

REINFORCED SOIL SLOPE

****From Royalton BRS 0147(13)**

- xx. DESCRIPTION. This work shall consist of constructing a reinforced soil slope in accordance with the Contract Documents and as directed by the Engineer.

The Contractor shall provide all labor, equipment, and materials necessary for, and incidental to, site preparation, furnishing, installing, and backfilling geogrid reinforcement as indicated.

- xx. ABBREVIATIONS AND DEFINITION OF TERMS.

CMD - Cross-Machine Direction.

MD - Machine Direction.

BIAXIAL GRID - A geogrid which has been manufactured with high tensile strength in two directions perpendicular to one another.

DIRECTION OF REINFORCEMENT - Refers to the orientation that the geogrid is used for a particular project, which is along the machine direction (roll direction) for uniaxial geogrid.

GEOGRID - A polymer grid structure specifically manufactured for use as soil reinforcement.

UNIAXIAL GRID - A geogrid which has been manufactured with high junction strength and high tensile strength and modulus in one direction only.

- xx. MATERIALS. Geogrids shall be new, clean, and in accordance with material specifications. In no instance shall second-hand, previously used, salvaged, or damaged materials be used.

Materials shall meet the following requirements:

- (a) Quality Assurance.

The latest edition of the following standards, as referenced herein, shall be applicable:

- (1) American Society of Testing and Materials (ASTM).
- (2) U.S. Army Corps of Engineers (COE).
- (3) Geosynthetic Research Institute (GRI).
- (4) Environmental Protection Agency (EPA).
- (5) American Association for State Highway and Transportation Officials (AASHTO).

Each roll shall be plainly and permanently marked with the following information:

- (1) Name or trademark of manufacturer.
- (2) Date of manufacture.
- (3) Product identification.

The Contractor shall supply data for each roll of material documenting that the strength and elongation at yield and break comply with the product specifications.

- (b) Submittals. Product data, certifications, shop drawings, and samples shall be submitted to the Engineer for approval 30 days prior to geogrid installation and embankment construction.

Submit manufacturer's catalog cuts, specifications, and installation instructions.

Submit certifications and shop drawings, which shall include, but are not limited to, the following:

- (1) Geogrid Placement Plan.
- (2) Installation Details.

Submit 6 in² sample of each type of geogrid proposed. Samples shall be taken from materials delivered to the project site.

Submit record drawings showing panel layout and installation sequence.

- (c) Product Delivery, Storage, and Handling. Contractor shall deliver sufficient materials to the site to prevent interruption of the work.

Contractor shall inspect all materials upon delivery. Contractor shall notify the Engineer, and vice versa, of any damage. Damaged materials shall be returned and replaced at no cost to the Agency.

Geogrid shall be stored above 0°C. Contractor shall prevent mud, wet cement, epoxy, and similar materials which may affix themselves to the grid, from coming into contact with the geogrid material. Rolled geogrid material shall be laid flat or stood on edge for storage. Geogrid shall be kept covered with protective wrapping until ready for use.

Geogrid shall be handled carefully with approved handling devices in strict conformance with the manufacturer's recommendations. Products shall not be dropped or rolled off trucks, nor shall products be otherwise dragged, rolled, or skidded.

- (d) Material Specifications. The geogrid reinforcement for primary slope stabilization shall be a uniaxially oriented

grid structure. The geogrid reinforcement for secondary slope stabilization shall be a biaxially oriented grid structure. The manufacturer shall furnish the Engineer with test reports certifying that the product meets the requirements of these provisions. A Type D certification shall be furnished in accordance with Subsection 700.02.

Uniaxial geogrid shall be regular grid structure. The geogrid shall have high resistance to deformation under sustained long-term design load while in service and shall also be resistant to ultraviolet degradation, damage under normal construction practices, and all forms of biological or chemical degradation normally encountered in the material being reinforced.

Biaxial geogrid shall be a regular grid structure. The geogrid shall maintain its reinforcement and interlock capabilities under repeated dynamic loads while in service and shall be resistant to ultraviolet degradation, damage under normal construction practices, and all forms of biological or chemical degradation normally encountered in the material being reinforced.

