SECTION 02834
MECHANICALLY STABILIZED EARTHEN RETAINING WALLS

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PART 1 GENERAL

1.1 SECTION INCLUDES

A. ADD3 Mechanically stabilized earth (MSE) retaining wall system with high-density polyethylene or polypropylene Tensar® geogrids and steel wire mesh facing units.

B. Face Fill and Backfill.

C. Geotextile, Turf Reinforcement Mat and Drainage Composite.

1.2 RELATED SECTIONS

A. Document 00300 - Information Available to Bidders: Geotechnical Report; Bore hole locations and findings of subsurface materials.

B. Section 01400 Testing and Inspection Services.

C. Section 02140 - Landfill Construction.

D. Section 02200 - Site Preparation.

E. Section 02280 - Dikes and Containment Structures.

F. Section 02300 - Earthwork; Excavation and preparation.

G. Section 02310 - Grading.

H. Section 02315 - Excavation.

I. Section 02316 - Fill and Backfill.

J. Section 02920 - Lawns and Grasses; Ground cover at finished grade.

1.3 REFERENCES

A. AASHTO M288 - Standard Specification for Geotextiles.

B. AASHTO T289 – Determining pH of Soil for Use in Corrosion Testing.

C. AASHTO Standard Specification for Highway Bridges.

D. ASTM A 82 / A82M- Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.

E. ASTM A 123 / A 123M - Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products.

F. ASTM A 185 - Standard Specification for Steel Welded Reinforcement, Plain, for Concrete. ASTM A 641 / A 641M-03 Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire

G. ASTM D 698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort.

H. ASTM D 1556 - Standard Test Method for Density of Soil in Place by the Sand-Cone Method.

I. ASTM D 2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.

J. ASTM D 2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

K. ASTM D 3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

L. ASTM D 4355 - Standard Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus).

M. ASTM D 4716 - Standard Test Method for Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextile Related Products.

N. ASTM D 6637 - Determining Tensile Properties of Geogrids by the Single or Multi-Rib Test Method; 2001.

O. ASTM F 904 - Standard Test Method for Comparison of Bond Strength or Ply Adhesion of Similar Laminates Made from Flexible Materials; 1991.

P. GRI-GG2 - Standard Test Method for Geogrid Junction Strength.

Q. FHWA NHI-00-043 – Mechanically Stabilized Earth Walls and Reinforced Soil Slope Design and Construction Guidelines (Demonstration Project 82), March 2001.

R. Tensar Earth Technologies, Inc. “SIERRA Slope Retention System Design Guidelines”.

S. FHWA Federal Highway Administration - Design Guidelines.

1.4 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.

C. Shop Drawings: Engineering drawings, elevations, and large-scale details of elevations, typical sections, details, and connections.
   1. Include design calculations sealed by a Registered Professional Engineer licensed in the State where the project is located.
   2. Manufacturer's certifications that the ultimate tensile strength and junction strength of the geogrid are equal to or greater than those specified.

D. Samples: Two samples of each wall system component including:
   1. Geogrids: 4 inch by 18 inch (100 mm by 450 mm) piece.
   2. Facing unit: 12 inch (300 mm) wide section of welded wire facing with one diagonal strut.
   3. Geotextile: 4 inches by 8 inches (100 mm by 200 mm) piece
   4. Turf Reinforcement Mat: 4 inches by 8 inches (100 mm by 203 mm) piece.
   5. Drainage Composite: 4 inches by 8 inches (100 mm by 200 mm) piece.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

A. Design Requirements: Design retaining wall system in accordance with the local codes and regulations and the design guidelines of FHWA or Tensar Earth Technologies, Inc. Design shall be by a professional engineer registered in the state where the project is located and who is employed by a firm that has designed at least five projects of similar construction and scope.

B. Manufacturer Qualifications: MSE wall system components manufactured by Tensar Earth Technologies, Inc. and companies approved and authorized by Tensar Earth Technologies, Inc.

C. Installer Qualifications: Firm with documented experience of at least five projects of similar construction and scope. Include brief description of each project and name and phone number of owner's representative knowledgeable in each listed project.

