



Florida Department of Transportation

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JARED W. PERDUE, P.E.
SECRETARY

November 15, 2023

Daniel Holt, PE, PTOE
Interim Director, Office of Technical Services
Federal Highway Administration
3500 Financial Plaza, Suite 400
Tallahassee, Florida 32312

Re: State Specifications Office
Section: 145
Proposed Specification: **1450000 Geosynthetic Reinforcement.**

Dear Mr. Holt:

We are submitting, for your approval, two copies of the above referenced Supplemental Specification.

The changes are proposed by Dino Jameson to cover geosynthetic reinforced embankment Type-3, clarify language for R-2 and R-4 types, add Contractor certification language, and update to match earthwork acceptance program.

Please review and transmit your comments, if any, within two weeks (10 business days). Comments should be sent via email daniel.strickland@dot.state.fl.us.

If you have any questions relating to this specification change, please call me at (850) 414-4130.

Sincerely,

Signature on File

Daniel Strickland, P.E.
State Specifications Engineer

DS/jb

Attachment

cc: Florida Transportation Builders' Assoc.
State Construction Engineer

GEOSYNTHETIC REINFORCEMENT.

(REV 6-29-23)

SECTION 145 is deleted and the following substituted:

145-1 Description.

This Section specifies the construction requirements for geosynthetics used in: geosynthetic reinforced soil slopes, ~~and~~ geosynthetic reinforced foundations ~~constructed over on~~ soft ~~in-situ~~ soils, and geosynthetic reinforced embankment. Furnish and place geosynthetics and any associated facing material or drainage blankets.

145-2 Responsibility.

Construct the geosynthetic reinforced feature, including materials, method, and installation based on information provided in the Contract Documents and the geosynthetic supplier's recommendations. Submit shop drawings in accordance with Section 5 showing the details and distribution of the selected geosynthetics that meet the design shown in the Plans. Alternate designs optimizing the selected geosynthetic materials ~~may be submitted~~ must be in accordance with Chapter 263 of the FDOT Design Manual.

~~————— For alternate designs, submit complete design calculations and details which include plan view, elevation view, and details in accordance with the Contract Documents. These shall show the extent, number of layers of geosynthetic reinforcement, minimum properties of each geosynthetic reinforcement layer, vertical spacing of geosynthetic reinforcement, orientation of geosynthetic facing details, details at special structures or obstructions, typical construction sequence, and top and bottom elevations of the geosynthetic reinforcement. Calculations shall be submitted to substantiate the design meets the requirements of Chapter 263 of the FDOT Design Manual and in accordance with the Plans. As a minimum, these shall clearly show the derivation of reinforcement requirements (i.e., type, spacing, length, etc.) and determination of all design parameters and factors. All plans and calculations are to be signed and sealed by a Professional Engineer registered in the State of Florida.~~

145-3 Materials.

145-3.1 Geosynthetic Materials: Use geosynthetic materials meeting the requirements of Section 985 and ~~are~~ listed on the Approved Product List (APL). Ensure the geosynthetic materials received at the job site are in unopened shipping packages and the packages are clearly labeled with the manufacturer's name, product name, style number, roll dimension and LOT number, otherwise, the Engineer will reject the material. Store geosynthetic materials in accordance with the manufacturer's instructions ensuring to protect the geosynthetic material from physical damage, debris, and temperatures greater than 140° F. Prevent mud, fluid concrete, asphalt, or other deleterious materials from coming in contact with the geosynthetic materials that could impact the performance of the geosynthetic material. Replace geosynthetic materials with defects, tears, punctures, flaws, deterioration, or other damage at no additional cost to the Department.

~~Deliver geosynthetic materials (including facing and drainage elements) to the job site in unopened shipping packages labeled with the supplier's name and product name. During shipping and storage, protect the geosynthetic from physical damage, debris and from temperatures greater than 140°F. Follow the supplier's recommendations regarding protection~~

~~from direct sunlight. At the time of installation, the Engineer will reject the material if it has defects, tears, punctures, flaws, deterioration, or other damage. However, if approved by the Engineer, the Contractor may repair torn or punctured sections by placing a patch over the damaged area. Replace or repair any rejected geosynthetic at no additional expense to the Department.~~

145-3.2 Geosynthetic Reinforced Soil Slopes:

145-3.2.1 Backfill Materials: Use only free draining backfill material in the reinforced fill volume as shown in the Plans meeting the following gradation limits as determined in accordance with AASHTO T 27 and FM 1-T011:

Sieve Size	Percent Passing
3-1/2 inches	100
3/4 inch	70 to 100
No. 4	30 to 100
No. 40	15 to 100
No. 100	5 to 65
No. 200	0 to 15

Do not use backfill material containing more than an average of 2.0% by weight of organic material, as determined by FM 1-T267 and by averaging the test results for three randomly selected, representative samples from each stratum or stockpile of a particular material. Consider the stratum or stockpile unsuitable for construction of the reinforced fill volume if an individual test value exceeds 3.0%.