In addition, geogrid shall conform to the following requirements:

(1) Long Term Tensile Strength.

- a. Primary Reinforcement for Geogrid. The Contractor shall provide certified tested geosynthetic meeting the long term allowable tensile strengths, T_{a1} as shown on the Plans and conforming to the following criteria:

$$T_{a1} = \frac{T_{ULT}}{RF}$$

Where: T_{a1} = Long Term Allowable Tensile Strength
The minimum value for T_{a1} permitted is 1000 lbs/ft.

T_{ULT} = Ultimate Tensile Strength, as determined in the primary strength direction in accordance with ASTM D6637.

$$RF = \text{Total Reduction Factor} = RF_{CR} \times RF_{ID} \times RF_D$$

RF_{CR} = Reduction Factor for Creep Deformation for 100 Year Design Life, calculated in accordance with Geosynthetic Research Institute

Standard Practice GRI-GG4 using ASTM Standard Test Methods D5262.

RF_{ID} = Reduction Factor for Installation Damage, calculated in accordance with

ASTM D5818. The minimum RF_{ID} value permitted is 1.10.

RF_D = Reduction Factor for Durability, as determined in accordance with EPA9090 and ASTM D4595. The minimum RF_D value permitted is 1.10.

The minimum "RF" values permitted based on extrapolation of product specific test data is:

$$\frac{\text{Permanent}}{RF} = 2.36$$

When product specific test data is not available, use the following reduction factor:

$$\frac{\text{Permanent}}{RF} = 8$$

The following manufacturers are capable of supplying geogrid that meets these specifications:

Manufacturer	Geogrid Type	Ultimate Strength (lbs/ft)	Creep Limited Strength (lbs/ft)
Carthage Mills	GX-300	3,250	2,211
TenCate Geosynthetics	Miragrid 3XT	3,500	2,215
Synteen Technical Fabrics	SF 35	3,435	2,230

Requests for substitutions for the above shall be submitted to the Agency's Office of Contract Administration a minimum of 10 days in advance of the bid opening date. Substitutions for the above after award shall be approved by the Resident Engineer.

- b. Secondary Reinforcement for Geogrid. The Contractor shall provide certified tested geosynthetic meeting the long term allowable tensile strength, T_{a1} (in the direction perpendicular to the slope) shown on the Plans.
- (e) Minimum Pullout Resistance Factor. The minimum pullout resistance factor will be 0.50 as determined by ASTM D6706.

- (f) Backfill. The Contractor shall provide select granular backfill material, to the lines and grades shown on the Plans, meeting the requirements of Subsection 703.04.
- (g) Facing.
 - (1) Bridge No. 27. The Contractor shall provide stone fill and geotextile as facing for the reinforced soil slopes to the lines and grades shown on the Plans. Stone shall conform to the requirements of Subsection 706.04(b). Geotextile shall conform to the requirements of Section 720 for Geotextile Under Stone Fill.
 - (2) Bridge No. 28. The Contractor shall provide 6 inches of topsoil placed on the face of the reinforced slope to the lines and grades shown on the Plans. The topsoil shall be seeded and fertilized and shall conform to the requirements of Section 651 for topsoil, seed, and fertilizer. The outward face treatment shall consist of a permanent erosion matting meeting the requirements of Subsection 755.11(b).

xx. INSTALLATION.

- (a) General. The Contractor shall provide on-site representatives for consultation from the geosynthetic suppliers for a minimum of three days at the start of the geogrid installation.

The Contractor shall be responsible for the storage, handling, and installation of all geogrids in accordance with the specifications and the manufacturer's recommendation.

- (b) Site Preparation. All areas immediately beneath the installation area for the geogrid shall be properly prepared as detailed on the Plans, as specified within these provisions, or as directed by the Engineer. Subgrade surface shall be level and free from deleterious material and loose or otherwise unsuitable soils in accordance with Section 203. Foundation surface shall be inspected and approved by the Engineer prior to fill placement.