D. Pre-Construction Meeting: Prior to construction of retaining walls, conduct a meeting at the site with the retaining wall materials supplier, the retaining wall installer, and the Contractor to review the retaining wall requirements. Notify the Owner and the Engineer at least 3 days in advance of the time of the meeting.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Prevent excessive mud, fluid concrete, epoxy, or other deleterious materials from coming in contact with and affixing to retaining wall materials.

C. Polymeric Materials: Store at temperatures above minus 20 degrees F (minus 29 degrees C); rolled materials may be laid flat or stood on end.

1.7 PROJECT CONDITIONS

A. Do not place backfill when subgrade is wet or frozen.

B. Do not place backfill during wet or freezing weather that prevents conformance with specified compaction requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer:
1. Welded Wire Facing Units and Diagonal Struts Manufacturers approved by Tensar Earth Technologies, Inc., 5883 Glenridge Dr., Ste. 200, Atlanta, GA 30328. ASD. Tel: (404) 250-1290 (Intl.), Toll Free: (888) 828-5128. Fax: 404-250-0461. Web Site: www.tensarcorp.com/A. E-mail: info@tensarcorp.com.
2. Tensar Structural Geogrid: The Tensar Corporation, Inc. 1210 Citizens Parkway, Morrow, GA 30309.

B. Substitutions: Not permitted.

C. Requests for substitutions will be considered in accordance with provisions of Section 01600.

2.2 MATERIALS

A. Wire Mesh Facing Units: Steel welded wire mesh facing unit, bent 90 degrees at long center line to form “L” shaped unit; vertical section as face to retain fill, and horizontal leg extending into fill diagonal steel struts supporting top edge of vertical leg.
1. Wire Mesh Facing Unit: Galvanized, in accordance with ASTM A 82, ASTM A 185 and ASTM A 123 / A 123M.
2. Wire Strut Type: Galvanized, in accordance with ASTM A 82 and ASTM A 641/641M.
3. Wire Mesh Facing Unit: Black in accordance with ASTM A 82 and ASTM A 185.
4. Wire Strut Type: Black in accordance with ASTM A 82.
5. Wire Mesh Spacing: 4.0 inches by 4.0 inches (100 mm by 100 mm) (vertical x horizontal wires) unless otherwise indicated on the Drawings.
6. Wire Mesh Minimum Diameters: 0.225 inch (5.72 mm), vertical wires and 0.225 inches (5.72 mm) horizontal wire (before galvanizing).
7. Wire Strut Minimum Diameter: 0.243 inch (6.17 mm).
8. Tie wire or cable ties to connect vertical wires of adjacent facing units.

B. Structural Geogrid: Tensar UX1100HS: Polymeric grid formed by a regular network of integrally connected tensile elements with apertures of sufficient size to allow interlocking with surrounding soil, rock, or earth; functions primarily as reinforcement.
1. Ultimate Tensile Strength: 3970 pounds per linear foot (58 kN/m), minimum average roll value, when tested in accordance with ASTM D 6637.

2. Junction Strength: 3,690 pounds per linear foot (54kN/m), minimum average roll value, when tested in accordance with GRI-GG2.

C. Structural Geogrid: Tensar UX1400HS: Polymeric grid formed by regular network of integrally connected tensile elements with apertures of sufficient size to allow interlocking with surrounding soil, rock or earth and function primarily as reinforcement.
1. Ultimate Tensile Strength: 4800 pounds per linear foot (70 kN/m), minimum average roll value, when tested in accordance with ASTM D 6637.
2. Junction Strength: 4520 pounds per linear foot (66kN/m), minimum average roll value, when tested in accordance with GRI-GG2.

D. Structural Geogrid: Tensar UX1500HS: Polymeric grid formed by regular network of integrally connected tensile elements with apertures of sufficient size to allow interlocking with surrounding soil, rock or earth and function primarily as reinforcement.
1. Ultimate Tensile Strength: 7810 pounds per linear foot (114 kN/m), minimum average roll value, when tested in accordance with ASTM D 6637.
2. Junction Strength: 7200 pounds per linear foot (105 kN/m), minimum average roll value, when tested in accordance with GRI-GG2.