Use backfill ~~material~~ with a maximum plasticity index of ~~6~~six as determined by AASHTO T 90, and a maximum liquid limit of 15 as determined by AASHTO T 89. Use backfill materials with a pH between ~~4.5~~ 5.0 and 10.0 as determined by FM 5-550. For polyester geosynthetic reinforcement, use backfill material with a pH between 5.0 and 9.0. ~~When metal pipes or other metal items are embedded in the backfill, use backfill with a pH between 6.0 and 10.0.~~ Do not use soil cement or lime stabilized backfill unless approved by the Engineer.

~~Have the backfill material tested for every soil type for pH by a Department approved independent testing laboratory prior to placement. Submit a signed and sealed certification by a Professional Engineer registered in the State of Florida, that the results have met the requirements of this Section.~~

145-3.2.2 Slope Face Treatment: For reinforced soil slopes, provide slope face material, if applicable, as shown in the Plans and listed on the APL.

145-3.3 Geosynthetic Reinforced Foundations Over Soft Soils: Use backfill material meeting the requirements of Section 120, all Contract Documents, and any other applicable specification requirements. Meet the pH criteria specified in 145-3.2.1 as determined by FM 5-550.

145-3.4 Geosynthetic Reinforced Embankment: Use backfill material meeting the requirements of Section 120 for Embankment, Section 160 for Stabilization, Section 200 for Rock Base, and Section 204 for Graded Aggregate Base, all Contract Documents, and any other applicable specification requirements. Meet the pH criteria specified in 145-3.2.1 as determined by FM 5-550.

145-4 Construction Requirements.

145-4.1 General: Obtain from the geosynthetic supplier, technical instructions, guidance in preconstruction activities, and on-site technical assistance during construction. Submit a copy of any instructions provided by the supplier to the Engineer prior to beginning installation.

145-4.2 Geosynthetic Reinforced Soil Slopes:

145-4.2.1 Foundation Preparation: Excavate to the limits shown in the Contract Documents. Remove all existing vegetation and all unsuitable foundation materials. Prepare the foundation in accordance with Section 110 and 120, except as noted herein.

Proof-~~roll~~ the graded area with a vibratory roller weighing a minimum of 8 tons or a sheepsfoot roller, where appropriate, exerting a compression of at least 250 psi on the tamper foot for at least five passes in the presence of the Engineer or as directed by the Engineer. Remove and replace any soft or loose foundation subsoils that are, ~~in the opinion of the Engineer,~~ incapable of sustaining the required proof rolling, ~~in accordance with Section 125.~~ Excavate to suitable foundation materials, satisfactory to the Engineer, regardless of the elevation shown in the Plans. Remove all loose and disintegrated rock or thin strata.

~~Provide~~ Ensure the proof-~~rolled~~ ground surfaces ~~which~~ are uniform, smooth, and free of abrupt changes in slope, debris, and irregularities that might damage the reinforcement. Promptly repair and restore to their original condition any areas outside the limits of disturbance shown in the Plans which are damaged as part of this work at no expense to the Department. Make every possible effort to avoid such damage.

145-4.2.2 Geosynthetic Placement: Place the geosynthetics at the proper elevation, location and orientation as shown in the Plans. In general, place the geosynthetics used for slope stabilization such that its primary direction of tensile strength is perpendicular to the plan face of the slope. Pull the geosynthetic material tight, and secure it as necessary to lay flat against the soil prior to fill placement.

Place adjacent rolls of geosynthetic to maintain 100% horizontal coverage at the face of the slope. When placing geosynthetic for curved embankments, do not allow less than 50% horizontal coverage or an unreinforced horizontal spacing greater than 3 feet at the end of the reinforcement farthest from the face of the slope. Do not allow vertical spacing of the geosynthetic layers to exceed the spacing shown ~~on~~ in the shop drawings.

