Reinforced Soil Slope System

Effective: December 4, 2008
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Description. This work shall consist of preparing the design, furnishing the materials, and constructing the reinforced soil slope (RSS) to the lines, grades and dimensions shown in the contract plans, this special provision, any additional requirements specified by the RSS system supplier in the approved shop drawings and as directed by the Engineer.

General. The RSS system shall consist of RSS fill, soil reinforcement and a facing treatment designed to provide adequate stability of slopes specified to have inclines between a 30 and 70 degrees which are resistant to erosion and requiring little or no long term maintenance. For slopes steeper than 45 degrees or where growing conditions, water runoff, or slope face erosion are concerns, hard armored facing shall be used. For slopes flatter than 45 degrees, vegetated facing treatment may be used, unless otherwise specified on the contract plans.

Submittals. The Contractor shall submit complete design calculations and shop drawings to the Department for review and approval. All submittals shall be sealed by a Professional Engineer licensed in the state of Illinois and shall contain all details, dimensions, quantities and cross sections necessary to construct the RSS and as a minimum, include the following:

(a) Plan, Elevation and Cross section sheet(s):

(1) Plan view showing the horizontal alignment and offset from the CL Roadway to the toe and top of the RSS. Beginning and end stations for the RSS system and transition areas shall be shown. These views shall be developed from the plan view Beginning and End Stations of RSS System shown in the contract plans.

(2) Elevation view indicating stations and elevations at the top and bottom of the RSS system. The stations and elevations of final ground line along the length of the wall shall also be indicated. These views shall be developed from the elevation view Top and Bottom Lines of the RSS System shown in the contract plans.

(3) Location, length, size, coverage ratio, type of soil reinforcement shall be shown. The stations or elevations where changes in soil reinforcement occur shall be clearly indicated. Any proposed splices in soil reinforcement shall be detailed.

(4) Typical cross section(s) showing the elements and limits of the RSS system. These views shall include the RSS fill, soil reinforcement, facing treatment, and their relationship to the right-of-way limits, excavation cut slopes, retained embankment, existing ground conditions and the finished grade line.

(5) Facing treatment details indicating type, elements and all dimensions necessary to construct the facing system. The details shall include facing interaction with the soil reinforcement and RSS fill. The specifications for installation, and establishment of vegetated facings, shall be provided and shall be according to the details on the plans. The selected facing shall provide a stable, erosion and sloughing resistant surface layer that will permit compaction against and near the face of the slope.

(6) Locations of utilities, signs, lighting, drainage, guardrail posts, future locations of piles, and other infrastructure within the reinforced volume shall be indicated. Details for placing reinforcements around such elements shall also be provided.

(7) Any general notes required for construction.

(b) Design Computations: The shop drawings shall be supported by detailed computations for each design section indicating the design criteria specified have been met.

(c) Manufacturer's Certification: The contractor shall include manufacturer's certifications and test results indicating that the proposed soil reinforcement, reinforced embankment and facing material satisfy the design parameters used and the materials portion of this specification. The Engineer reserves the right to obtain random samples of materials for testing by the department to confirm the certification values.

No work or ordering of materials for the structure shall be done until the submittal has been approved by the Engineer.

Materials. The RSS materials shall conform to the IDOT Standard Specifications, the supplier's standards, and the following:

(a) The soil reinforcement shall be manufactured from high density polyethylene (HDPE) uniaxial, polypropylene (PP) biaxial resins, or high tenacity polyester (PET) fibers that can develop the Long-Term Allowable Strength and Pullout Resistance required per the Contractors approved design. The soil reinforcement shall be stored between -20 and 140 degrees F (-29 and 60 degrees C). The following standards shall be used to determine the soil reinforcement design properties:

ASTM D 638	Tensile Properties of Plastic
ASTM D 1238	Melt Flow (HDPE and PP)
ASTM D 1248	Molding and Extrusion (HDPE)
ASTM D 1505	Specific Gravity (HDPE)
ASTM D 4218	Carbon Black Content (HDPE)
ASTM D 2455	Carboxyl End Group (PET)
ASTM D 4603	Intrinsic Viscosity (PET)
ASTM D 5262	Unconfined tension Creep Behavior of Geosynthetics
GRI:GG1	Geogrid Rib Tensile Strength
GRI:GG2	Geogrid Junction Strength
GRI:GG4	Long Term Design Strength of Geogrid
GRI:GG5	Evaluating Geogrid Pullout Behavior

(b) The RSS fill, defined as the material placed within the soil reinforcement limits for the RSS system (excluding facing treatment), shall be in accordance with Sections 205, 1003, or 1004 of the Standard Specifications and shall satisfy the following:

(1) It shall have 100 % passing the ¾ in. (19mm) sieve and a maximum 35 % passing the #200 (75 micron) sieve, as determined according to AASHTO T-88.

