SP-126010
(New)

Iowa Department of Transportation

SPECIAL PROVISIONS
FOR
REINFORCED SOIL SLOPE SYSTEM

Buchanan County
BRS-C010(83)--60-10

Effective Date
April 16, 2013

THE STANDARD SPECIFICATIONS, SERIES 2012, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD

1.0 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.

1.1 General.

The RSS system shall consist of RSS fill, soil reinforcement, a facing treatment, and incidental materials 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

1.2 Reference Standards

American Society for Testing and Materials (ASTM)
1. ASTM D 638 Tensile Properties of Plastic
2. ASTM D 1238 Melt Flow (HDPE and PP)
3. ASTM D 1248 Molding and Extrusion (HDPE)
4. ASTM D 1505 Specific Gravity (HDPE)
5. ASTM D 4218 Carbon Black Content (HDPE)
6. ASTM D 2455 Carboxyl End Group (PET)
7. ASTM D 4603 Intrinsic Viscosity (PET)
8. ASTM D 5262 Unconfined tension Creep Behavior of Geosynthetics
9. ASTM D 422 Particle Size Analysis
10. ASTM D 698 Laboratory Compaction Characteristics of Soil –Standard Effort
11. ASTM D 4318 Liquid Limit, Plastic Limit and Plasticity Index of Soils

12. ASTM D 4595 Tensile Properties of Geotextiles - Wide Width Strip
13. ASTM D 5262 Unconfined Tension Creep Behavior of Geosynthetics
14. ASTM D 3034 Polyvinyl Chloride Pipe (PVC)
15. ASTM D 1248 Corrugated Plastic Pipe

Geosynthetic Research Institute (GRI)
1. GRI:GG1 Geogrid Rib Tensile Strength
2. GRI:GG2 Geogrid Junction Strength
3. GRI:GG4 Long Term Design Strength of Geogrid
4. GRI:GG5 Evaluating Geogrid Pullout Behavior

American Association of State Highway and Transportation Officials (AASHTO) LRFD Bridge Design, 5th Edition, 2010.

1.2 Design Requirements.

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" utilizing AASHTO earth pressure and stability design criteria. Metallic reinforcement systems shall be designed in accordance with AASHTO LRFD Bridge Design Specifications for, Section 11.10, using the Coherent Gravity Method. All designs shall conform to the minimum safety factors in this Specification. Design submittals not meeting this design criteria or technical/administrative criteria specified will be rejected in their entirety until complete compliance is achieved.

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 (Tal) 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% and the maximum vertical spacing between primary reinforcement layers is 3 feet. 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 (Tal) 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 of the RSS system shall be based on the following soil parameters.

Soil	ϕ '	c'	γ
Reinforced Backfill	30 degrees (min)	0 psf	120 pcf
Retained Backfill	25 degrees	0 psf	110 pcf
Foundation Backfill	28 degrees	0 psf	120 pcf

The design computations shall indicate the factor of safety for the temporary construction and permanent slopes, considering both internal stability and external stability.

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. Address hydrostatic, rapid drawdown, and erosive forces. Minimum live loads of 100 psf shall be used for all slopes.

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.

1.3 Submittals

The Contractor shall submit complete design calculations and shop drawings to the Engineer a minimum of 14 days prior to the anticipated start date for the RSS a submittal package for review and approval. All submittals shall be sealed by a Professional Engineer licensed in the state of Iowa and shall contain all details, dimensions, quantities and cross sections necessary to construct the RSS and as a minimum, include the following:

1. Plan, Elevation and Cross section sheet(s):
    i) 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.
    ii) 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.
    iii) 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.
    iv) 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.
    v) 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.
    vi) 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.
    vii) Any general notes required for construction.
2. Design Computations: The shop drawings shall be supported by detailed computations for each design section indicating the design criteria specified have been met.
3. 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.
4. Contractor's certification that:
    i) The specific RSS system proposed for use on this project has been successfully used on a minimum of five similar projects and has been successfully installed on a minimum of 1,000,000 square feet of retaining walls.
    ii) The contractor has a minimum of 20,000 square feet of experience with the proposed SRW system. Contact names and telephone numbers shall be listed for projects used to document the

20,000 square feet.

1.4 Delivery, Storage and Handling

The contractor shall check all materials upon delivery to assure that the proper type, grade, color and material certification have been received. Contractor shall protect materials from damage due to jobsite conditions and in accordance with the manufacturer's recommendations. Damaged materials shall not be incorporated into the work.

2.0 PRODUCTS

2.1 Definitions

1. Soil Reinforcement - geosynthetic or steel reinforcement formed by a regular network of integrally connected tensile elements with apertures of sufficient size to allow interlocking with surrounding soil, rock or earth and function as reinforcement. Soil reinforcement shall be specifically manufactured for soil reinforcement.
2. Unit Drainage Fill - drainage aggregate that is placed within and behind the wall face.
3. Reinforced Backfill - compacted soil that is within the reinforced soil volume as shown on the plans.
4. Foundation Soil – compacted, imported or in-situ soil beneath entire wall.
5. Retained Soil – compacted, imported or in-situ soil behind reinforced zone of the retaining wall.
6. Base Leveling Pad - level compacted gravel or unreinforced concrete pad upon which the first course of segmental concrete facing units is placed.

2.2 Soil Reinforcement

Geosynthetic Reinforcement - shall be evaluated in accordance with NCMA Section 3.5 with the following additions and clarifications.

