

Section 809—Geogrid Materials

809.1 General Description

This Specification includes requirements for geogrid used in reinforced slopes and Mechanically Stabilized Embankment (MSE) Wall backfill.

809.1.01 Definitions

ASTM—American Society for Testing and Materials

GRI—Geosynthetic Research Institute

809.1.02 Related References

A. Standard Specifications

Section 106—Control of Materials

Section 626—Mechanically Stabilized Embankment Retaining Walls

Section 627—Mechanically Stabilized Embankment Retaining Wall—Contractor Design

B. Referenced Documents

AASHTO Task Force 27 Guidelines

U. S. Environmental Protection Agency, Method 9090—Chemical Compatibility

Association of Textile Chemists and Colorists, Method 30—Soil Burial

American Association of Textile Chemists and Colorists, Method 100—Preparation of Bacterial Broth

ASTM D 638

ASTM D 746

ASTM D 975

ASTM D 1238

ASTM D 1505

ASTM D 1525

ASTM D 2165

ASTM O 4335

ASTM D 4595

GRI – GG1

GRI – GG2-87

GRI – GG3a or GG3b

GRI – GG5

809.1.03 Submittals

Supply certification from the manufacturer showing the physical properties of the material used and conformance with the Specifications according to Subsection 106.05 of the Specifications.

Provide evidence from the manufacturer that the geogrid has been used successfully in installations with similar environmental and project conditions.

Obtain prior approval from the Office of Materials and Research for all materials before use on construction.

Submit product specifications and test results to the Engineer for review and approval at least 45 days prior to intended use.

Do not begin placement of geogrid until the test results have been reviewed and approved by the Engineer.

809.2 Materials

A. Requirements

Use geogrid that is free of defects, punctures or flaws.

1. Geogrid for Reinforced Slopes

Use geogrid materials for reinforced slope construction that consist of the following:

- Either a biaxial or uniaxial grid of polymer tensile elements manufactured into a regular network with apertures of sufficient size to allow for soil interlock.
- A commercially prepared material of high tenacity polyester, high density polyethylene (HDPE) or polypropylene that is formed by stretching, heat welding, chemical welding, knitting, weaving or combinations of these methods.

Adhere to the following additional requirements:

a. Long Term Design Strengths

- 1) Use geogrid that meets the minimum long-term design strengths (TLT) in the machine direction as indicated on the plans.
- 2) Provide to the Engineer, in writing, the ultimate tensile strength of the grid (TULT) to verify the calculation in obtaining the long-term design loads (TLT).

These strengths are required for the Project and are determined based on the AASHTO Task Force 27 guidelines, which incorporates reduction factors to the ultimate strength of the geogrid for creep, site damage and durability.

- 3) Calculate the long-term design strength using the following formula:

$$TLT = \frac{TULT \times CRC}{FC \times FD}$$

Where:	TLT	=	Long-term design load—lb/ft (kg/m)
	TULT	=	Geogrid ultimate tensile strength—lb/ft (kg/m)
	CRC	=	Creep reduction coefficient
	FC	=	Factor of safety to account for construction damage
	FD	=	Factor of safety to account for product durability

b. Determine TULT

Determine the TULT based on wide strip tensile testing as noted in Subsection 809.2.02.

c. Determine Reduction Factors

Determine the reduction factors by the methods described in paragraphs a - e as follows:

1) Creep

- a) Provide evidence from the manufacturer that the geogrid has been tested in laboratory creep tests according to the following criteria:
 - Conducted for a minimum duration of 10,000 hours
 - Tests were made for a range of load levels, including loads that the geogrid will be subjected to on the Project.
- b) Ensure these tests are conducted as specified in Subsection 809.2.02.
- c) Extrapolate the results extrapolated to a minimum design life of 75 years.
- d) Determine the tension level at which the total strain of the geogrid is not expected to exceed 10% within the design life of 75 years (designated Tw).
- e) Calculate the creep reduction factor as follows:

$$CRC = \frac{Tw}{TULT}$$

In the absence of test data, use the following creep reduction factors for different polymers:

<u>Polymer Type</u>	<u>Creep Reduction Coefficient</u>
Polyester	0.40
Polypropylene	0.20
Polyamide	0.35
Polyethylene	0.20

2) Construction Damage

- a) Provide evidence from the manufacturer that the geogrid has been subjected to full scale construction damage tests using fill materials and construction procedures which are representative of those on the Project.
- b) Excavate and test the grid according to Subsection 809.2.02.
- c) Calculate the construction damage factor of safety using the following formula:

$$FC = \frac{TULT}{TC}$$

Where: FC = The construction damage factor

TC = The ultimate strength of the excavated grid that has been subjected to construction damage tests.

