Project Name:
Project Number:

Section 02070

Specification for Geosynthetic Used as Soil Reinforcement in Mechanically Stabilized Earth Retaining Structures

1 GENERAL

1.1 SECTION INCLUDES

A. Geosynthetic to provide reinforcement for mechanically stabilized earth retaining structures. The primary function of the geosynthetic is reinforcement.

1.2 RELATED SECTIONS

A. Section 02050 - Basic Site Materials and Methods
B. Section 02100 - Site Remediation
C. Section 02200 - Site Preparation
D. Section 02300 - Earthwork
E. Section 02830 - Retaining Walls

1.3 UNIT PRICES

A. Method of Measurement: By the square meter (or square yard - as indicated in contract documents) including seams, overlaps, and wastage.

B. Basis of Payment: By the square meter (or square yard - as indicated in contract documents) installed.

1.4 REFERENCES

A. AASHTO Standards
   1. T88 - Particle Size Analysis of Soils
   2. T90 - Determining the Plastic Limit and Plasticity Index of Soils
   3. T99 - The Moisture-Density Relations of Soils Using a 5.5lb (2.5 kg) Rammer and a 12in (305 mm) Drop
   4. Standard Specifications for Highway Bridges

B. American Society for Testing and Materials (ASTM):

   1. D 123 - Standard Terminology Relating to Textiles
   2. D 276 - Test Method for Identification of Fibers in Textiles
   3. D 4354 - Practice for Sampling of Geosynthetics for Testing
   4. D 4355 - Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus)
   5. D 4439 - Terminology for Geotextiles
   6. D 4595 - Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method
   7. D 4759 - Practice for Determining the Specification Conformance of Geosynthetics
   8. D 4873 - Guide for Identification, Storage, and Handling of Geotextiles
   9. D 5262 - Test Method for Evaluating the Unconfined Tension Creep Behavior of Geosynthetics
   10. D 5321 - Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
   11. D 6637 - Standard Test Method for Determining the Tensile Properties of Geogrids by the Single

Rib or Multi-Rib Tensile Method

B. National Concrete Masonry Association (NCMA) - Design Manual for Segmental Retaining Walls, Second Edition, 1997.

C. Geosynthetic Research Institute:
1. GRI-GT6 - Geotextile Pullout
2. GRI-GT7 - Determination of the Long-Term Design Strength of Geotextiles
3. GRI-GG4(b) - Determination of the Long-Term Design Strength of Flexible Geogrids
4. GRI-GG5 - Test Method for Geogrid Pullout
5. GRI-GG7 - Carboxyl End Group Content of PET Yarns
6. GRI-GG8 - Determination of the Number Average Molecular Weight of PET Yarns Based on a Relative Viscosity Value

D. Federal Highway Administration (FHWA)

1. FHWA SA-96-071 - Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Design and Construction Guidelines
2. FHWA SA-96-072 - Corrosion/Degradation of Soil Reinforcements for Mechanically Stabilized Earth Walls and Reinforced Soil Slopes

E. American Association for Laboratory Accreditation (A2LA)

F. Geosynthetic Accreditation Institute (GAI) - Laboratory Accreditation Program (LAP).

G. National Transportation Product Evaluation Program (NTPEP)

H. International Standards Organization (ISO) – 9001:2000

1.5 DEFINITIONS

A. Minimum Average Roll Value (MARV): Property value calculated as typical minus two standard deviations. Statistically, it yields a 97.7 percent degree of confidence that any sample taken during quality assurance testing will exceed value reported.

1.6 SUBMITTALS

A. Submit the following :

1. Certification: The contractor shall provide to the Engineer a certificate stating the name of the manufacturer, product name, style number, chemical composition of the filaments or yarns and other pertinent information to fully describe the geosynthetic. The Certification shall state that the furnished geosynthetic meets MARV requirements of the specification as evaluated under the Manufacturer's quality control program. The Certification shall be attested to by a person having legal authority to bind the Manufacturer.

2. Quality Standards: The contractor shall provide to the Engineer the manufacturer’s Quality Control Plan along with their current A2LA, GAI-LAP, and ISO 9001:2000 certificates.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. The geotextile manufacturer shall have all of the following credentials:

a. Geosynthetic Accreditation Institute (GAI)- Laboratory Accreditation Program (LAP)

b. American Association for Laboratory Accreditation (A2LA)

c. ISO 9001:2000 Quality Management System

B. The geotextile manufacturer shall have a GAI-LAP accredited laboratory at the location of production capable of performing the ASTM tests as outlined in the specification.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Geosynthetic labeling, shipment, and storage shall follow ASTM D 4873. Product labels shall clearly show the manufacturer or supplier name, style name, and roll number.