1. The minimum RFID shall be ≥ 1.05.
2. The minimum RFD shall be ≥ 1.10.
3. The minimum FSUNC shall be ≥ 1.5.
4. Geogrids not providing a minimum junction strength of 40 lbs per foot per GRI: GG2 and all geotextiles shall have a minimum mass of 8 oz/sy and meet the strength requirements of AASHTO M-288-96 Class 1 geotextile.
5. Geogrids not providing a minimum stiffness (flexural rigidity) of 30,000 mg-cm per ASTM D1388 and all geotextiles shall be staked during placement per Section 3.1.B.
6. PET geosynthetics shall be coated with a suitable coating immutably bonded to the PET bundles. The coating shall contain a minimum of 1-% carbon black measured per ASTM 4218. Geogrids not meeting this requirement and all geotextiles shall use a minimum RFD = 1.6.
7. PET geosynthetics shall possess a Molecular Weight ≥ 25,000 g/m per GRI: GG8 and a carboxyl end group number ≤ 30 per GRI: GG7. PET geosynthetics not meeting this criteria shall use a minimum RFD = 2.0.
8. HDPE geogrids shall have a melt flow index value≥ 0.88. HDPE geogrids not meeting this criteria shall use a minimum RFD = 2.0.
9. Manufacturing Quality Control - The geosynthetic manufacturer shall have a quality control program that includes QC testing no less frequently than each 400,000 square feet of production. The testing, as a minimum, shall include Tensile Strength per ASTM D4595.

Steel Reinforcement - shall meet the requirements of and possess the minimum strength and durability at the end of the 75 year design life. Allowable tensile stress shall not exceed 0.55Fy at the end of the design service life.

2.3 Unit Drainage Fill

Unit Drainage Fill shall consist of clean 1 inch minus crushed stone or crushed gravel meeting the following gradation per ASTM D422. Geotextile shall not be substituted for unit drainage fill.

Sieve Size	Percent Passing
1 inch	100
3/4 inch	75-100
No. 4	0-10
No. 50	0-5

2.4 Reinforced Backfill

Reinforced Backfill shall consist of soil meeting the following requirements.

1. Less than 35% passing the No. 200 sieve per ASTM D422 with a maximum size of 3/4 inches (4 inch maximum for steel reinforced systems)
2. A plasticity index less than 10 per ASTM D4318
3. An effective internal angle of friction > 30 degrees per ASTM D2166 or D3080 at the compaction standard
4. Less than 0.5% organic material
5. Material can be site-excavated soils where the above requirements can be met. Unsuitable soils for backfill including ML, CL, MH, CH, OH or Pt shall not be used in the backfill or in the reinforced soil mass.
6. Use of an effective friction angle greater than 30 degrees for design shall be verified by appropriate testing submitted to and approved by the Engineer prior to construction.
7. Backfill reinforced with geosynthetic shall have a pH in the range of 3 to 9 per ASTM G51.
8. Backfill reinforced with steel reinforcement shall have a pH in the range of 5 to 10 per ASTM G51, minimum resistivity of 3000 ohm-cm at 100% saturation per ASTM G57 and free of sulfates > 200 ppm or chlorides > 100 ppm. If the resistivity is ≥ 5000 ohm-cm, the chloride and sulphate requirements are waived.
9. Subject to approval, the Engineer may allow slightly wider ranges of pH for higher resistivities.
10. Backfill placed under freezing conditions shall consist of a cleaner granular material to reduce the potential for freezing. A material gradation shall be submitted for approval prior to use.

2.5 Base Leveling Pad

Base leveling pad shall be constructed of dense graded crushed stone or crushed gravel. A concrete leveling pad consisting of lean unreinforced concrete may be used at the RSS contractor's option.

2.6 Facing Treatment

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 complying with Article 2601.03 of the Standard Specifications. Wall shall be constructed such that the vegetated portion of the wall is completed prior to the latest seeding dates shown in Section 2601 of the Standard Specifications.

Hard armored facing may consist of rip rap or natural limestone ledge rock placed in horizontal coursing as 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.

3.0 CONSTRUCTION

3.1 General

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.

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 Section 2402 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.

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 of that shown on the shop drawings.

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 95% of the maximum density determined in accordance with AASHTO T-99. A minimum of one density test every 3 foot 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 inches 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.

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 rip rap or natural limestone ledge rock shall be placed in horizontal coursing and integrated with soil reinforcement unless otherwise specified in the approved shop drawings.

Construction and construction tolerances shall be in accordance with NCMA Section 6 and 7 or AASHTO Section 7 with the following additions or clarifications.

1. A minimum of 1 cubic foot of unit drainage fill shall be used for each square foot of slope face and shall be placed between and behind the facing units and shall extend back from the face of the wall a minimum of 2 feet. Geotextile is not an acceptable substitute for unit drainage fill unless the entire reinforced backfill zone meets the requirements of AASHTO Section 7.3.6.3 and connection strength requirements can be met without unit drainage fill.
2. Reinforcement not meeting the minimum stiffness requirement of Section 2.3.A (5) or wider than 12 feet shall be staked at the corners and on 12 foot centers along the roll edges to prevent wrinkling or other distortion of the reinforcement during backfill placement.

4.0 MEASUREMENT AND PAYMENT

4.1 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 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.

4.2 Payment

This work, which shall be full compensation for design, supply, and installation of the RSS including any excavation, base leveling pad, placement of soil reinforcement, unit drainage fill, reinforced backfill, facing treatment, subdrain, vegetative facing, and other items specified on the approved shop drawings, equipment, materials and labor necessary to construct a segmental retaining wall in accordance with the contract documents will be paid for at the contract unit price per Square Foot for Reinforced Soil Slope System.