Do not make any splices or seams in the primary direction of tensile strength in the geosynthetic without approval of the Engineer. When splices in the primary direction are approved, make splices full width of the geosynthetic strip by using a similar material with similar strength. Use a splice mechanism that allows a minimum of 95% load transfer from piece to piece of geosynthetic. Make only one splice per length of geosynthetic. Do not place splices within 6 feet of the slope face, within 6 feet below top of slope, or horizontally adjacent to another splice.

Place only that amount of geosynthetic material, including facing and drainage material, which will be covered in a single days' production.

Do not operate equipment directly on the geosynthetics. Operate equipment such that no turning movements occur on the areas where geosynthetic is in place with less than 12 inches of fill cover. Fill and compact ruts of more than 3 inches in depth as they develop. Replace or repair any rejected geosynthetic at no additional cost expense to the Department.

145-4.2.3 Backfill Placement: Perform work in accordance with an approved QC Plan meeting the requirements of 105-3. A LOT is defined as a single lift of finished

embankment not to exceed 500 feet in length. Maintain uniform moisture content of the backfill material prior to and during compaction throughout each layer of material. Use backfill material having a placement moisture content within 2% on the dry side of optimum. Do not place wet backfill with moisture content greater than optimum in the fill. Spread backfill material over the geosynthetic in the direction of geosynthetic overlaps. Do not stockpile backfill materials on the installed geosynthetics. Avoid construction procedures or equipment which, in the opinion of the Engineer, will cause excessive mudwaving.

Uniformly compact each layer, using equipment that will achieve the required density. Compact the backfill using either smooth wheel or rubber tire rollers. Do not use sheepsfoot, grid rollers, or other types of equipment employing a foot. At the end of each day's operation, slope the backfill surface ~~in order~~ to permit runoff of rainwater away from the slope face, or provide some other positive drainage. Do not exceed the maximum allowable lift thickness in Section 120.

145-4.2.4 Repairs: ~~Replace geosynthetic reinforcement damaged during or after installation at no expense to the Department.~~ Repair geosynthetics damaged during or after installation only after the supplier establishes that the interior and exterior stability is not affected and after obtaining the Engineer's approval. Make such repairs as follows:

Remove all backfill material from the damaged area of the reinforcement geosynthetic plus an additional 4 feet in all directions beyond the limits of damage. Place a patch consisting of the same material as the reinforcement geosynthetic over the damaged area in accordance with the supplier's recommendation. Overlap the undamaged reinforcement geosynthetic with the patch a minimum of 3 feet in all directions. Then replace and compact backfill material in accordance with 145-4.2.3.

145-4.2.5 Slope Face Treatment: Place the slope face treatment at the elevation and location shown in the Plans and are listed on the APL, if applicable.

145-4.3 Geosynthetic Reinforced Foundations Constructed on Over Soft In-Situ Soft Soils: This subsection specifies requirements for geosynthetics used to improve embankment stability by strengthening and increasing the embankment stiffness.

145-4.3.1 Preparation: For some applications involving reinforcement of soft in situ soils, the Engineer may require that some vegetation be left in place. If directed in the Plans or by the Engineer, cut trees to within 6 inches of the existing surface, and leave the stumps in place. Remove fallen trunks, limbs, etc. greater than 3 inches in diameter.

145-4.3.2 Backfill Placement: ~~Meet the requirements of 145-4.2.3.~~ Use materials meeting the requirements of 145-3.3. Perform work in accordance with an approved QC Plan meeting the requirements of 105-3 and Section 120 for Embankment, all Contract Documents, and any other applicable specification requirements.

145-4.3.3 Geosynthetic Placement: Meet the requirements of 145-4.2.2 except as noted herein. Position and orient the geosynthetics over prepared surfaces with the machine direction perpendicular to the embankment alignment. Place a geotextile filter of a type recommended by the designer of the geosynthetic system under the reinforcement geosynthetic.

Cut and overlap geosynthetics as necessary to accommodate curves. Overlaps shall be a minimum of 3 feet, unless specified otherwise in the Contract Documents for a particular application. ~~Overlap or join ends and sides of adjacent geosynthetic courses as shown in the Plans and in accordance with 145-4.2.2.~~ Make any overlaps in geosynthetics in the same direction that ~~covering~~ embankment will be spread. Take care to ensure that the geosynthetic sections do not separate at overlaps during construction. Pull the geosynthetic material tight by

hand to a tension that removes all slack and wrinkles or as recommended by the supplier. To reduce overlaps, the geosynthetic material may be sewn together in accordance with the supplier's recommendations. Sew the seams with thread meeting the chemical requirements and minimum seam strength requirements for the application.