(2) For non-granular (cohesive) material, the liquid limit (LL) shall not exceed 50 and the plasticity index (PI) shall not be less than 12.

(3) It shall have a minimum Standard Dry Density of 90 lb./cu ft (1442 kg/cu m) when tested according to AASHTO T 99, and shall not have an organic content greater than 10 percent when tested according to AASHTO T 194.

(4) The material shall not be compacted at a moisture content in excess of 110 percent of the optimum moisture content as determined according to AASHTO T 99.

(5) It shall have an in place compacted minimum cohesion of 1000 psf (48 kPa) or a minimum friction angle of 30 degrees.

(6) Soundness shall be class C quality or better according to AASHTO T 104 for any fine or course aggregates used.

(7) pH shall be no less than 3 for PP and HDPE soil reinforcement or between 3 and 9 if PET soil reinforcement is used.

Prior to placing the embankment fill, the source material shall be approved by the Engineer and in-place samples may be tested to ensure that the material meets the above requirements.

(c) The Facing treatment shall be either vegetated or hard armored facing, as specified on the plans.

The vegetated facing treatment materials shall include any top soil, compost, seeding, sod, erosion controls, watering provisions, or other vegetative systems (all according to the Standard Specifications).

Hard armored facing may consist of gabions, wire mesh baskets, geocell, riprap, precast elements or other articulated units shown on the plans. The infill for hard armored facing shall be either vegetation soil or coarse aggregate, as shown on the plans, or if not specified as per the suppliers written specifications.

(d) Retained embankment, defined as the embankment placed behind or above the soil reinforcement limits shall be according to Section 205 of the Standard Specifications.

Design Criteria. The design shall be completed according to the FHWA publications FHWA-SA-96-071 titled “Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Design and Construction Guidelines” and FHWA-SA-96-072 titled “Corrosion/Degradation of Soil Reinforcement for Mechanically Stabilized Earth Walls and Reinforced Soil Slopes.”

The RSS supplier shall be responsible for all internal and external stability aspects of the slope at all stages of construction. The design shall provide the minimum factors of safety using the soil reinforcement Long-Term Allowable Strength (T_{al}) and Pullout Resistance, for the RSS fill proposed.

The soil reinforcement coefficient of interaction and mechanical interlock with the proposed RSS fill material shall be selected and documented with appropriate test data. The soil reinforcement shall be dimensionally stable and able to retain its geometry under

construction stresses and have high resistance to damage during installation considering ultraviolet degradation and all forms of chemical and biological degradation encountered in the RSS fill.

Soil reinforcement coverage ratios must be maintained at no less than 50 percent and the maximum vertical spacing between primary reinforcement layers is 1 m (3 ft.). The design of any joints or splices in the soil reinforcement shall be limited to positive mechanical connections such as a 'bodkin' slat bar type connection detail unless otherwise approved during the shop drawing review. The appropriate test data documenting the connection design capacity (T_{al}) with minimal elongation will be required as part of the submittal package for approval. Lap splices in the main soil reinforcement will not be allowed.

The design and shop drawings shall be based on the boring data included in the contract plans and any geotechnical reports which may be available upon request. From the evaluation of this data, the design computations shall indicate the following design parameters used.

(a) Engineering properties of the foundation soils including shear strength assumed and the factor of safety for the temporary construction and permanent slopes.

(b) Engineering properties of the RSS fill soils including shear strength, unit weight, and friction angle parameters (c, γ, and Φ).

(c) Engineering properties of the retained embankment soils behind the embankment fill, including shear strength, unit weight, and friction angle parameters (c, γ, and Φ).

External loads, such as those applied through structure foundations, from traffic or railroads, slope surcharge etc., shall be accounted for in the stability design. The presence of all appurtenances behind, in front of, mounted upon, or passing through the wall volume such as drainage structures, utilities, structure foundation elements or other items shall be accounted for in the stability design.

