

**SECTION 31 32 00
SOIL STABILIZATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Cellular confinement system for soil stabilization.
- B. Cellular confinement system for slope protection.
- C. Cellular confinement system for earth retention.
- D. Cellular confinement system for channel protection.
- E. Cellular confinement system for load support.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete
- B. Section 31 23 23.13 - Backfill
- C. Section 31 25 00 - Erosion and Sedimentation Controls
- D. Section 31 30 00 - Earthwork
- E. Section 31 32 13.13 - Asphalt Soil Stabilization
- F. Section 31 35 23 - Slope Protection with Slope Paving

1.03 REFERENCE STANDARDS

- A. AASHTO M 288 - Standard Specification for Geosynthetics for Highway Applications; 2024.
- B. ASTM D1004 - Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting; 2021.
- C. ASTM D1603 - Standard Test Method for Carbon Black Content in Olefin Plastics; 2020.
- D. ASTM D1693 - Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics; 2021.
- E. ASTM D5199 - Standard Test Method for Measuring the Nominal Thickness of Geosynthetics; 2012 (Reapproved 2019).
- F. ISO 9001 - Quality Management Systems — Requirements; 2015, with Amendment (2024).
- G. AASHTO M 218 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) for Corrugated Steel Pipe.
- H. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- I. ASTM D1505 - Standard Test Method for Density of Plastics by the Density-Gradient Technique.
- J. ASTM D5394 - Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.
- K. ASTM D5596 - Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.
- L. ASTM D5721 - Standard Practice for Air-Oven Aging of Polyolefin Geomembranes
- M. ASTM D5885 - Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry.
- N. ASTM D6693 - Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes.
- O. ASTM D7328 - Standard Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent UV Condensation Apparatus.
- P. Geosynthetic Research Institute (GRI) GS13 - Standard Guide for Geomembrane-Related Geocell Seam Strength and Its Efficiency With Respect to the Perforated Sheet Strength.

- Q. GS14 - Standard Test Method for Average Wall Thickness of a Geomembrane-Related Geocell by Indirect Measurement.
- R. US Army Corps of Engineers (USACE) Technical Report GL-86, Appendix A.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data:
 - 1. Manufacturer's data sheets on each product to be used.
 - 2. Preparation instructions and recommendations.
 - 3. Storage and handling requirements and recommendations.
 - 4. Typical installation methods.
- C. Shop Drawings: Including but not limited to details of materials, construction dimensions, section layout, cell depth, system components and relationship with adjacent construction.
- D. Verification Samples: Two representative units of each type.
- E. Manufacturer's Certificate of Compliance: Indicate geocells comply with specified requirements including, but not limited to, minimum seam strengths.
- F. Manufacturer's Certificate of Analysis: Containing the following test results for the project-specific cellular confinement material to ensure compliance:
 - 1. Base resin lot numbers.
 - 2. Resin density per ASTM D1505.
 - 3. Production lot numbers.
 - 4. Material thickness per ASTM D5199.
 - 5. Sheet thickness per GRI-GS14.
 - 6. Short term seam peel strength per USACE Technical Report GL-86, Appendix A.
 - 7. Carbon black percentage.
- G. Quality Assurance Certification: Submit manufacturer's ISO 9001 and CE quality assurance certifications.
- H. If required, provide calculations for the recommended anchor system, tendon system or anchor trenches.
 - 1. Include design conditions, slope stability calculations, and friction angles. Provide the number of stakes, stake length, attachment device, and spacing.
 - 2. Include design conditions, slope stability calculations, calculated factors of safety, friction angles. Provide the number of tendons, tendon type, load transfer device, and spacing.
 - 3. Provide the pipe type and diameter, or the minimum anchor pullout strength, and calculations for the recommended crest anchorage system.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with a minimum 20 years documented experience producing cellular confinement systems.
 - 1. Raw Material Sourcing: The cellular confinement system material must be manufactured with raw materials produced in the USA.
 - 2. Quality Management System: The manufacturer's quality management system shall be certified and in accordance with ISO 9001 and CE certification.
 - 3. Alternate materials submitted must provide a certification that the 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.
 - 4. An ISO certification for the substitute material will not be acceptable unless it is proven it pertains specifically to the geocell manufacturing operations.
 - 5. In addition, submit a certification for alternate materials showing that the cellular confinement material meets product specifications per CE Declaration of Performance.