TULT = Geogrid ultimate tensile strength—lb/ft (kg/m)

- d) If construction damage tests have been made, but with fills or construction procedures other than those represented on the Project, use a minimum value of FC of 1.25. Use a lower value of FC only if substantiated with damage tests using fills and construction procedures specific to the Project.
 - e) In the absence of any construction damage tests, use a FC value of 3.0.
- 3) Product Durability

- a) Provide evidence from the manufacturer that the geogrid has been subjected to a series of durability tests to examine the effects of chemical and biological exposure on the grid, as described in the AASHTO Task Force 27 report.
- b) Include the following in the durability studies:
 - Effect on short-term and long-term mechanical properties.
 - Changes to the following:
 - Reinforcement microstructure
 - Dimensions
 - Mass
 - Oxidation
 - Environmental stress cracking
 - Hydrolysis
 - Temperature
 - Plasticization
 - Surface micrology
 - Variations in the infrared spectrum analysis.
 - A full investigation into the synergetic effects of different environments, particularly temperature. Subject the reinforcement to a working stress during the environmental test.
- c) Ensure that geogrid used in the Work has been subjected to the environmental conditioning as outlined by the following, as a minimum:
 - U.S. Environmental Protection Agency, Method 9090 – Chemical Compatibility.
 - Association of Textile Chemists and Colorists, Method 30 – Soil Burial.
 - American Association of Textile Chemists and Colorists, Method 100 – Preparation of Bacterial Broth.
- d) Investigate the full range of soil environments to which the reinforcements may be potentially exposed and shall include as a minimum:
 - pH in the range of 2, 4, 8, 12 – ASTM-D-2165
 - Diesel oil – ASTM-D-975
 - Fungi and Bacteria
 - UV exposure 500 hrs – ASTM-O-4335
 - Solvents and agents that are site specific.

In the performance of this testing the conditioning temperature is laboratory standard plus 1.5 times laboratory standard for the pH environments.

When no conditioning time period is given, use 30 days. Extrapolate results from short-term tests to the required design life of 75 years.

After the geogrid is subjected to these conditions, test the geogrid according to Subsection 809.2.02, and calculate the durability factor of safety by the following formula:

$$FD = \frac{TULT}{TD}$$

Where: TD = The ultimate strength of the geogrid subjected to product durability tests.

The minimum allowable value of FD is 1.10. In the absence of any geogrid durability tests, use a Durability Factor (FD) of 2.0.

4) Pullout Resistance:

- a) Provide evidence from the manufacturer that the geogrid has been subjected to full-scale pullout tests using backfill materials representative of those on the Project, as described in the AASHTO Task Force 27 report.
- b) Base pullout resistance for design on a maximum of elongation of the embedded geogrid of 3/4 in (19 mm) as measured at the leading edge of the compressive zone within the soil mass and not the ultimate pullout capacity.
- c) Where insufficient data exists to evaluate the pullout resistance of geogrid as a function of soil type, conduct pullout tests on a project specific basis until the engineering behavior of the soil-reinforcement system is clearly defined.
- d) Perform pullout using vertical stress variations (Sv) and reinforcement element configurations simulating actual project conditions.
- e) Perform pullout tests according to Subsection 809.2.02 on samples with a minimum embedded length of 2 ft (600 mm). Perform the tests on samples with a minimum width of 1 foot (300 mm), or a width equal to a 4 longitudinal grid element, whichever is greater. Conduct the tests at 70 oF ±4 oF (21°C ± 2 °C) at constant strain rates of 0.02 in (0.5mm) per minute.