E. Structural Geogrid: Tensar UX1600HS: Polymeric grid formed by regular network of integrally connected tensile elements with apertures of sufficient size to allow interlocking with surrounding soil, rock or earth and function primarily as reinforcement.
1. Ultimate Tensile Strength: 9870 pounds per linear foot (144 kN/m), minimum average roll value, when tested in accordance with ASTM D 6637.
2. Junction Strength: 9250 pounds per linear foot (135 kN/m), minimum average roll value, when tested in accordance with GRI-GG2.

F. Structural Geogrid: Tensar UX1700HS: Polymeric grid formed by regular network of integrally connected tensile elements with apertures of sufficient size to allow interlocking with surrounding soil, rock or earth and function primarily as reinforcement.
1. Ultimate Tensile Strength: 11,990 pounds per linear foot (175 kN/m), minimum average roll value, when tested in accordance with ASTM D 6637.
2. Junction Strength: 10,970 pounds per linear foot (160 kN/m), minimum average roll value, when tested in accordance with GRI-GG2.

G. Structural Geogrid: Tensar UX1800HS: Polymeric grid formed by regular network of integrally connected tensile elements with apertures of sufficient size to allow interlocking with surrounding soil, rock or earth and function primarily as reinforcement.
1. Ultimate Tensile Strength: 14,390 pounds per linear foot (210 kN/m), minimum average roll value, when tested in accordance with ASTM D 6637.
2. Junction Strength: 12,340 pounds per linear foot (180 kN/m), minimum average roll value, when tested in accordance with GRI-GG2.

H. Structural Geogrid: Tensar BX1200: Polymeric grid formed by regular network of integrally connected tensile elements with apertures of sufficient size to allow interlocking with surrounding soil, rock or earth and function primarily as reinforcement.
1. Ultimate Tensile Strength (cross machine direction): 1970 pounds per linear foot (28.8 kN/m), minimum average roll value, when tested in accordance with ASTM D 6637.
2. Junction Strength: 1830 pounds per linear foot (26.7 kN/m), minimum average roll value, when tested in accordance with GRI-GG2.

I. Structural Geogrid: Tensar BX1100: Polymeric grid formed by regular network of integrally connected tensile elements with apertures of sufficient size to allow interlocking with surrounding soil, rock or earth and function primarily as reinforcement.
   1. Ultimate Tensile Strength (cross machine direction): 1300 pounds per linear foot (19 kN/m), minimum average roll value, when tested in accordance with ASTM D 6637.
   2. Junction Strength: 1200 pounds per linear foot (17.5 kN/m), minimum average roll value, when tested in accordance with GRI-GG2.

J. Geogrid (Face Backing): Tensar BX1120: Polymeric grid formed by regular network of integrally connected tensile elements with apertures of sufficient size to retain a 1 inch to 2 inch (25 mm to 50 mm) Stone Face Fill.
   1. Aperture Size: 1 inch by 1.3 inches (25 mm by 33 mm).
   2. Carbon Black Content: 2.0 percent.

K. Stone Fill: Free draining, uniformly graded stone placed immediately behind the face of the wire mesh facing unit.
   1. 100 percent passing a 4-inch (100 mm) sieve.
   2. 0 to 10 percent passing a 2-inch (50 mm) sieve.
   3. 100 percent passing a 2-inch (50 mm) sieve.
   4. 0 to 15 percent passing a 1-inch (25 mm) sieve.

L. Plantable Fill: Fine grained organic soil placed immediately behind the face of the facing unit for the purpose of supporting vegetation.
   1. 100 percent passing a No. 10 (2.0 mm) sieve.
   2. 0 to 75 percent passing a No. 200 (0.075 mm)sieve.
   3. LL < 50.
   4. PI < 20.

