the ATRA Tendon Clips placed in the section, thread the tendons through the cell wall I-slots in the unexpanded section.

i. Locate the corresponding mark on the Tendon and position it in front of the cell wall. Hold the tendon and connect to the ATRA Tendon Clip. Refer to the Channel Installation Manual for ATRA Tendon Clip tie-off instructions.

j. Repeat this process on each cell row Tendon/ATRA Tendon Clip run.

k. Place the collapsed section in the anchor trench, drive ATRA Anchors in the first row of cells so the arm of the anchor engages with the top of the cell wall and expand down the slope. Number of anchors shall be per the Contract Documents.

l. Adjust the section (i.e. a shake or two of the expanded section works well for this) so that the section and tendons are uniformly taut.

m. After the sections are expanded, drive ATRA Anchors so the arm of the anchor engages with the top of the cell wall.

n. Anchorage pattern and stake length shall be as indicated on the Contract Documents.

o. Terminate the bottom of the tendons with ATRA Tendon Clips.

p. Fill the anchorage trench with the specified material and compact as required by the Contract Documents.

Alternate Method – On Channel Installation

a. Excavate the anchor trench at the top of the channel slope to the depth as shown on the Contract Documents.
b. Position collapsed sections at the crest of the slope.
c. Feed precut lengths of specified tendon material through the I-slots in the cell walls before expanding individual sections into position. Number of tendons per section shall be per the Contract Documents. Leave the trailing length of the tendon on the upslope side of the section to allow for connection of the ATRA Tendon Clips.
d. Place the collapsed section in the anchor trench, drive ATRA Anchors in the first row of cells so the arm of the anchor engages with the top of the cell wall and expand down the slope.
e. Install the ATRA Tendon Clips at the locations indicated on the Contract Documents.
f. Hold the tendon and connect to each ATRA Tendon Clip. Refer to the Channel Installation Manual for ATRA Tendon Clip tie-off instructions.
g. Adjust the section (i.e. a shake or two of the expanded section works well for this) so that the section and tendons are uniformly taut.
h. After the sections are expanded as desired, drive ATRA Anchors so the arm of the anchor engages with the top of the cell wall.
i. Anchorage pattern and stake length shall be as indicated on the Contract Documents.
j. Terminate the bottom of the tendons as required.
k. Fill the anchorage trench with the specified material and compact as required by the Contract Documents.

6. Anchorage with Tendons and ATRA GFRP Anchors

Preferred Method – Top of Channel Slope Installation

a. Excavate the anchor trench at the top of the channel slope to the depth as shown on the Contract Documents.
b. Position the collapsed sections at the crest of the slope.
c. Measure and cut the tendon run lengths for each tendon location.
d. Mark the tendons with a black permanent marker per the ATRA Tendon Clip Location Chart.
e. Thread the tendons through the unexpanded section.
f. Starting from the first cell, count the number of cells to the next ATRA Tendon Clip location and repeat along that cell row.
g. Repeat this procedure for each additional cell row Tendon/ATRA Tendon Clip run.
h. With all the ATRA Tendon Clips placed in the section, thread the tendons through the cell wall I-slots in the unexpanded section.
i. Locate the corresponding mark on the Tendon and position it in front of the cell wall. Hold the tendon and connect to the ATRA Tendon Clip. Refer to the Channel Installation Manual for ATRA Tendon Clip tie-off instructions.
j. Repeat this process on each cell row Tendon/ATRA Tendon Clip run.

k. Place the collapsed section in the anchor trench, drive ATRA GFRP anchors in the first row of cells so the arm of the anchor engages with the top of the cell wall and expand down the slope. Number of anchors shall be per the Contract Documents.

l. Adjust the section (i.e. a shake or two of the expanded section works well for this) so that the section and tendons are uniformly taut.

m. After the sections are expanded, drive ATRA GFRP Anchors so the arm of the anchor engages with the top of the cell wall.

n. Anchorage pattern and stake length shall be as indicated on the Contract Documents

o. Terminate the bottom of the tendons with ATRA Tendon Clips.

p. Fill the anchorage trench with the specified material and compact as required by the Contract Documents.

Alternate Method – On Channel Slope Installation

a. Excavate the anchor trench at the top of the channel slope to the depth as shown on the Contract Documents.

b. Position collapsed sections at the crest of the slope.

c. Feed precut lengths of specified tendon material through the I-slots in the cell walls before expanding individual sections into position. Number of tendons per section shall be per the Contract Documents. Leave the trailing length of the tendon on the upslope side of the section to allow for connection of the ATRA Tendon Clips.

d. Place the collapsed section in the anchor trench, drive ATRA GFRP Anchors in the first row of cells so the arm of the anchor engages with the top of the cell wall and expand down the slope. Number of anchors shall be per Contract Documents.

e. Install the ATRA Tendon Clips at the locations indicated on the Contract Documents.

f. Hold the tendon and connect to each ATRA Tendon Clip. Refer to the Channel Installation Manual for ATRA Tendon Clip tie-off instructions.

g. Adjust the section (i.e. a shake or two of the expanded section works well for this) so that the section and tendons are uniformly taut.

h. After the sections are expanded as desired, drive ATRA GFRP Anchors so the arm of the anchor engages with the top of the cell wall.

i. Anchorage pattern and stake length shall be as indicated on the Contract Documents

j. Terminate the bottom of the tendons with ATRA Tendon Clips.

k. Fill the anchorage trench with the specified material and compact as required by the Contract Documents.