145-4.3.4 Repairs: Meet the requirements of 145-4.2.4.

145-4.4 Geosynthetic Reinforced Embankment: This subsection specifies requirements for geosynthetics used to provide structural support of traffic loads over the life of the pavement. This reinforcement application involves a relatively shallow flexible pavement substructure (embankment/subgrade/base profile) that is constructed over unsuitable soils that are at or near the ground surface.

145-4.4.1 Preparation: Remove all existing vegetation and all unsuitable foundation materials as shown in the Plans. Prepare the foundation in accordance with Section 110 and 120 or to the limits shown in the Contract Documents.

145-4.4.2 Backfill Placement: Use materials meeting the requirements of 145-3.4. Perform work in accordance with an approved QC Plan meeting the requirements of 105-3, Section 120 for Embankment, Section 160 for Stabilization, Section 200 for Rock Base, and Section 204 for Graded Aggregate Base, all Contract Documents, and any other applicable specification requirements. Spread backfill material over the reinforcement geosynthetic in the direction of the geosynthetic overlaps. Place the first lift of backfill materials over the reinforcement geosynthetic to a minimum thickness of 4 inches. Place backfill material in a manner to avoid any damage or disturbance to the geosynthetic reinforcement material

145-4.4.3 Geosynthetic Placement: Meet the requirements of 145-4.3.3.

145-4.4.3 Repairs: Meet the requirements of 145-4.2.4.

145-5 Certification.

For geosynthetic materials, submit to the Engineer the product label with the manufacturer's name, product name, style number, roll dimension and LOT number at least fourteen days prior to placement. In addition, provide two 8-inch by 10-inch samples of geosynthetic materials for product identification to the Engineer. The acceptance of the geosynthetic material is subject to the approval of the State Materials Office (SMO). ~~Submit certification from the supplier, at least ten days prior to placement, that the products used are the same products listed on the APL, are in accordance with the project design requirements and is recommended by the supplier for use at this location.~~

~~Acceptance of furnished material will be based on the supplier's certification and visual inspection by the Engineer.~~ For backfill materials, submit to the Engineer a signed and sealed certification by a Professional Engineer registered in the State of Florida, that the pH meets the requirements of 145-3.

145-6 Acceptance Program.

145-6.1 General Requirements: ~~Meet the requirements of 120-10 except delete the requirements of 120-10.1.4.1, 120-10.1.6, 120-10.2 and 120-10.3.~~

145-6.1.1 Equipment Comparison: ~~Meet the requirements of 120-10.1.1.~~

145-6.1.2 Initial Production LOT: ~~Meet the requirements of 120-10.1.2 except as modified herein.~~

145-6.1.3 Density over 105%: ~~Meet the requirements of 120-10.1.3 except as modified herein.~~

145-6.2 Quality Control Tests:

145-6.2.1 Geosynthetic Reinforced Soil Slopes:

145-6.2.1.1 Maximum Density Determination: Collect enough material to split and create three separate samples. Determine test locations, including stations and offsets, using the Random Number generator approved by the Department. Retain the Verification and Resolution samples for the Department until the Engineer accepts the LOTs represented by the samples. Determine modified Proctor maximum density and optimum moisture content by sampling and testing the material in accordance FM 1-T 180. Determine the maximum QC density in accordance with FM 1-T180.

When compacting A-3 or A-2-4 materials to meet the ~~alternate~~ optional acceptance criteria in ~~145-6.2.1.4~~ 145-6.3.1.1, determine the maximum density in accordance with FM 1-T099. ~~Perform gradation tests on the sample collected in accordance with AASHTO T 27 and FM 1-T011.~~

145-6.2.1.2 Soil Classification and Organic Content Testing: Perform soil classification tests on the sample collected in 145-6.2.1.1, in accordance with AASHTO T 27 and FM 1-T011, AASHTO T89, AASHTO T90, and FM 1-T267. Classify the soil in accordance with AASHTO M145 to determine compliance with soil utilization requirements as specified in Standard Plans, Index 120-001. Meet the testing parameters set forth in 145-3.2.1.

145-6.2.1.3 pH Testing: Perform pH testing in accordance with FM 5-550 and meet the pH test criteria set forth in 145-3.2.1.

145-6.2.1.4 Density Testing Requirements: Meet the requirements of 120-10.1.4.2 except as modified herein. Ensure compliance with the requirements of nuclear density testing in accordance with FM 1-T238. Determine the in-place moisture content for each density test. Use FM 5-507 (Determination of Moisture Content by Means of a Calcium Carbide Gas Pressure Moisture Tester), or FM 5-535 (Laboratory Determination of Moisture Content by Granular Soils by Use of a Microwave Oven) for moisture determination.