M. Reinforced Backfill: Granular fill with a pH range of 2 to 12, when tested in accordance with AASHTO T 289, and graded as follows:
   1. 100 to 75 percent passing a 2-inch (50 mm) sieve.
   2. 100 to 75 percent passing a 3/4-inch (19 mm) sieve.
   3. 100 to 20 percent passing a No. 4 (4.75 mm) sieve.
   4. 0 to 60 percent passing a No. 40 (0.425 mm) sieve.
   5. 0 to 35 percent passing a No. 200 (0.075 mm) sieve.

N. Geotextile: Non-woven geotextile, AASHTO M288, Class 3.

O. Turf Reinforcement Mat: North American Green C350 permanent turf reinforcement mat. Mat shall consist of evenly distributed 100 percent coconut fiber matrix weighing 0.50 lbs per SY (0.27 kg/sq m) encapsulated in a 3-D matting structure consisting of two, top and bottom, heavyweight UV stabilized polypropylene nets, with a nominal weight of 8 lbs/1000 SF (0.04 kg/sq m) and a corrugated high strength center net with an nominal weight of 24 lbs/1000 SF (0.12 kg/sq m). The three nets shall be stitched together on 1.50 inch (38 mm) centers with UV stabilized polypropylene thread to form a permanent three-dimensional turf reinforcement mat with a minimum thickness of 0.5 inches (13 mm).

P. Drainage Composite: Non-woven geotextile, AASHTO M288, Class 3, bonded to both sides of a polyethylene net structure.

1. Minimum Allowable Transmissivity: Not less than 1.5 gallons per minute per foot of width (3 x 10^{-4} square meters per second) when tested in accordance with ASTM D 4716 at a confirming pressure of 14.5 pounds per square inch (100 kPa).
2. Minimum Allowable Peel Strength of Geotextile from Polyethylene Net: Not less than 1 pound per inch of width (175 Newtons per meter of width) when tested in accordance with ASTM F 904.

PART 3 EXECUTION

3.1 PREPARATION

A. Do not begin installation until excavation to foundation elevation has been completed and the foundation for the reinforced fill and leveling pad has been properly prepared.

B. If subgrade preparation is the responsibility of others, notify Engineer of unsatisfactory preparation. Do not begin work until unsatisfactory conditions have been rectified.

C. Excavation:
1. Excavate subgrade vertically to plan elevation and horizontally to designed geogrid lengths.
2. Geotechnical Engineer will inspect foundation area to ensure proper bearing strength.
3. Remove soils not meeting required strength and replace with Geotechnical Engineer-approved materials.

D. Compaction: Compact foundation materials to a minimum of 95 percent Standard Proctor Dry Density in accordance with ASTM D 698.

3.2 CONSTRUCTION

A. Construct ADD^3 MSE wall system in accordance with approved shop drawings and manufacturer's instructions.

B. Facing Unit Installation:
1. Place the first course of wire mesh facing units with the horizontal legs resting on the foundation material.
2. Verify that the first row of facing units is level from end to end and from front-to-back.
3. Overlap the horizontal wire extensions of front faces of adjacent facing units. Tie together vertical wires of adjacent facing units as required to maintain alignment and prevent escape of backfill material.
4. Use a string line or equivalent to align straight sections.
5. Place subsequent courses of facing units on previous courses, at a setback, if any, as shown on shop drawings.
6. Align subsequent courses of facing units using a string line or other suitable method that is independent of the final position of the underlying course of facing units.

C. Structural Geogrid Installation:
1. Unroll the structural geogrid and cut to length shown on plans. Uniaxial structural geogrids shall be unrolled perpendicular to the wall face. Cut uniaxial geogrid ribs at

the front side of the transverse bar. . Biaxial geogrids shall be unrolled parallel to the wall face.