7. Anchorage with Tendons, ATRA Tendon Clips and Pipe Deadman Anchorage

Preferred Method – Top of Channel Slope Installation

a. Excavate the anchor trench at the top of the channel slope to the depth as shown on the Contract Documents.

b. Install pipe Deadman in anchor trench. Pipe type, diameter and thickness shall be as shown on the Contract Documents.

c. Position the collapsed sections at the crest of the slope.

d. Measure and cut the tendon run lengths for each tendon location allowing extra length to connect to deadman anchor.
e. Mark the tendons with a black permanent marker per the ATRA Tendon Clip Location Chart.
f. Thread the tendons through the unexpanded section.
g. Starting from the first cell, count the number of cells to the next ATRA Tendon Clip location and repeat along that cell row.
h. Repeat this procedure for each additional cell row Tendon/ATRA Tendon Clip run.
i. With all the ATRA Tendon Clips placed in the section, thread the tendons through the cell wall I-slots in the unexpanded section.
j. Locate the corresponding mark on the Tendon and position it in front of the cell wall. Hold the tendon and connect to the ATRA Tendon Clip. Refer to the Channel Installation Manual for ATRA Tendon Clip tie-off instructions.
k. Repeat this process on each cell row Tendon/ATRA Tendon Clip run.
l. Place the collapsed section in the anchor trench, connect tendons to the deadman anchor and expand down the slope.
m. Adjust the section (i.e. a shake or two of the expanded section works well for this) so that the section and tendons are uniformly taut.
n. Terminate the bottom of the tendons with ATRA Tendon Clips.
o. Fill the anchorage trench with the specified material and compact as required by the Contract Documents.

Alternate Method – On Channel Slope Installation

a. Excavate the anchor trench at the top of the channel slope to the depth as shown on the Contract Documents.
b. Install pipe Deadman in anchor trench. Pipe type, diameter and thickness shall be as shown on the Contract Documents.
c. Position collapsed sections at the crest of the slope.
d. Feed precut lengths of specified tendon material through the I-slots in cell walls before expanding individual sections into position. Number of tendons per section shall be per the Contract Documents. Leave the trailing length of the tendon on the upslope side of the section to allow for connection to deadman anchor.
e. Place the collapsed section in the anchor trench, connect tendon to deadman anchor and expand down the slope.
f. Install the ATRA Tendon Clips at the locations indicated on the Contract Documents.
g. Hold the tendon and connect to each ATRA Tendon Clip. Refer to the Channel Installation Manual for ATRA Tendon Clip tie-off instructions.
h. Adjust the section (i.e. a shake or two of the expanded section works well for this) so that the section and tendons are uniformly taut.
i. Terminate the bottom of the tendons with ATRA Tendon Clips.
j. Fill the anchorage trench with the specified material and compact as required by the Contract Documents.

8. Anchorage with Tendons and Earth Anchors

Preferred Method – Top of Channel Slope Installation

a. Excavate the anchor trench at the top of the channel slope to the depth as shown on the Contract Documents.
b. Position the collapsed sections at the crest of the slope.
c. Measure and cut the tendon run lengths for each tendon location allowing extra length to connect to earth anchor.
d. Mark the tendons with a black permanent marker per the ATRA Tendon Clip Location Chart.
e. Thread the tendons through the unexpanded section.
f. Starting from the first cell, count the number of cells to the next ATRA Tendon Clip location and repeat along that cell row.
g. Repeat this procedure for each additional cell row Tendon/ATRA Tendon Clip run.
h. With all the ATRA Tendon Clips placed in the section, thread the tendons through the I-slots in the unexpanded section.
i. Locate the corresponding mark on the Tendon and position it in front of the cell wall. Hold the tendon and connect to the ATRA Tendon Clip. Refer to the Channel Installation Manual for ATRA Tendon Clip tie-off instructions.
j. Repeat this process on each cell row Tendon/ATRA Tendon Clip run.
k. Place the collapsed section in the anchor trench and expand down the slope.
l. Adjust the section (i.e. a shake or two of the expanded section works well for this) so that the section and tendons are uniformly taut.
m. Install earth anchors in accordance with Manufacturer's recommendations and instructions. Earth anchor type and strength shall be as shown on the Contract Documents.
n. Secure tendons to earth anchors.
o. Terminate the bottom of the tendons with ATRA Tendon Clips.
p. Fill the anchorage trench with the specified material and compact as required by the Contract Documents.