145-6.3.1 Acceptance Criteria: For select backfill, obtain a density in each LOT of at least 95% of the maximum density as determined by FM 1-T180.

145-6.3.1.1

~~Optional Acceptance Criteria~~ Alternatively, for A-3 and A-2-4 backfill materials, ~~Obtain~~ a minimum density of 100% of the standard Proctor maximum dry density as determined by FM 1-T099.

The combined width from both reinforced fill volume and retained fill material may be considered the same LOT if both volumes comprise the same material and both are compacted with the same procedure, lift thickness, equipment, and compacting effort.

145-6.2.1.5 ~~145-6.4~~ **Frequency:** Conduct sampling and testing at a minimum frequency listed in the table below. The Engineer will perform verification sampling and tests at a minimum frequency listed in the table below.

Table 145-2		
Test Name	Quality Control (QC)	Verification
Maximum Density	One per soil type	One per soil type
Density	One per LOT	One per four LOTs
Soil Classification, Gradation, LL & PI	One per <u>soil type</u>	One per <u>soil type</u>
Organic Content	One per soil type	One per soil type
<u>pH</u>	<u>One per soil type</u>	<u>One per soil type</u>

~~In addition, test for pH at a minimum frequency of one test per soil type at point of placement according to 145-3. The Engineer will collect enough material to split and create two separate samples and retain one for resolution at point of placement until LOTs represented by the samples are accepted.~~

145-6.2.1.65 Test Selection and Reporting: Determine test locations including stations and offsets, using the random number generator approved by the Engineer. Do not use notepads or worksheets to record data for later transfer into the Earthwork Records System (ERS) section of the Department's database. Notify the Engineer upon successful completion of QC testing on each LOT.

145-6.2.2 Geosynthetic Reinforced Foundation Over Soft Soils: Meet the acceptance criteria for backfill and compaction requirements for embankment material in accordance with Section 120, all Contract Documents, and any other applicable specification requirements. In addition to the requirements of the applicable earthwork material, test for pH in accordance with FM 5-550 and meet the pH test criteria set forth in 145-3.2.1.

145-6.2.3 Geosynthetic Reinforced Embankment: Meet the acceptance criteria for backfill and compaction requirements for embankment material in accordance with Section 120, Stabilization requirements in accordance with 160, Rock Base requirements in accordance with Section 200, Graded Aggregate Base requirements in accordance with Section 204, all Contract Documents, and any other applicable specification requirements. In addition to the requirements of the applicable earthwork material, test for pH in accordance with FM 5-550 and meet the pH test criteria set forth in 145-3.2.1.

145-6.3 Department Verification: Meet the requirements of 120-10.1.5 except that the Engineer will conduct Verification tests to accept all materials and work associated with 145-6.2.

145-6.4 Payment for Resolution Tests: Meet the requirements of 120-10.1.7.

145-7 Verification Comparison Criteria and Resolution Procedures:

145-7.1 Geosynthetic Reinforced Soil Slopes:

145-7.1.1 Maximum Density Determination: ~~The Engineer will collect enough material to split and create two separate samples and retain one for resolution until LOTs represented by the samples are accepted.~~ The Engineer will verify the QC test results in accordance with the procedures specified in ~~meet the requirements of~~ 120-10.4.1 except replace FM 1-T099 with FM 1-T180. If the Contractor selects the optional acceptance criteria, the Engineer will verify the QC test results of FM 1-T099 in accordance with 120-10.4.1.

145-7.1.2 Density Testing: Meet the requirements of 120-10.4.2.

145-7.1.3 Soil Classification, Organic Content, and pH Testing

Gradation: The Engineer will verify the QC test results if the verification test results meets the gradation limits set forth in ~~the gradation table of 145-3.2.1 for gradation (AASHTO T27 and FM 1-T011), liquid limit (AASHTO T89), plasticity index (AASHTO T90), organic content (FM 1-T267), and pH (FM 5-550) testing.~~ Otherwise, the Engineer will test the sample retained in 145-6.2.1.1. The State Materials Office (SMO) or an AASHTO accredited laboratory designated by the SMO will perform resolution testing. ~~The material will be sampled and tested in accordance with AASHTO T 27 and FM 1-T011.~~

If the resolution test result satisfies the required gradation limits, liquid limit, plasticity index, organic content, and pH, then the LOTs will be verified. If the resolution test results do not verify QC test results meet the required gradation limits, then reconstruct the LOTs with acceptable material. The Engineer will perform new verification testing post reconstructing the LOTs.