2. Place the structural geogrid over or across the horizontal leg of the facing units as indicated on the approved shop drawings and as follows:
   a. Place the structural geogrid over the horizontal leg of the facing units. The transverse bar of uniaxial geogrids or the edge of biaxial geogrids shall be positioned immediately behind vertical face of the unit.
   b. Place the structural geogrid across the horizontal leg and up the inside of the facing unit. Drape the anchorage length of the structural geogrid over the top of the facing unit during placement and compaction of the face fill and reinforced backfill.
3. Place the face backing biaxial facing geogrid, geotextile and/or the turf reinforcement mat inside the wire facing unit anchored into the fill top and bottom as shown on the shop drawings.
4. After placement of geogrid and any required face wrap, place seven wire support struts on approximately 20-inch (500-mm) centers connecting the upper horizontal wire on the face of facing unit to the transverse wire at the rear of the facing unit. Place one of the support struts at each end of the facing unit between the outer two vertical wires.

D. Fill:

1. Place the Structural Geogrid and Face Backing material flat over or across the horizontal leg of the Facing Unit and secure by placing facing fill over the geogrid and horizontal leg of the Facing Unit prior to placement of reinforced fill over rest of geogrid.
2. Stone Face Fill, 2-inch to 4-inch (50-mm to 100-mm): Place stone face fill over horizontal leg of Facing Unit to dimensions shown on shop drawings and cover with geotextile to separate from reinforced backfill. Compacted lift thickness: Maximum 9 inches (225 mm).
3. Stone Face Fill, 1-inch to 2-inch (25-mm to 50-mm): Place Tensar BX1120 Face Backing geogrid inside facing unit and place stone fill over horizontal leg of Facing Unit to dimensions shown on shop drawings and cover with geotextile to separate from reinforced backfill. Compacted lift thickness: Maximum 9 inches (225 mm).
4. Plantable Face Fill: Place the Turf Reinforcement Mat inside Facing Unit and place plantable fill in lifts to dimensions shown on shop drawings. Compacted lift thickness: Maximum 9 inches (225 mm).
5. Soil Face Fill: Place geotextile inside facing unit and place reinforced backfill as shown on shop drawings. Compacted lift thickness: Maximum 9 inches (225 mm).
6. Pull the geogrid taut to remove slack in the geogrid behind the facing unit and stake or pin the geogrid near the opposite end to maintain alignment and tension during filling.
7. Reinforced Backfill: Place reinforced backfill material in compacted lifts, maximum 9 inches (225 mm) deep. Compact to minimum of 95 percent Standard Proctor Dry Density in accordance with ASTM D 698.
8. Place a minimum of 3 inches (75 mm) of fill between overlapping layers of geogrid where overlapping occurs behind curves and corners of the wall.
9. Rubber tired vehicles may travel on the geogrid at low speeds, less than 5 miles per hour (10 km/hr). Turning of vehicles should be avoided to prevent dislocation or damage to the geogrid and the connected wall facing units.

10. Tracked vehicles shall not be operated directly on the geogrid. A minimum of 8 inches (200 mm) of fill cover over the geogrid is required for operation of tracked construction vehicles in the reinforced zone.
11. Use only hand-operated compaction equipment within 3 feet (1 m) of front face. Use a minimum of 3 passes to compact this zone.
12. Do not perform soil density testing within 3 feet (1 m) of front face.
13. Smooth and level, backfill (or slope as shown on shop drawings) to ensure that geogrid lays flat.

3.3 FIELD QUALITY CONTROL

A. Testing and Inspection will be provided by the Owners Testing Agency as specified in Section 01400 Testing and Inspection Services. Notify the Engineer 72 hours in advance of testing.

B. Testing and Inspection shall be provided by an independent laboratory provided by the Contractor and acceptable to the Architect.

C. Perform laboratory material tests in accordance with ASTM D 698.

D. Perform in place compaction tests in accordance with the following:
   1. Density Tests: ASTM D 1556, ASTM D 2167, or ASTM D 2922 as appropriate for material tested.
   2. Moisture Tests: ASTM D 3017.

E. Frequency of Tests:
   1. Subgrade Soil: A minimum of one test per 1000 SF (100 SM) of surface area.
   2. Reinforced Backfill: Provide one test for every 50 CY (40 CM) of fill placed.

3.4 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION