**REINFORCED SOIL SLOPES: (12-17-19)**

**Description**

Construct reinforced soil slopes (RSS) consisting of select material and geogrid reinforcement in the reinforced zone with erosion control products on slope faces. Slope erosion control includes matting with shoulder and slope borrow or geocells with compost blankets. Construct RSS in accordance with the contract and if included in the plans, Geotechnical Standard Detail No. 1802.01 or 1802.02. RSS are required to reinforce embankments and stabilize slopes at locations shown in the plans and as directed. Define “geogrids” as primary or secondary geogrids and “matting” as coir fiber mats or matting for erosion control. Define “standard RSS” as an RSS that meets either of the standard reinforced soil slope drawings (Geotechnical Standard Detail No. 1802.01 or 1802.02).

**Materials**

Refer to Division 10 of the *Standard Specifications*.

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| **Item** | **Section** |
| Geogrids | 1056 |
| Matting for Erosion Control | 1060-8 |
| Select Materials | 1016 |
| Shoulder and Slope Borrow | 1019-2 |

Unless required otherwise in the plans, use Class I, II or III select material in the reinforced zone of RSS. Use geocells that meet the *Cellular Confinement Systems* provision, seeded compost blankets that meet the *Compost Blanket* provision and coir fiber mats that meet the *Coir Fiber Mat* provision.

Handle and store geogrids in accordance with Article 1056-2 of the *Standard Specifications*. Define “machine direction” (MD) and “cross-machine direction” (CD) for geogrids per Article 1056-3 of the *Standard Specifications*. Provide Type 1 material certifications and identify geogrids in accordance with Article 1056-3 of the *Standard Specifications*.

Use primary geogrids with a roll width of at least 4 ft and an “approved” status code in accordance with the NCDOT Geosynthetic Reinforcement Evaluation Program. The list of approved geogrids is available from:

[connect.ncdot.gov/resources/Geological/Pages/Products.aspx](https://connect.ncdot.gov/resources/Geological/Pages/Products.aspx)

Provide primary geogrids with design strengths in accordance with the plans. For standard RSS and based on actual RSS angle and height and select material to be used in the reinforced zone at each standard RSS location, provide primary geogrids with long-term design strengths in accordance with Geotechnical Standard Detail No. 1802.01 or 1802.02. Primary geogrids are approved for long-term design strengths for a 75-year design life in the MD based on material type. Define material type from the website above for select material as follows:

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| **Material Type** | **Select Material** |
| Borrow | Class I Select Material |
| Fine Aggregate | Class II or III Select Material |

For secondary geogrids, provide extruded geogrids produced in the United States and manufactured from punched and drawn polypropylene sheets. Use secondary geogrids with a roll width of at least 6 ft that meet the following:

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| **Property** | **Requirement1** | **Test Method** |
| Aperture Dimensions**2** | 1" x 1.3" | Direct Measure |
| Minimum Rib Thickness**2** | 0.03" x 0.03" | Direct Measure |
| Tensile Strength @ 2% Strain**2** | 280 lb/ft x 450 lb/ft | ASTM D6637, Method B |
| Tensile Strength @ 5% Strain**2** | 580 lb/ft x 920 lb/ft |
| Ultimate Tensile Strength**2** | 850 lb/ft x 1,300 lb/ft |
| Junction Efficiency**3**  (MD) | 93% | ASTM D7737 |
| Flexural Rigidity**4** | 250,000 mg–cm | ASTM D7748 |
| Aperture Stability Modulus**5** | 0.32 lb–ft/degrees | ASTM D7864 |
| UV Resistance  (500 hr exposure) | 100% retained | ASTM D4355 |

* 1. MARV per Article 1056-3 of the *Standard Specifications* except dimensions and thickness are nominal.
  2. Requirement for MD x CD.
  3. Junction Efficiency (%) = (Average Junction Strength (Xjave) Ultimate Tensile Strength in the MD from ASTM D6637, Method A) 100.
  4. Test specimens two ribs wide, with transverse ribs cut flush with exterior edges of longitudinal ribs, and sufficiently long to enable measurement of the overhang dimension.
  5. Applied moment of 17.7 lb–inch (torque increment).

**Construction Methods**

Before starting RSS construction, the Engineer may require a preconstruction meeting to discuss the construction and inspection of the RSS. If this meeting is required and occurs before all RSS submittals and material certifications have been accepted, additional preconstruction meetings may be required before beginning construction of RSS without accepted submittals. The Resident or District Engineer, Area Construction Engineer, Geotechnical Operations Engineer, Contractor and RSS Contractor Superintendent will attend preconstruction meetings.

Control drainage during construction in the vicinity of RSS. Direct run off away from RSS, select material and backfill. Contain and maintain select material and backfill and protect material from erosion.

Excavate as necessary for RSS in accordance with the contract. Maintain a horizontal clearance of at least 12" between the ends of primary geogrids and limits of reinforced zone as shown in the plans. When excavating existing slopes, bench slopes in accordance with Subarticle 235-3(A) of the *Standard Specifications*. Notify the Engineer when excavation is complete. Do not place primary geogrids until excavation dimensions and in-situ material are approved.

Place geogrids within 3" of locations shown in the plans. Install geogrids with the orientation, dimensions and number of layers shown in the plans. Before placing select material, pull geogrids taut so they are in tension and free of kinks, folds, wrinkles or creases. Contact the Engineer when existing or future obstructions such as foundations, pavements, pipes, inlets or utilities will interfere with geogrids. If necessary, the top geogrid layer may be lowered up to 9" to avoid obstructions. Extend geogrids to slope faces.

Install primary geogrids with the MD perpendicular to the embankment centerline. The MD is the direction of the length or long dimension of the geogrid roll. Do not splice or overlap primary geogrids in the MD so splices or overlaps are parallel to toe of RSS. Unless shown otherwise in the plans and except for clearances at the ends of primary geogrids, completely cover select material at each primary geogrid layer with geogrid so primary geogrids are adjacent to each other in the CD, i.e., perpendicular to the MD. The CD is the direction of the width or short dimension of the geogrid roll.

Install secondary geogrids with MD parallel to toe of RSS. Secondary geogrids should be continuous for each secondary geogrid layer. If secondary geogrid roll length is too short, overlap ends of secondary geogrid rolls at least 12" in the direction that select material will be placed to prevent lifting the edge of the top geogrid.

Place select material in the reinforced zone in 8" to 10" thick lifts and compact material in accordance with Subarticle 235-3(C) of the *Standard Specifications*. For RSS steeper than 1.5:1 (H:V), compact slope faces with an approved method. Do not use sheepsfoot, grid rollers or other types of compaction equipment with feet. Do not displace or damage geogrids when placing and compacting select material. End dumping directly on geogrids is not permitted. Do not operate heavy equipment on geogrids until they are covered with at least 8" of select material. To prevent damaging geogrids, minimize turning and avoid sudden braking and sharp turns with compaction equipment. Replace any damaged geogrids to the satisfaction of the Engineer. Construct remaining portions of embankments outside the reinforced zone in accordance with Section 235 of the *Standard Specifications*.

Plate slope faces of RSS with at least 6" of shoulder and slope borrow except when using geocells for slope erosion control. Install slope erosion control as shown in the plans and as soon as possible to prevent damage to slope faces of RSS. If damage occurs, repair RSS and slope faces to the satisfaction of the Engineer before seeding or installing erosion control products. For matting, seed slope faces and cover shoulder and slope borrow with coir fiber mat or matting for erosion control as shown in the plans in accordance with the *Coir Fiber Mat* provision or Section 1631 of the *Standard Specifications*, respectively. Install geocells filled with seeded compost in accordance with the accepted submittals and the *Cellular Confinement Systems* and *Compost Blanket* provisions. Maintain slope erosion control until vegetation is established.

**Measurement and Payment**

*Reinforced Soil Slopes* will be measured and paid in square yards. RSS will be measured along the slope faces of RSS before installing slope erosion control as the square yards of RSS. No payment will be made for repairing damaged RSS or slope faces.

The contract unit price for *Reinforced Soil Slopes* will be full compensation for providing labor, tools, equipment and RSS materials, compacting select materials and supplying and placing geogrids, select material, shoulder and slope borrow and any incidentals necessary to construct RSS except for erosion control products. The contract unit price for *Reinforced Soil Slopes* will also be full compensation for excavating and hauling and removing excavated materials to install RSS.

Coir fiber mat and matting for erosion control will be measured and paid in accordance with the *Coir Fiber Mat* provision and Article 1631-4 of the *Standard Specifications*, respectively. Geocells and seeded compost blankets will be measured and paid in accordance with the *Cellular Confinement Systems* and *Compost Blanket* provisions, respectively.

Payment will be made under:

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| --- | --- | --- |
| **Pay Item** |  | **Pay Unit** |
| Reinforced Soil Slopes | | Square Yard |



**PE SEAL NAME**

**PE #**