- (c) Geogrid Placement. The geogrid shall be installed in accordance with the manufacturer's recommendations. The geogrid shall be placed within the layers of the compacted soil as shown on the Plans or as directed by the Engineer.

The geogrid shall be placed in continuous longitudinal strips in the direction of the main reinforcement. Adjacent strips, in the case of 100 percent coverage in plan view, need not be overlapped. However, if the Contractor is unable to complete a required length with a single continuous length of geogrid, a joint may be made with the approval of the Engineer.

Place only that amount of geogrid required pending work to prevent undue damage. After a layer of geogrid has been placed in its entirety, the next succeeding layer of soil shall be placed in its entirety and compacted. After the specified layer has been placed in its entirety, the next geogrid layer shall be installed in its entirety. The process shall be repeated for each subsequent layer of geogrid and soil.

Geogrid reinforcement shall be placed to lay flat and pulled tight prior to backfilling. After a layer of geogrid has been placed, suitable means, such as pins or small piles of soil, shall be used to hold geogrid in position until the subsequent soil layer can be placed. Under no circumstances shall a track-type vehicle be allowed on the geogrid before at least 6 inches of soil has been placed.

During construction, the surface of the fill shall be kept approximately horizontal. Geogrid shall be placed directly on the compacted horizontal fill surface. Geogrids are to be placed within 3 inches of the design elevations and extend the length as shown on the elevation view, unless otherwise directed by the Engineer. The Contractor shall verify correct orientation of the geogrid.

Place stone fill, grubbing material, topsoil, and permanent erosion matting where required, as shown on the Plans.

- (d) Backfill Placement. Replace any damage geosynthetic prior to placement of any overlying material at no cost to the Agency. Backfill shall be compacted as specified by project specifications or to at least 95 percent of the maximum density determined in accordance with AASHTO-T99, whichever is greater. Backfill within 3 feet of slope face shall typically be compacted with hand equipment.

In-place density testing shall be performed by the Contractor for every soil lift at a frequency of 1 test per every 4300 ft², or as otherwise specified by the Engineer. Backfill shall be placed, spread, and compacted in such a manner to minimize the development of wrinkles and/or displacement of the geogrid.

Fill shall be placed in 8 inch maximum lift thicknesses.

Backfill shall be graded away from the slope crest and rolled at the end of each workday to prevent ponding of water on the reinforced soil mass. Site shall be maintained to prevent the flow of water from overtopping slope crest during construction and after completion of slope. Slope face shall be trimmed such that geogrid reinforcement extends to surface.

Turning of tracked vehicles shall be kept to a minimum to prevent tracks from displacing the fill and the geogrid. Rubber-tired equipment may pass over the geogrid

reinforcement at slow speeds, less than 10 mph. Sudden braking and sharp turning shall be avoided.

xx. METHOD OF MEASUREMENT. The quantity of Special Provision (Reinforced Soil Slope) to be measured for payment will be the number of vertical square meters (square yards) of face area. The height shall be computed based on the elevations indicated on the cross sections for the top and bottom limits of the slope as shown on the Plans. The length shall be measured around the toe of slope to the limits of reinforced soil slope as shown on the Plans. The calculated payment area shall not include creep, joints or deformation of panels in place.

xx. BASIS OF PAYMENT. The accepted quantity of Special Provision (Reinforced Soil Slope) will be paid for at the Contract unit price per square meter (square yard). Payment will be full compensation for furnishing and installing the specified materials in accordance with the Contract Documents, including on-site supplier representation, site preparation, geosynthetic reinforcement, geotextile placed under backfill, and backfill, and for furnishing all labor, tools, equipment and incidentals necessary to complete the work.

Excavation will be paid for separately under Contract item 204.20.

Payment for stone fill, geotextile placed under surface stone fill, topsoil, erosion matting, granular backfill for structures, and underdrain will be made separately under the appropriate Contract items.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
900.675 Special Provision (Reinforced Soil Slope)	Square Meter (Square Yard)