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APPENDIX GE-07

Geogrid Reinforcement of Soil Embankment
(Contact Document)

State of Ohio
Department of Transportation
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Innerbelt Bridge
Construction Contract Group 1 (CCG1)

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GEOGRID REINFORCEMENT OF SOIL EMBANKMENT

1.0 DESCRIPTION

This work shall include the furnishing and installing of geogrid reinforcement to the lines, grades and orientation shown in the plans, or as directed by the Engineer. The geogrids shall be of the type shown on the plans and as detailed herein. Soil embankment as described and required herein shall be paid for under C&MS 203.

2.0 MATERIALS

2.1 PHYSICAL PROPERTIES

The geogrid shall be a regular network of integrally connected polymer elements with aperture geometry sufficient to permit significant mechanical interlock with the surrounding soil or rock. The geogrid shall be dimensionally stable and able to retain its geometry under construction stresses. The material shall have high resistance to ultraviolet degradation and to all forms of chemical and biological degradation encountered in the soil being reinforced.

Geogrids shall meet the following minimum tensile properties. Test methods with the GRI prefix refer to standard practice of the Geosynthetic Research Institute. No preloading is permitted in determination of tensile strength.

Tensile Strength	**Method**	**Type**						
		P1	**P2**	**P3**	**P4**	**P5**	**S1**	**S2**
5% Strain (lb/ft)	ASTM D4595	1850	3160	3450	4700	5000	800	1200
Ultimate (lb/ft)	ASTM D4595	---	---	---	---	---	1400	2100
Long Term Design (lb/ft)	see below	1300	2000	2500	3300	4200	---	---

2.1.1 LONG-TERM DESIGN TENSILE STRENGTH

The long-term design strength (T_A) shall be defined by the following:

$$T_A = T_{ULT} \div (FS_{CR} \times FS_{ID} \times FS_{DU} \times FS_{JNT})$$

2.1.2 ULTIMATE TENSILE STRENGTH, T_{ULT}

The ultimate tensile strength shall be the minimum average roll value as tested per ASTM D4595.

2.1.3 PARTIAL FACTOR OF SAFETY FOR CREEP DEFORMATION, FS_{CR}

This value is the ratio of T_{ULT} to creep limited strength determined in accordance with ASTM D5262. The test results shall be extrapolated for a 75-year design life per GRI:GG3a or GRI:GG3b. Creep performance testing at a designated temperature is limited to one order of magnitude in extrapolation. Elevated temperature testing for a minimum 10,000 hours and extrapolation to a minimum 100,000 hours is required. Creep testing shall be performed on representative samples of the product and not on a single component of geogrid. Default values for FS_{CR} shall not be accepted. The minimum value permitted shall be 2.00.

2.1.4 PARTIAL FACTOR OF SAFETY FOR INSTALLATION DAMAGE, FS_{ID}

This value shall be determined from installation damage tests consistent with ASTM D-5818 modified as per FHWA Publication No. FHWA-SA-96-072, Corrosion/Degradation of Soil Reinforcements for Mechanically Stabilized Earth Walls and Reinforced Soil Slopes, Section 5.1. The backfill and compaction methods used for testing shall be equal to or more severe than those for the proposed construction. If testing according to this criteria has not been conducted, a default value of 3.0 shall be used. The minimum value permitted shall be 1.10.

2.1.5 PARTIAL FACTOR OF SAFETY FOR DURABILITY, FS_{DU}

Only geogrids meeting the following criteria are permitted. For coated PET geogrids, testing by the inherent viscosity method (ASTM D-4603) with correlation or determination directly using gel permeation chromatography, shall yield a molecular weight greater than 25,000; and the carboxyl end group number shall be less than 30 as determined by GRI:GG7. For HDPE and PP geogrids, testing according to ASTM D-4355 shall yield a strength retained not less than 70 percent after 500 hours.

The value is the partial factor of safety considering chemical and biological degradation. It

shall be defined by the equation:

FS_{DU} = **1 ɘ (1 + R)**

where R is the strength reduction ratio of the 50 degree Celsius incubation test at 120 days as determined by test method EPA 9090. The incubation fluid shall have a pH of 12 or higher. Strength shall be determined by GRI:GG1 on the longitudinal rib. If testing according to these requirements has not been conducted, reduction factor default values of 1.30 shall be used. The minimum value permitted for specific polymer types is as follows:

HDPE	1.10
PET	1.15
PP	1.10

2.1.6 PARTIAL FACTOR OF SAFETY FOR JOINT STRENGTH, FS_{JNT}

This value is the partial factor of safety which shall be considered when separate lengths of geogrids are connected together or overlapped in the direction of the primary reinforcement. The value of FS_{JNT} shall be taken as the ratio of the unjointed specimen strength to the jointed specimen strength. Testing shall be conducted in accordance with ASTM D4595 for mechanically connected joints and GRI:GG4 or GRI:GT7. The loading shall be not less than the long-term design tensile strength. Default values for FS_{JNT} shall not be accepted. The minimum value permitted shall be 1.00 if there is no reduction in strength of the jointed specimen or if no joints are used.