The design of the soil reinforcing system shall account for the strength reduction due to long-term creep, chemical and biological degradation, stage construction issues, and installation damage and shall insure stress levels are above the allowable at the end of a 75 year design life.

Construction Requirements. The Contractor shall obtain technical assistance from the supplier during slope erection to demonstrate proper construction procedures and shall include any costs related to this technical assistance in the unit price bid for this item.

(a) Site preparation. The foundation soils supporting the RSS shall be graded for a width equal to the length of the lowest soil reinforcement length. Cut slope surfaces shall be benched to allow the RSS to be keyed into the existing retained embankment. Prior to soil reinforcement placement, the foundation soils shall be compacted with a smooth wheel vibratory roller. Any foundation soils found to be unsuitable shall be removed and replaced, as directed by the Engineer, and shall be paid for according to Article 109.04 of the Standard Specifications unless otherwise specified in the Contract.

Water shall be diverted from the area where soil reinforcement is being placed and soil is being compacted. Diversion shall be performed using a method approved by the Engineer.

(b) Soil Reinforcement. At each soil reinforcement level, the RSS fill material should be roughly leveled and compacted before placing the soil reinforcement. Reinforcement placement shall be installed in accordance with the manufacturer's recommendations and as shown on the approved shop drawings. The reinforcement shall be placed in continuous longitudinal strips in the direction of main reinforcement. Joints or splices will only be allowed if detailed in the approved shop drawings.

Place only that amount of reinforcement required for immediately pending work to prevent undue damage. After a layer of soil reinforcement has been placed, the next succeeding layer of RSS fill shall be placed and compacted. After the required facing treatment is installed and a series of RSS fill lifts are placed to the next level of soil reinforcement, the next soil reinforcement layer shall be installed and the process shall be repeated until the RSS height is completed. Soil reinforcement layers shall be laid flat, pulled tight prior to backfilling, and held in place with pins or other methods. Each soil reinforcement layer shall be placed to within 3 inches (75 mm) of that shown on the shop drawings.

(c) RSS Fill Placement. RSS fill within the soil reinforcement shall be placed and compacted according to the Standard Specifications, and as specified herein. The embankment shall be compacted to at least 95percent of the maximum density determined in accordance with AASHTO T-99. A minimum of one density test every 3 ft. (0.9 m) lift of fill will be performed by the Engineer. RSS fill shall be placed, spread, and compacted in such a manner to avoid the development of wrinkles and/or displacement of the soil reinforcement. Where retained embankment must be placed behind the RSS, its placement shall closely follow placement of the RSS fill.

RSS fill and retained embankment shall be graded away from the slope crest and rolled at the end of each work day to prevent ponding of water on surface of the reinforced soil mass.

A minimum fill thickness of 6 in. (150 mm) is required prior to operation of tracked vehicles over the reinforcement and turning of tracked vehicles should be kept to a minimum to prevent displacing the soil reinforcement. If approved by the Engineer, rubber-tired equipment may pass over the reinforcement at speeds of less than 5 mph. Sudden braking and sharp turning shall be avoided. No rubber-tired wheel traffic will be allowed in direct contact with coated geosynthetic geogrid, as damage to the coating could result.

Compaction adjacent to the backside of the facing treatment shall be achieved by use of light weight mechanical tampers, rollers, vibratory system or other methods to provide short and long term erosion and facing stability.

(d) Facing Treatment

For vegetated slope facing, the construction of any top soil, compost, seeding, sod, mulching, erosion controls, watering, shall be according to the Standard Specifications unless otherwise specified in the approved shop drawings.

For hard slope facing, the construction of any gabions, wire mesh baskets, geocell, coarse aggregate, riprap, precast elements or other articulated units shall be according to the standard Specifications unless otherwise specified in the approved shop drawings.

Method of Measurement. The Reinforced Soil Slope System will be measured for payment in square feet of vertical projected slope face area. The system will be measured from the Top of RSS System Line to the Bottom of RSS System Line for the length of the slope as shown on the contract plans. Any additional face area below or above the top or bottom of RSS Contract plan lines to satisfy the design stability requirements or stepping of the facing will be not be measured for payment but considered included in the cost of the measured area defined above.

Basis of Payment. This work, including any excavation, placement of soil reinforcement, RSS fill, facing treatment, and other items specified on the approved shop drawings will be paid for at the contract unit price per Square Foot (Square Meter) for Reinforced Soil Slope System.