- B. Manufacturer's Field Representative Qualifications: Manufacturer shall provide a qualified field representative experienced in cellular confinement system installation.
- C. Installer Qualifications: Company experienced in cellular confinement system installation with minimum 5 years documented experience with projects of similar scope and complexity or company has been trained by Geo Products or a Geo products distributor.
- D. Source Limitations: Each type of product from a single manufacturing source to ensure uniformity.
- E. Mock-Up: Construct a mock-up with actual materials in sufficient time for Architect's review and to not delay construction progress. Locate mock-up as acceptable to Architect and provide temporary foundations and support.
 - 1. Intent of mock-up is to demonstrate quality of workmanship.
 - 2. If mock-up is not acceptable, rebuild mock-up until satisfactory results are achieved.
 - 3. Retain mock-up during construction as standard for comparison with completed work.
 - 4. Do not alter or remove mock-up until work is completed or removal is authorized.

1.06 PRE-INSTALLATION CONFERENCE

- A. Convene a conference approximately two weeks before scheduled commencement of the Work. Attendees shall include Contractor, Engineer, installer, manufacturer's representative and trades involved. Agenda shall include schedule, responsibilities, critical path items and approvals.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to site in manufacturer's original, unopened pallets and packaging, with labels clearly identifying product name and manufacturer.
- B. Store and handle in strict compliance with manufacturer's written instructions and recommendations.
- C. Protect from damage due to weather, excessive temperature, and construction operations.

1.08 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.
- B. If ambient conditions are not met at the time of delivery, manufacturer reserves the right to void the warranty.

1.09 WARRANTY

- A. Manufacturer's Standard Limited Warranty: Against defects in materials and workmanship at the time of manufacture for a period of 10 years of normal use and service.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturer: _____.
- B. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 - Product Requirements.

2.02 CELLULAR CONFINEMENT SYSTEM

- A. Material Properties: Virgin, non-thermally degraded, high-density polyethylene (HDPE); no post-consumer resins (PCR) of any type are added to the formulation.
 - 1. Polymer Density, ASTM D1505: 58.4 - 60.2 lbs per cu ft (0.935 - 0.965 grams per cu cm).
 - 2. Environmental Stress Crack Resistance, ASTM D5394: Greater than 400 hours.
 - 3. Environmental Stress Crack Resistance, ASTM D1693: 6000 hours.
 - 4. Minimum Carbon Black Content, ASTM D1603: 1.5 - 2% percent by weight.
 - 5. Carbon Black Dispersion, ASTM D5596.