Evaluate the pullout resistance by the following relation:

$$Tp = (2 \tan P) \times Sv \times Ls \times fd$$

Where:

- Tp = Ultimate pullout capacity of tensile reinforcement—lb/ft (kg/m)
- Sv = Vertical stress—lb/ ft2 (kg/m2)
- Ls = Total length of geogrid beyond failure plane—ft (m)
- P = Internal angle of friction of select backfill
- fd = Equivalent coefficient of direct sliding derived from pullout tests

The equivalent coefficient of direct sliding, fd, may be related to the open area of the grid. In the absence of product specific data tested with site-specific granular backfill, estimate the from the following preliminary analysis:

% Open Area of Grid	Direct Sliding
80% more	0.5
51 to 79	0.7
50 or less	0.6

Ensure the pullout resistance, T_p , meets the following minimum strength requirement:

$$T_p = \text{FPO} \times \text{TLT} \text{ with a displacement less than or equal to } \frac{3}{4} \text{ in (19 mm)}$$

Where:

FPO	=	Factor of safety against pullout, equal to 1.5
TLT	=	Long-term design load—lb/ft (kg/m)

5) Junction Strength:

- Ensure that the summation of the shear strength of the joints occurring in a 12 in (300 mm) length of the grid sample is greater than the ultimate tensile strength of the element to which they are attached.
- If this condition is not met, reduce the allowable reinforcement tension, T_w , by the ratio of the shear strengths to the ultimate strength.
- Determine the ultimate tensile strength according to Subsection 809.2.02 and translate it into an ultimate strength per element by dividing the number of elements per foot (meter) of width.
- Measure the junction strength according to Subsection 809.2.02.

2. MSE Wall Backfill Stabilizing Geogrid (SR 3)

Use geogrid materials for MSE wall construction that meets the following requirements:

- Is a biaxial grid of polymer tensile elements manufactured into a regular network with apertures of sufficient size to allow for soil interlock.
- Is a commercially prepared material of copolymerized high density polyethylene (HDPE) that is formed by stretching, heat welding, chemical welding, or combinations of these methods.
- Has the following physical properties:

Physical Properties	
Property	Requirement
Melt Index	0.00176 - 0.00846 oz./10 min. (0.05 -0.24 grams/10 min.)
Density	59.0 – 59.6 pcf (0.945 - 0.955 grams/cc)
Tensile Strength	500 ksf (24 000 kPa) minimum
Ultimate Elongation	500% min.
Brittleness	-100 °F (-73 °C) maximum
Vicat Softening Point	260 °F (127 °C) minimum
Chemical Resistance	Resistant to all natural occurring alkaline and acidic soil conditions
Biological Resistance	Resistant to attack by bacteria and fungi

- Has the following structural and mechanical properties:

MSE Wall Geogrid—Structural and Mechanical Properties	
Property	Requirement
Roll Length	100 ft.(30 m)
Roll Width	3 ft. or 4.5 ft. (1 m or 1.4 m)
Roll Weight	82 lb—3 ft roll (37.2 kg—1 m roll); or 114 lb—4.5 ft roll (51.7 kg—1.4 m roll)
Grid Pitch	0.6 in. x 4 in. (15 x 100mm)
Color	Black
Ultimate Tensile Strength	7.47 kips/ft (109 kN/m)
Extension @ Ult. Tensile Strength	17.0% maximum

MSE Wall Geogrid—Structural and Mechanical Properties	
Extension @ Design Load (0.4 Ult.)	3.0% maximum
Modulus in Tension	9000 ksi (62 000 MPa)
Thermal Stability	Stable over a range of -60 °F to 174 °F (-51 °C to 79 °C)
Note: Tests are based on 10 single rib samples extended at a constant rate of 1 inch (25 mm)/min. at a temperature of 68 ± 4 °F (20 ± 2 °C.)	

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test geogrid according to the following:

Test Property	Test Method
Reinforced Slopes	
Tensile Strength—Wide Width	ASTM D 4595
Tensile Strength—Single Rib Strand	GRI – GG1
Junction Strength	GRI – GG2-87
Tensile Creep Testing	GRI – GG3a or GG3b
Geogrid Pullout	GRI –GG5
MSE Wall Backfill Stabilizing Geogrid (SR 3)	
Melt Index	ASTM D 1238
Density	ASTM D 1505
Tensile Strength	ASTM D 638
Ultimate Elongation	ASTM D 638
Vicat Softening Point	ASTM D 1525
Brittleness	ASTM D 746

D. Materials Warranty

General Provisions 101 through 150.

809.2.01 Delivery, Storage, and Handling

During shipment and storage, protect the grid from mud, dirt, dust, debris and exposure to ultraviolet light, including sunlight.

Section 810—Roadway Materials**810.1 General Description**

This section includes the requirements for the materials used in roadway construction.

810.1.01 Related References**A. Standard Specifications**

General Provisions 101 through 150.

B. Referenced Documents

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