Alternate Method – On Channel Slope Installation

a. Excavate the anchor trench at the top of the channel slope to the depth as shown on the Contract Documents.
b. Position collapsed sections at the crest of the slope.
c. Feed precut lengths of specified tendon material through the I-slots in the cell walls before expanding individual sections into position. Number of tendons per section shall be per the Contract Documents. Leave the trailing length of the tendon on the upslope side of the section to allow for connection of the ATRA Tendon Clips.
d. Place the collapsed section in the anchor trench and expand down the slope.
e. Install the ATRA Tendon Clips at the locations indicated on the Contract Documents.
f. Hold the tendon and attaché to the ATRA Tendon Clips. Refer to the Channel Installation Manual for ATRA Tendon Clip tie-off instructions.
g. Adjust the section (i.e. a shake or two of the expanded section works well for this) so that the section and tendons are uniformly taut.

h. Install earth anchors in accordance with Manufacturer's recommendations and instructions. Earth anchor type and strength shall be as shown on the Contract Documents.

i. Secure tendons to earth anchors.

j. Terminate the bottom of the tendons with ATRA Tendon Clips.

k. Fill the anchorage trench with the specified material and compact as required by the Contract Documents.

E. Section Placement and Connection

1. Verify all sections are expanded uniformly to required dimensions and that outer cells of each section are correctly aligned. Interleaf or overlap edges of adjacent sections. Ensure upper surfaces of adjoining sections are flush at joint and adjoining cells are fully aligned at the cell wall slot.

2. Connect the sections with ATRA keys at each interleaf and end to end connection. Insert the ATRA key through the cell wall I-slot before inserting through the adjacent cell. Turn the ATRA key 90 degrees to lock the sections together

Specifier Note: Specifier shall select the cell infill type in F-I below that corresponds to infill choice from Section 2.6 and delete the others. Contact Presto Geosystems for assistance.

F. Topsoil Infill Placement

1. Place specified infill in expanded cells with suitable material handling equipment, such as a backhoe, front-end loader, conveyor, or crane-mounted skip.

2. Limit drop height to a maximum of 3 feet (1 m) to prevent panel distortion.

3. Fill sections from the crest of the channel slope to toe or in accordance with Engineer's direction.

4. Infill material shall be free-flowing and not frozen when placed into the sections.

5. Evenly spread infill and tamp into place.

G. Aggregate Infill Placement

1. Place specified infill in expanded cells with suitable material handling equipment, such as a backhoe, front-end loader, conveyor, or crane-mounted skip.

2. Limit drop height to a maximum of 3 feet (1 m) to prevent panel distortion.

3. Fill sections from the crest of the channel slope to toe or in accordance with Engineer's direction.

4. Infill material shall be free-flowing and not frozen when placed into the sections.

5. Evenly spread infill and ensure the infill is flush with the cell walls.

H. Concrete Infill Placement

1. Concrete shall be placed, finished and cured in accordance with the Contract Documents.

2. Once placing operation commences, it shall be carried out as a continuous operation until a designated section is completed or as approved by the Engineer.

3. Limit the drop height of concrete to 3 feet (1 meter) to prevent panel distortion. Elephant trunks and/or tremies shall be used to prevent free fall of concrete.

4. Where concrete chutes are used, the end of the chute shall be baffled to prevent segregation of the concrete.

5. The concrete shall be thoroughly compacted by means of an approved vibrator. The period of vibration shall not be less than 2 seconds nor more than 5 seconds at any one point.
6. Concrete shall be flush with the top of the walls.
7. Apply specified finish.

I. Engineered Infill Placement

1. Place specified infill in expanded cells with suitable material handling equipment, such as a backhoe, front-end loader, conveyor, or crane-mounted skip.
2. Limit drop height to a maximum of 3 feet (1 m) to prevent panel distortion.
3. Fill sections from the crest of the channel slope to toe or in accordance with Engineer's direction.
4. Infill material shall be free-flowing and not frozen when placed into the sections.
5. Evenly spread infill and ensure the infill is flush with the cell walls.

J. Surface Treatment

Specifier Note: If chosen, edit for the selected surface treatment type and delete the others.

1. Vegetation shall be as specified in the Contract Documents and installed immediately after the infill is placed and protected with mulch.
2. Surface protection shall be installed immediately after placement of the infill material and installed and secured per the Manufacturer's instructions.

Appendix A
Short-Term Seam Strength Test 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.

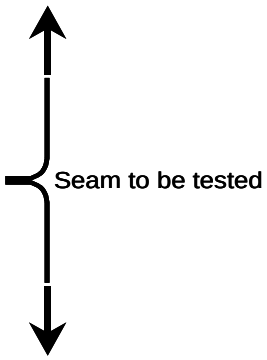

Figure A1

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 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.

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:

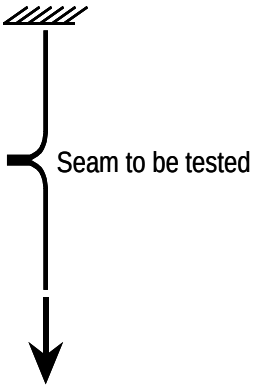

Figure B1

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.

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 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 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.

END OF SECTION