6. Nominal Sheet Thickness by Weight, GRI-GS14: 50 mils 0.05 inch plus or minus 10 percent.
 7. Nominal Sheet Thickness, Smooth Sheet, ASTM D5199: 50 mils 0.05 inch plus 10 percent, minus 5 percent.
 8. Nominal Sheet Thickness, Textured Sheet, ASTM D5199: 60 mils 0.06 inch plus 10 percent, minus 5 percent.
 9. Seam Efficiency, Perforated Strip, GRI-GS13: 100 percent.
 10. Resistance to Oxidative Degradation (HPOIT), ASTM D5885: Over 400 minutes.
 11. UV Resistance, ASTM D7238: Over 50 percent HPOIT retained after 1500 hours.
 12. Polyethylene Strips:
 - a. Indentations: Textured with rhomboidal (diamond shape) indentations.
 - b. Surface Density of Indentations: 140 to 200 per in² (22 to 31 per sq cm).
- B. Base Material: Polyethylene Stabilized with carbon black.
1. Density in Accordance with ASTM D1505: 58.4 to 60.2 lbs per cu ft (935 to 964 kg per cu m).
 2. Environmental Stress Crack Resistance (ESCR) in Accordance with ASTM D1693: 5000 hours.
 3. Resistance to Oxidation in Accordance with EN ISO 13438: 100 years minimum.
 4. Exposure to Accelerated Weathering in Accordance with EN 12224: 100 percent of original strip tensile strength is to be retained.
 5. The Flexural Storage Modulus in Accordance with ISO 6721: 116110 psi minimum.
 6. Ultra-Violet Light Stabilization: With carbon black.
 7. Carbon Black Content: 1.5 to 2 percent by weight, through addition of a carrier with certified black content; homogeneously distributed throughout material.
 8. The manufacturer must have an in-place quality control to prevent irregularities in strip material.
- C. Geocell Strain / Stress Properties:
1. Geocell Strain-Stress: Provide manufacturer's large-scale field-testing data to verify 50 percent reduction in stress on base layer interface using poorly graded stone infill material. Test at 10,000 vertical cycles on minimum 49 cell test section at 80 psi. Lab testing is unacceptable.
 - a. EV Ratio: Initial load modulus EV1 and reload modulus EV2 ratio to be less than 2.7.
 - b. Static Load Test:
 - 1) Initial Load: 70 psi.
 - 2) Second Load: 100 psi.
 - 3) Hold reload for three minutes.
- D. Cell Walls: Perforated.
1. Perforations:
 - a. For Cell Depths of 3 inches and 6 inches: 15 to 17 percent of cell wall area is removed.
 - b. For Cell Depths of 4 inches and 8 inches: 11 to 13 percent of cell wall area is removed.
 2. Horizontal Rows: 0.4 inch diameter holes, 0.65 inch on center.
 3. Pattern: Staggered horizontal rows, hole centers separated 0.33 inch.
 4. Edge of Cell Wall to Nearest Edge of Perforations: 0.31 inch.
 5. Centerline of Weld to Nearest Edge of Perforations: 1.1 inches minimum.
 6. Slotting: Standard in the center of the non-perforated areas and at the center of each weld; 0.45 x 1.9 inches (11.4 mm x 48.3 mm).
- E. Seams:
1. Minimum Seam Strength:
 - a. Reports providing written certification of test results in compliance with minimum design requirements.

- b. Materials submitted with average or typical values will not be accepted.
- 2. Seam Peel Strength: USACE Technical Report GL-86-19, Appendix A.
 - a. For 3 inches Cell Depth: 240 lb (1065 N).
 - b. For 4 inches Cell Depth: 320 lb (1420 N).
 - c. For 6 inches Cell Depth: 480 lb (2130 N).
 - d. For 8 inches Cell Depth: 640 lb (2840 N).
- 3. Seam Hang Strength: For 4 inch welded joints.
 - a. Supports load of 160 lb (72.5 kg) for 30 days minimum.
 - b. Supports load of 160 lb (72.5 kg) for 7 days minimum while undergoing temperature change from 74 degrees Fahrenheit to 130 degrees Fahrenheit on 1 hour cycle.
- 4. 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 Fahrenheit.
 - b. Room temperature to be in accordance with ASTM E41.
 - c. Test Samples: Two, four-inch 3.94 inch wide strips welded together.
 - 1) Consisting of two carbon black stabilized strips is to support a 160 pound load for test period.
- 5. Internal Junction Efficiency: Determined by EN ISO 10319 and EN ISO 13426-1.
 - a. A ratio of junction performance to perforated strip performance.
 - b. Minimum Internal Junction Efficiency: 100 percent or greater.
- 6. Mechanical Junction Efficiency: Determined by EN ISO 10319 and EN ISO 13426-1.
 - a. A ratio of junction performance to perforated strip performance
 - b. Minimum Mechanical Junction Efficiency: 100 percent or greater.
 - c. Connection Type: Integral components as designated by the Manufacturer.

