
Supplemental Technical Specification for

Reinforced Soil Slopes (RSS)

SCDOT Designation: SC-M-206-1 (4/16)

1.0 DESCRIPTION

1.1 Construct a reinforced soil slope in accordance with these specifications, plans, or as directed by the Resident Construction Engineer (RCE) and in conformance with the lines, grades, dimensions, and design shown on the plans. The work addressed by this specification includes furnishing and placing of reinforced backfill materials, placing geogrid soil reinforcements (primary and secondary), furnishing secondary soil reinforcement, furnishing and placing topsoil and any associated facing material, furnishing and placing temporary/permanent wire forms (excluding concrete slope protection) and furnishing and placing any drainage indicated in the plans.

2.0 TESTING STANDARDS

2.1 Use the latest edition of the testing standards indicated in this specification. Substitution of standards will require the prior written approval of the Materials and Research Engineer (MRE) with concurrence of the Geotechnical Engineer-of-Record (GEOR). Provide copies of all substituted standards to the RCE if requested. The RCE will provide the copies to the MRE and GEOR for approval and concurrence.

3.0 RESPONSIBILITY

3.1 Ensure the satisfactory construction of the reinforced soil slope feature including materials, methods, and installation based on information provided in the plans, specifications, and the geogrid reinforcement supplier's recommendations. Provide the geogrid reinforcement, facing material, geotextile erosion control blankets, sod, fasteners, hold-downs, splice or seaming hardware, wire forms, and all necessary incidentals. Cooperate with the RCE in the event that the RCE chooses to randomly sample the stock piled geogrid reinforcement.

4.0 MATERIALS

4.1 Check the geogrid soil reinforcement upon delivery to ensure that the proper material has been received. Label geogrid rolls per ASTM D4873, *Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples*. During all periods of shipment and storage, protect the geogrid rolls from temperatures greater than 140°F, mud, dirt, dust, and debris. Follow the manufacturer's recommendations regarding protection from direct sunlight. At the time of installation, reject the geogrid reinforcement if it has defects, tears, punctures, flaws, deterioration, or damage incurred during manufacture, transportation, or storage. Replace, at no additional cost to the Department, any geogrid reinforcement damaged during storage or installation. However, if approved by the RCE, placing a patch over the damaged area may repair torn or punctured sections. Replace or repair any rejected geogrid reinforcement at no additional cost to the Department.

4.2 For primary and secondary reinforcement, see Supplemental Technical Specification entitled *Geogrid Soil Reinforcement* (SC-M-203-2).

4.3 For separation between stone material and the reinforced soil backfill, see Supplemental Technical Specification entitled *Geosynthetic Materials for Separation and Stabilization* (SC-M-203-1), if shown on the plans.

4.4 Use fill materials conforming to the following gradation limits as determined in accordance with SC-T-4 and SC-T-5:

Sieve Size	Percent Passing
¾ inch	100.0
No. 4	20.0 – 100.0
No. 40	0.0 – 60.0
No. 100	0.0 – 30.0
No. 200	0.0 – 15.0

4.5 All reinforced backfill shall have the following soil properties:

1. pH values shall range between 3.0 to 9.0 ($3.0 \leq \text{pH} \leq 9.0$) (ASTM G51).
2. Organic content shall not exceed 1.0 percent (weight of organic material to weight of total sample) as determined by ASTM D2974 for material finer than no. 10 sieve.
3. Internal friction angle shall not be less than the value specified on the plans as determined by the standard direct shear test, ASTM D3080 on the portion finer than the No. 10 sieve. The normal force to be used during testing will be shown on the plans. Compact the test samples to 95% ASTM D698 (Method C or D) of maximum density at optimum moisture content.
4. The coefficient of uniformity, C_u , shall be 4 or greater, but less than 20. Compute the coefficient of uniformity, C_u , as follows:

$$C_u = \frac{D_{60}}{D_{10}}$$

Where D_{60} is the particle diameter at 60% passing and D_{10} is the particle diameter at 10% passing.

5. Plasticity Index (PI) shall be less than or equal to 6 and the Liquid Limit (LL) shall be less than or equal to 30 as determined by ASTM D4318.

4.6 Test the reinforced backfill materials for all soil property requirements indicated previously using an AASHTO accredited laboratory, during initial source evaluation or if a change in source is requested. Sample and test the reinforced backfill material once every 4,000 cubic yards for gradation, organic content, liquid limit, plasticity index and pH. Sample and test reinforced backfill material once every 20,000 cubic yards for internal friction angle.

A variation in testing frequency may be required if a variation in material gradation or composition is observed.

5.0 CONSTRUCTION REQUIREMENTS

5.1 Prepare the foundation in accordance with the specifications, except as noted herein or on the plans. Unless otherwise shown on the plans or directed by the RCE, remove all existing vegetation and all unsuitable foundation materials from those areas where the Reinforced Soil Slope is to be placed.

5.2 Excavation the foundation soil to the lines and grades as shown on the plans or as directed by the RCE. Fill over-excavated or muck excavated areas with compacted backfill material or as outlined in the Special Provisions. Proof roll the graded area with a static roller weighing a minimum of 8 tons for at least 5 passes in the presence of the RCE or as directed by the RCE. Remove and replace any soft or loose foundation subsoils, in the opinion of the RCE, incapable of sustaining the required proof rolling in accordance with the specifications.

5.3 Place the geogrid reinforcement on surfaces that are uniform, level, smooth and free of abrupt changes in slope, debris and irregularities that could damage the geogrid reinforcement. Promptly repair and restore any areas outside the limits of RSS shown on the plans that are damaged as part of this work to their original condition at the Contractor's expense. In addition, notify the RCE if areas beyond the limits of the RSS are damaged. Make every possible effort to avoid such damage.

5.4 Maintain the uniformity of the moisture content of the backfill material prior to and during compaction throughout each layer of material. Maintain the moisture content of the backfill materials at not more than 2 percentage points below the optimum moisture content and not more than the optimum moisture content. Remove and rework backfill material with placement moisture content in excess of the optimum moisture content, until the moisture content is uniformly acceptable throughout the entire lift. Do not transport excessively moist backfill materials to the site for any reason.

5.5 Construct the reinforced embankment in accordance with Section 205. Compact the reinforced backfill to no less than 95.0 percent of the maximum dry density in accordance with ASTM D698 (Method A or C as applicable) or SC T-25 (Method A or C as applicable). Perform compaction control testing of the reinforced backfill at a minimum frequency of 1 density test either every 25 feet of reinforced slope within 150 feet of the bridge abutments per lift or for every 75 feet of reinforced slope per lift more than 150 feet from the bridge abutments). Do not use sheepsfoot or grid-type rollers for compacting backfill within the reinforced backfill.

5.6 Use 8-inch maximum soil lift thickness (loose). Decrease this lift thickness if necessary to obtain the density. Place, spread, and compact reinforced backfill in such a manner that minimizes the development of wrinkles and/or movement of the geogrid. Do not operate any construction equipment directly on the geogrid reinforcement material under any circumstances. Place the fill material in uniform layers so that there is a minimum lift thickness (loose) of 8 inches between the geogrid reinforcement material and equipment tires or tracks at all times. A minimum fill thickness (compacted) of 6 inches is required prior to allowing the turning of any construction vehicles over the geogrid. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displacing the compacted fill

and damaging the geogrid. Vehicles are to avoid sudden braking and sharp turning while within the zone of geogrid reinforcement. Fill and compact material in ruts of more than 3 inches in depth as the ruts develop in the cover soil.

5.7 At the end of each day's operations, shape the last level of backfill to permit runoff of rainwater away from the slope face. In addition, allow no surface runoff from adjacent areas to enter the reinforcement zone until this zone is protected from infiltration. Repair at the Contractor's expense any damage or movement caused by erosion, sloughing, or saturation of the reinforced backfill or retained backfill.

5.8 Due to the unique nature of this type of construction, provide a qualified and experienced representative of the geogrid manufacturer or its supplier for a minimum of 1 day of site assistance at the start of installation, to assist the Contractor and the RCE in the proper construction/installation techniques. Thereafter, the representative shall be available on an as needed basis, as requested by the RCE, during construction of the remainder of the project. Submit a copy of any instructions provided by the supplier to the RCE prior to beginning installation.

5.9 Place the geogrid reinforcement at the proper elevation, location, and orientation as shown on the plans and specifications or as directed by the RCE. Orient uniaxial strength geogrid used as the primary reinforcement perpendicular to the slope face or centerline. Biaxial strength geogrid when used as primary reinforcement may be laid out either perpendicular to the slope face or parallel to the slope face provided that it is being placed over a stable subgrade (i.e. not over soft soils). If a biaxial geogrid, when used as the primary reinforcement, is being placed over a soft foundation, place the strong axis of the biaxial geogrid perpendicular to the slope face. Verify correct orientation (roll direction) of the geogrid. Geogrid may be temporarily secured in-place with staples, pins, sand bags, or backfill as required by fill properties, fill placement procedures, or weather conditions, or as directed by the RCE. Pull tight and secure the geogrid reinforcement material as necessary to lay flat against the soil prior to fill placement.

5.10 Unless otherwise called for on the plans, butt together adjacent rolls of geogrid reinforcement together to maintain 100% horizontal coverage. Do not exceed the vertical spacing of the primary soil reinforcing layers shown in the plans.

5.11 Do not splice or overlap primary geogrid in the primary strength direction. No overlapping is required between adjacent rolls of primary soil reinforcement.

5.12 Overlap secondary soil reinforcement a minimum of 12 inches along the roll edges parallel to the reinforcement direction. Overlaps are not allowed for edges perpendicular to the reinforcement direction.

5.13 Place only that amount of geosynthetic material (including reinforcement and drainage material) required for immediately pending work to prevent undue damage to the materials. After a layer of geosynthetic has been placed, place and compact the next succeeding layer of soil. After the specified soil layer has been placed and compacted, install the next geosynthetic layer. Repeat the process for each subsequent layer of geosynthetic and soil.

5.14 Replace, at no additional cost to the Department, any geosynthetic reinforcement damaged during installation.

6.0 METHOD OF MEASUREMENT

The quantity of geogrid reinforced slope to be used for payment shall be the area, in square feet, of the vertical projection of the slope face, measured from the top of slope to the proposed final ground line at the toe of the slope and from the beginning to end limits as shown on the plans, regardless of the length or number of layers of geosynthetic within the reinforced volume and including any reinforcement required below the toe of the slope elevation.

7.0 BASIS OF PAYMENT

The quantity, determined as provided above, shall be paid for at the contract unit price per vertical square foot of geosynthetic reinforced soil slope. Payment shall be full compensation for all work, materials, and services required including, the soil slope secondary reinforcements, placement of reinforced embankment backfill and secondary reinforcements, topsoil, any associated facing material (stone and geotextile for slope preservation), and temporary wire forms (excluding concrete slope protection), installation, testing, and required submittals. The primary geogrid reinforcing will be measured and paid for as *Geogrid Soil Reinforcement* (SC-M-203-2). The reinforced backfill zone material will be measured and paid for as *Borrow Excavation*. Additional costs associated with using select material within the reinforced backfill zone will be included in the Reinforced Soil Slope item.

Payment will be made under:

Item No.	Pay Item	Pay Unit
2061200	Reinforced Soil Slope	SF