B. Each geosynthetic roll shall be wrapped with a material that will protect the geosynthetic from damage due to shipment, water, sunlight, and contaminants.

C. During storage, geosynthetic rolls shall be elevated off the ground and adequately covered to protect them from the following: site construction damage, precipitation, extended ultraviolet radiation including sunlight, chemicals that are strong acids or strong bases, flames including welding sparks, excess temperatures, and any other environmental conditions that may damage the physical property values of the geosynthetic.

2 PRODUCTS

2.1 MANUFACTURERS

A. TenCate Geosynthetics
365 South Holland Drive
Pendergrass, GA, USA 30567
1-800-685-9990
1-706-693-2226
1-706-693-2083, fax
www.mirafi.com

2.2 MATERIALS

A. Reinforcement Geosynthetics:

1. The geosynthetic shall be manufactured with fibers consisting of long-chain synthetic polymers composed of at least 95 percent by weight of polyolefins or polyesters. They shall form a stable network such that the filaments or yarns retain their dimensional stability relative to each other, including selvages.

2. The geosynthetic shall meet the requirements of Table 1. All numeric values in Table 1 represent MARV in the principal reinforcement direction.

TABLE 1 - REINFORCEMENT GEOGRIDS

Property[1]	Units	S1	P1	P2	P3	P4	P5	P6	P7
T_{ult}[2]	kN/m	29.2	51.1	68.6	86.1	108.0	138.6	181.2	259.1
	(lbs/ft)	(2000)	(3500)	(4700)	(5900)	(7400)	(9500)	(12420)	(17760)
LTDS[3]	kN/m	15.8	28.0	37.6	47.2	59.2	76.0	99.3	142.0
(Sand)	(lbs/ft)	(1082)	(1918)	(2575)	(3233)	(4055)	(5206)	(6805)	(9732)
LTDS[3]	kN/m	15.1	26.7	35.9	45.0	56.5	72.5	94.8	135.5
(Sandy Gravel)	(lbs/ft)	(1033)	(1831)	(2458)	(3086)	(3871)	(4969)	(6496)	(9289)
LTDS[3]	kN/m	11.1	23.5	231.6	39.6	49.7	63.8	83.4	119.3
(Gravel)	(lbs/ft)	(758)	(1611)	(2163)	(2716)	(3406)	(4373)	(5717)	(8175)

[1] Values listed for Type S1 are for machine and cross-machine directions. Values listed for Types P1, P2, P3, P4, P5, P6, P7 are machine direction only.

[2] T_{ULT} shall be the minimum average roll value (MARV) ultimate tensile strength as tested per ASTM D 6637.

[3] T_{al} or LTDS, are determined per AASHTO, FHWA, GRI, and NCMA guidelines where LTDS = $T_{ULT}/(RF_{CR}xRF_{ID}xRF_{D})$.

3. Approved geosynthetics are as follows:

Type S1: Miragrid 2XT
Type P1: Miragrid 3XT
Type P2: Miragrid 5XT
Type P3: Miragrid 7XT
Type P4: Miragrid 8XT
Type P5: Miragrid 10XT
Type P6: Miragrid 20XT
Type P7: Miragrid 22XT

4. Long-Term Design Strength (LTDS) and Allowable Tensile Strength (T_a) are determined per AASHTO, FHWA, GRI, and NCMA guidelines where;

$$\text{LTDS} = \frac{T_{ULT}}{(RF_{CR})(RF_{ID})(RF_{D})}$$

a. T_{ULT}, Ultimate Tensile Strength, shall be the minimum average roll value (MARV) ultimate tensile strength as tested per ASTM D 6637.

b. RF_{CR}, Reduction Factor for Creep Deformation, is the ratio of T_{ULT} to creep limited strength determined in accordance with ASTM D 5262. The results shall be extrapolated for a 75 year design life using elevated temperature and/or stress rupture testing for 10,000 hours or room temperature testing for 65,700 hours per GRI-GG4(b). Total reinforcement strain shall be less than 10% over the 75-year design life. A minimum RF_{CR} shall be as follows:

Polymer Type	RF_{CR}
Polyester	1.58
High Density Polyethylene	2.6
Polypropylene	4.0

c. RF_{ID}, Reduction Factor for Installation Damage, shall be determined from construction damage tests for each product or product family proposed for use with project specific, representative or more severe backfill materials and construction techniques. Testing

shall be consistent with GRI-GG4(b). A default RF_{ID} value of 2.0 shall be used if such testing has not been conducted. A minimum RF_{ID} shall be 1.05.

d. RF_D, Reduction Factor for Durability, shall be based on polyester yarn testing per FHWA durability guidelines. Polyester yarns shall have a Molecular Weight > 25,000 g/m per GRI-GG8 and a carboxyl end group number < 30 per GRI-GG7. A default RF_D value of 3.0 shall be used if polyester yarns do not meet these requirements. A minimum RF_D shall be 1.10.

5. Soil Interaction Coefficient, C_i value shall be determined from short-term effective stress pullout tests per GRI-GG5 or GRI-GT6 over the range of normal stresses encountered. The maximum pullout force used to determine C_i shall be limited to the lessor of T_a or the force that yields 1.5 inches displacement. The minimum C_i value shall not be less than 0.7, determined as follows:

$$C_i = \frac{F}{2L\sigma_N \tan\varphi} \quad .$$

where F = Pullout Force (lb/ft), per GRI-GG5 or GRI-GT6
L = Geosynthetic Embedment Length in Test (ft)
σ_N = Effective Normal Stress (psf)
φ = Effective Soil Friction Angle, Degrees

6. Direct Sliding Coefficient, C_{ds} value shall be determined in accordance with ASTM D 5321 over the range of normal stresses encountered. The minimum C_{ds} value shall not be less than 0.7, determined as follows:

$$C_{ds} = \frac{R_{ds}}{L\sigma_N \tan\varphi} \quad .$$

where R_{ds} = Maximum Shear Resistance (lb/ft), per ASTM D 5321
L = Stationary Length of Geosynthetic (ft)
σ_N = Effective Normal Stress (psf)
φ = Effective Soil Friction Angle, Degrees

7. UV Resistance shall be determined in accordance with ASTM D 4355. Geosynthetics shall retain a minimum of 70% of the Ultimate Tensile Strength per ASTM D 4595 after UV exposure.

2.3 QUALITY CONTROL

A. Manufacturing Quality Control: Testing shall be performed at a laboratory accredited by GAI-LAP and A2LA for tests required for the geosynthetic, at frequency meeting or exceeding ASTM D 4354.

B. Ultraviolet Stability shall be verified by an independent laboratory on the geosynthetic or a geosynthetic of similar construction and yarn type.

3 EXECUTION

3.1 PREPARATION

A. Foundation soil shall be excavated to the line and grades as shown on the construction drawings or as directed by the Engineer. Over-excavated areas shall be filled with compacted backfill material as per project specifications or as directed by the Engineer. As a minimum, foundation soil shall be proof rolled prior to backfill and geosynthetic placement.

3.2 INSTALLATION

A. Geosynthetic shall be laid at the proper elevation and orientation as shown on the construction drawings or as directed by the Engineer. Correct orientation of the geosynthetic shall be verified by Contractor.

B. Geosynthetic may be temporarily secured in-place with staples, pins, sand bags or backfill as required by fill properties, fill placement procedure or weather condition, or as directed by the Engineer.

C. Primary geosynthetic may **not** be overlapped or connected mechanically to form splices in the primary strength direction. Single panel lengths are required in the primary strength direction. No overlapping is required between adjacent rolls unless specified by the Engineer.

D. Backfill material shall be placed in lifts and compacted as directed under project specifications. Backfill shall be placed, spread and compacted in such a manner as to minimize the development of wrinkles in and/or movement of the geosynthetic. A minimum fill thickness of 150 mm (6 in) is required prior to the operation of tracked vehicles over the geosynthetic.

E. Turning of tracked vehicles should be kept to minimum to prevent tracks from displacing the fill and damaging the geosynthetic. Rubber tired equipment may pass over the geosynthetic reinforcement at low speeds, less than 16 km/hr (10 mph). Sudden braking and sharp turns shall be avoided. Any geosynthetic damaged during installation shall be replaced by the Contractor at no additional cost to the Owner.

END OF SECTION