2.03 INSTALLATION COMPONENTS

- A. Panel Connection Components:
 - 1. Description: Injection molded, high-strength, UV stabilized, Nylon part used to connect geocell panels together at each fin and end to end connections.
 - 2. Connection Type: Mechanical across the full depth of the cell.
 - 3. Minimum Break Strength: 310 lb (140 kg).
 - 4. Color: Black, UV resistant.
- B. Anchoring Components:
 - 1. Twist Pins:
 - a. Materials: Galvanized steel conforming to ASTM A123.
 - b. Testing: The twist pin must have supporting 3rd party testing available that provides pullout resistance in 3 separate soil types (clay, loam, sand).
 - 2. Steel Reinforcing Bars
 - 3. Fiberglass Reinforced Polymer (FRP) Reinforcing Bars
 - 4. Straight Stakes: Support and anchor geocells
- C. Tendon Anchorages:
 - 1. Anchorage Materials: Woven polyester; high tenacity, industrial continuous filament, polyester yarn woven into a braided strap.
 - a. Elongation: 9 to 15 percent at break.
 - 2. Anchorage Materials: Woven polypropylene 3-strand twisted rope.
 - a. Minimum Break Strength: 2200 lbf (9.34 kN).

2.04 INFILL MATERIAL

- A. Infill material shall be free of any foreign material.
- B. Clays, silts and organic materials are not acceptable infill material.
- C. Infill material shall be free-flowing and not frozen when placed in the geocell sections.

2.05 ADDITIONAL GEOSYNTHETIC COMPONENTS

- A. Nonwoven Geotextiles: As specified in Division 31.
- B. Geomembrane Layers: As specified in the appropriate subdrainage sections as specified in the appropriate sections in Division 33.
- C. Surface Protection: Consisting of erosion control blankets or turf reinforcement geosynthetic mats as specified in appropriate sections in Division 31.
- D. Turf Protection: Surface protection of hydroseed as specified in the appropriate sections in Division 32.

PART 3 EXECUTION

3.01 EXAMINATION AND PREPARATION

- A. Examine and prepare areas to receive geocells using the methods recommended by the manufacturer for achieving best result for the project conditions.
 - 1. Prepare site by removing vegetative cover, debris, and unacceptable soils from area where geocells will be installed.
 - 2. Replace removed soils with acceptable materials.
 - 3. Complete earthwork, including toe-in trenches when required for slope or channel lining applications, as specified in Division 31.
- B. Do not proceed with preparation or installation until unacceptable conditions have been corrected have been prepared using the methods recommended by the manufacturer and deviations from manufacturer's recommended tolerances are corrected. Commencement of installation constitutes acceptance of conditions.
- C. If preparation is the responsibility of another installer, notify Engineer and Architect in writing of deviations from manufacturer's recommended installation tolerances and conditions.

3.02 INSTALLATION

- A. Install geocells in accordance with manufacturer's instructions, approved submittals and in proper relationship with adjacent construction at locations indicated on the Drawings.
 - 1. Install nonwoven geotextiles as specified in Division 31.
 - 2. Install geocells in accordance with manufacturer's instructions at locations indicated on the drawings.
 - 3. Anchor geocell sections as necessary to resist sliding due to gravitational forces and sheet flow.
 - 4. Ensure top edges of adjoining cell walls are flush with each other and in proper alignment.
 - 5. Deliver infill material to geocells from top of slope or channel to bottom in accordance with manufacturer's instructions.
 - 6. Limit drop height of infill material to a maximum of 3 feet to prevent damage to geocells.

3.03 CLEANING AND PROTECTION

- A. Clean and protect products in accordance with the manufacturer's recommendations.
- B. Repair or replace damaged products before work is covered, and before Substantial Completion.

END OF SECTION 31 32 00