~~**145-7.4 Liquid Limit and Plasticity Index (LL&PI):** The Engineer will verify the QC results if the verification result satisfies the plasticity index and liquid limit criteria set forth in 548-2.6. Otherwise, the Engineer will test the sample retained in 145-6.1. The SMO or an AASHTO accredited laboratory designated by the SMO will perform resolution testing. The material will be sampled and tested in accordance with AASHTO T 90 and AASHTO T 89, respectively.~~

~~If the resolution test result satisfies the required criteria, LOTs of that soil type will be verified. If the resolution test results do not meet the required criteria, reconstruct the corresponding LOTs with acceptable material. The Engineer will perform new verification testing.~~

~~**145-7.5 Soil Classification:** The Engineer will meet the requirements of 120-10.4.3 except test the sample retained in 145-6.1 instead of taking the additional one.~~

~~**145-7.6 Organic Content:** The Engineer will verify the QC results if the verification result satisfies the organic content test criteria set forth in 145-3.2. Otherwise, the Engineer will collect three additional samples. The material will be sampled and tested in accordance with FM 1-T267 and by averaging the test results for three randomly selected samples from at least one lift per soil type. The SMO or an AASHTO accredited laboratory designated by the SMO will perform resolution testing. If the resolution test result satisfies the required criteria, material of that soil type will be verified and accepted. If the resolution test results do not meet the required criteria, reject the material and reconstruct with acceptable material.~~

~~**145-7.7 pH:** The Engineer will verify the QC results if the verification result satisfies the pH test criteria set forth in 145-3.2. Otherwise the Engineer will collect an additional sample. The SMO or an AASHTO accredited laboratory designated by the SMO will perform resolution testing. The material will be sampled and tested in accordance with FM 5-550. If the resolution test result satisfies the required criteria, material of that soil type will be verified and accepted. If the resolution test results do not meet the required criteria, reject the material and reconstruct with acceptable material.~~

145-7.2 Geosynthetic Reinforced Foundations Over Soft Soils: Meet the verification comparison criteria and resolution procedure for embankment material in accordance with Section 120. In addition, the Engineer will verify the QC tests results if the verification test results meet the limits set forth in 145-3.2.1 for pH in accordance with FM 5-550. Otherwise, the Engineer will follow the resolution procedures specified in 145-7.1.3.

145-7.3 Geosynthetic Reinforced Embankment: Meet the verification comparison criteria and resolution procedure for embankment material in accordance with Section 120, Stabilization requirements in accordance with 160, Rock Base requirements in accordance with Section 200, and Graded Aggregate Base with Section 204. In addition, the Engineer will verify the QC tests results if the verification test results meet the limits set forth in 145-3.2.1 for pH in accordance with FM 5-550. Otherwise, the Engineer will follow the resolution procedures specified in 145-7.1.3.

145-8 Method of Measurement.

145-8.1 Geosynthetic Reinforced Soil Slopes: The quantity to be paid for will be the plan quantity area, in square feet, of the projected vertical height of the slope face, measured from the top of slope to the finished graded surface at the toe of slope and from the beginning to end limits as shown in 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 slope elevation.

145-8.2 Geosynthetic Reinforced Foundations ~~o~~Over Soft Soils: The quantity to be paid for will be the plan quantity area, in square yards, of the embankment to be reinforced as shown in the Plans, regardless of the length or number of layers of geosynthetic within the reinforced soil volume, and including any reinforcement required below the original ground elevation.

145-8.3 Geosynthetic Reinforced Embankment: Meet the requirements of 145-8.2.

145-9 Basis of Payment.

145-9.1 Geosynthetic Reinforced Soil Slopes: Price and payment will be full compensation for all work, materials, and services specified in this Section, including ~~design and shop drawings,~~ geosynthetic materials, ~~facing drainage materials and/or treatment,~~ installation, testing, and required submittals. The cost and placement of all backfill material will be included in the pay quantity for embankment or borrow excavation, as applicable.

145-9.2 Geosynthetic Reinforced Foundations ~~o~~Over Soft Soils: Price and payment will be full compensation for all work, materials, and services specified in this Section, including geosynthetic materials, geotextile filter materials, facing materials, drainage materials, installation, testing, and required submittals. The cost and placement of all backfill will be included in the pay quantity for embankment or borrow excavation, as applicable.