2.1.7 SOIL-REINFORCEMENT INTERACTION

The geogrid shall develop a minimum long-term interaction coefficient of 0.70 in a fine-grained soil having not less than 50 percent passing the No. 200 sieve. The value shall be determined in accordance with GRI:GG5 or GRI:GT6.

2.2 CERTIFICATION AND TESTING

The DBT shall submit certified test data, measured in full accordance with the test methods and standards specified, to cover each shipment of material. Upon request of the Engineer, the DBT shall provide documented test results from an independent testing laboratory for any of the criteria specified. No extra payment will be made for testing.

2.3 DEFECTS

During shipment and storage, the geogrid shall be protected from temperatures greater than 140 degrees F., and mud, dirt, dust and debris. The manufacturer=s recommendations regarding protection from direct sunlight shall be followed. The geogrid shall be rejected if it has defects, tears, punctures, flaws, deterioration or damage incurred during manufacturing, transportation or storage. If approved by the Engineer, torn or punctured sections may be repaired by placing a patch over the damaged area.

3.0 CONSTRUCTION METHODS

3.1 INSTALLATION

The geogrid shall be placed horizontally at the elevations and orientations shown on the plans. The vertical position of each layer shall be maintained within 2 inches. Correct orientation (roll direction) of the geogrid shall be verified by the DBT. Type P1, P2, P3, P4, and P5 geogrid shall have its roll direction perpendicular to the slope face and no overlap is required between adjacent rolls. Type S1 and S2 geogrid shall have its roll direction parallel to the slope face with overlaps not less than 6 inches in the roll direction and no overlaps across the roll.

The geogrid shall be secured in-place to prevent movement during fill operations. The geogrid shall be secured with staples, pins, sandbags, fill or as directed by the Engineer.

3.2 CONNECTIONS AND OVERLAPS

The geogrid shall be placed in continuous strips in the direction specified. If the DBT is unable to complete the required continuous length, Type P1, P2, P3, P4, and P5 will be permitted to be jointed, with the approval of the Engineer. Not more than one joint per length of geogrid shall be permitted. Joints shall be made by either a mechanical connection or an overlap. Mechanical connections shall use a polymer bar or sewing with Kevlar thread. Bar connections shall be placed, as a minimum, on the second row of apertures from the end of the roll and shall be held taut during fill placement. Overlap connections shall be not less than 5 feet in length, with not less than 4 inches separating the two layers.

Joints shall be set back not less than 15 feet behind the finished slope surface. Joints shall be staggered not less than 10 feet between adjacent rolls or between consecutive layers.

3.3 EMBANKMENT, AS PER PLAN

Placement of the embankment material shall conform to all applicable requirements of Item 203, except that compaction shall be not less than 95 percent of maximum dry density as determined by AASHTO T99 or other approved method. Material shall be soil as defined in 203.02, except that no organic content shall be permitted and the Plasticity Index, as determined by ASTM D424, shall not be greater than 20.

Embankment soils shall have a pH in the range of 3 to 9. Testing of the embankment material with respect to pH may not be required. At the Engineer's discretion, when soils potentially corrosive to the geogrid are suspected, the Engineer may elect to perform his own pH testing in accordance with ASTM G51. Embankment soils having a pH outside the acceptable ranges shall be rejected.

The material shall be placed, spread and compacted in a manner that prevents the development of wrinkles or movement of the geogrid. Tracked construction equipment shall not be operated directly upon the geogrid. A minimum fill thickness of 6 inches is required prior to operation of tracked vehicles over the geogrid. Turning of tracked vehicles shall be kept to a minimum to prevent tracks from displacing the fill and damaging the geogrid. Rubber-tired equipment may pass over the geogrid at slow speeds, less than 10 m.p.h. Sudden braking and sharp turning shall be avoided. Damaged geogrids shall be replaced or repaired at no cost to the Department.

3.4 ON-SITE REPRESENTATIVE

The DBT shall provide an experienced and qualified representative of the geogrid manufacturer on-site at the initiation of the project. The representative shall be available at least three working days, unless excused by the Engineer.