145-9.3 Geosynthetic Reinforced Embankment: Meet the requirements of 145-9.2

145-9.4~~3~~ Payment Items: Payment will be made under:

- Item No. 145- 1- Geosynthetic Reinforced Soil Slopes - per square foot.
- Item No. 145- 2- Geosynthetic Reinforced Foundations over Soft Soils - per square yard.

Item No. 145- 3- Geosynthetic Reinforced Embankment - per square yard.

GEOSYNTHETIC REINFORCEMENT.

(REV 6-29-23)

SECTION 145 is deleted and the following substituted:

145-1 Description.

This Section specifies the construction requirements for geosynthetics used in geosynthetic reinforced soil slopes, geosynthetic reinforced foundations over soft soils, and geosynthetic reinforced embankment. Furnish and place geosynthetics and any associated facing material or drainage blankets.

145-2 Responsibility.

Construct the geosynthetic reinforced feature, including materials, method, and installation based on information provided in the Contract Documents and the geosynthetic supplier's recommendations. Submit shop drawings in accordance with Section 5 showing the details and distribution of the selected geosynthetics that meet the design shown in the Plans. Alternate designs optimizing the selected geosynthetic materials must be in accordance with Chapter 263 of the FDOT Design Manual.

145-3 Materials.

145-3.1 Geosynthetic Materials: Use geosynthetic materials meeting the requirements of Section 985 and listed on the Approved Product List (APL). Ensure the geosynthetic materials received at the job site are in unopened shipping packages and the packages are clearly labeled with the manufacturer's name, product name, style number, roll dimension and LOT number, otherwise, the Engineer will reject the material. Store geosynthetic materials in accordance with the manufacturer's instructions ensuring to protect the geosynthetic material from physical damage, debris, and temperatures greater than 140° F. Prevent mud, fluid concrete, asphalt, or other deleterious materials from coming in contact with the geosynthetic materials that could impact the performance of the geosynthetic material. Replace geosynthetic materials with defects, tears, punctures, flaws, deterioration, or other damage at no additional cost to the Department.

145-3.2 Geosynthetic Reinforced Soil Slopes:

145-3.2.1 Backfill Materials: Use only free draining backfill material in the reinforced fill volume as shown in the Plans meeting the following gradation limits as determined in accordance with AASHTO T 27 and FM 1-T011:

Sieve Size	Percent Passing
3-1/2 inches	100
3/4 inch	70 to 100
No. 4	30 to 100
No. 40	15 to 100
No. 100	5 to 65
No. 200	0 to 15

Do not use backfill material containing more than an average of 2.0% by weight of organic material, as determined by FM 1-T267 and by averaging the test results for three randomly selected, representative samples from each stratum or stockpile of a particular material. Consider the stratum or stockpile unsuitable for construction of the reinforced fill volume if an individual test value exceeds 3.0%.

Use backfill material with a maximum plasticity index of 6 as determined by AASHTO T 90, and a maximum liquid limit of 15 as determined by AASHTO T 89. Use backfill material with a pH between 5.0 and 10.0 as determined by FM 5-550. For polyester geosynthetic reinforcement, use backfill material with a pH between 5.0 and 9.0. Do not use soil cement or lime stabilized backfill unless approved by the Engineer.

145-3.2.2 Slope Face Treatment: For reinforced soil slopes, provide slope face material, if applicable, as shown in the Plans and listed on the APL.

145-3.3 Geosynthetic Reinforced Foundations Over Soft Soils: Use backfill material meeting the requirements of Section 120, all Contract Documents, and any other applicable specification requirements. Meet the pH criteria specified in 145-3.2.1 as determined by FM 5-550.

145-3.4 Geosynthetic Reinforced Embankment: Use backfill material meeting the requirements of Section 120 for Embankment, Section 160 for Stabilization, Section 200 for Rock Base, and Section 204 for Graded Aggregate Base, all Contract Documents, and any other applicable specification requirements. Meet the pH criteria specified in 145-3.2.1 as determined by FM 5-550.

145-4 Construction Requirements.

145-4.1 General: Obtain from the geosynthetic supplier, technical instructions, guidance in preconstruction activities, and on-site technical assistance during construction. Submit a copy of any instructions provided by the supplier to the Engineer prior to beginning installation.

145-4.2 Geosynthetic Reinforced Soil Slopes:

145-4.2.1 Foundation Preparation: Excavate to the limits shown in the Contract Documents. Remove all existing vegetation and all unsuitable foundation materials. Prepare the foundation in accordance with Section 110 and 120, except as noted herein.

Proof-roll the graded area with a vibratory roller weighing a minimum of 8 tons or a sheepsfoot roller, where appropriate, exerting a compression of at least 250 psi on the tamper foot for at least five passes in the presence of the Engineer or as directed by the Engineer. Remove and replace any soft or loose foundation subsoils that are incapable of sustaining the required proof rolling. Excavate to suitable foundation materials, satisfactory to the Engineer, regardless of the elevation shown in the Plans. Remove all loose and disintegrated rock or thin strata.

Ensure the proof-rolled ground surfaces are uniform, smooth, and free of abrupt changes in slope, debris, and irregularities that might damage the reinforcement. Promptly repair and restore to their original condition any areas outside the limits of disturbance shown in the Plans which are damaged as part of this work at no expense to the Department. Make every possible effort to avoid such damage.

145-4.2.2 Geosynthetic Placement: Place the geosynthetics at the proper elevation, location and orientation as shown in the Plans. In general, place the geosynthetics used for slope stabilization such that its primary direction of tensile strength is perpendicular to the plan face of the slope. Pull the geosynthetic material tight and secure it as necessary to lay flat against the soil prior to fill placement.

Place adjacent rolls of geosynthetic to maintain 100% horizontal coverage at the face of the slope. When placing geosynthetic for curved embankments, do not allow less than 50% horizontal coverage or an unreinforced horizontal spacing greater than 3 feet at the end of the reinforcement farthest from the face of the slope. Do not allow vertical spacing of the geosynthetic layers to exceed the spacing shown in the shop drawings.

Do not make any splices or seams in the primary direction of tensile strength in the geosynthetic without approval of the Engineer. When splices in the primary direction are approved, make splices full width of the geosynthetic strip by using a similar material with similar strength. Use a splice mechanism that allows a minimum of 95% load transfer from piece to piece of geosynthetic. Make only one splice per length of geosynthetic. Do not place splices within 6 feet of the slope face, within 6 feet below top of slope, or horizontally adjacent to another splice.

Place only that amount of geosynthetic material, including facing and drainage material, which will be covered in a single days' production.

Do not operate equipment directly on the geosynthetics. Operate equipment such that no turning movements occur on the areas where geosynthetic is in place with less than 12 inches of fill cover. Fill and compact ruts of more than 3 inches in depth as they develop. Replace or repair any rejected geosynthetic at no additional cost to the Department.

145-4.2.3 Backfill Placement: Perform work in accordance with an approved QC Plan meeting the requirements of 105-3. A LOT is defined as a single lift of finished embankment not to exceed 500 feet in length. Maintain uniform moisture content of the backfill material prior to and during compaction throughout each layer of material. Use backfill material having a placement moisture content within 2% on the dry side of optimum. Do not place wet backfill with moisture content greater than optimum in the fill. Spread backfill material over the geosynthetic in the direction of geosynthetic overlaps. Do not stockpile backfill materials on the installed geosynthetics. Avoid construction procedures or equipment which, in the opinion of the Engineer, will cause excessive mudwaving.

Uniformly compact each layer, using equipment that will achieve the required density. Compact the backfill using either smooth wheel or rubber tire rollers. Do not use sheepsfoot, grid rollers, or other types of equipment employing a foot. At the end of each day's operation, slope the backfill surface to permit runoff of rainwater away from the slope face, or provide some other positive drainage. Do not exceed the maximum allowable lift thickness in Section 120.

145-4.2.4 Repairs: Repair geosynthetics damaged during or after installation only after the supplier establishes that the interior and exterior stability is not affected and after obtaining the Engineer's approval. Make such repairs as follows:

Remove all backfill material from the damaged area of the reinforcement geosynthetic plus an additional 4 feet in all directions beyond the limits of damage. Place a patch consisting of the same material as the reinforcement geosynthetic over the damaged area in accordance with the supplier's recommendation. Overlap the undamaged reinforcement geosynthetic with the patch a minimum of 3 feet in all directions. Then replace and compact backfill material in accordance with 145-4.2.3.

145-4.2.5 Slope Face Treatment: Place the slope face treatment at the elevation and location shown in the Plans and are listed on the APL, if applicable.

145-4.3 Geosynthetic Reinforced Foundations Over Soft Soils: This subsection specifies requirements for geosynthetics used to improve embankment stability by strengthening and increasing the embankment stiffness.

145-4.3.1 Preparation: For some applications involving reinforcement of soft in situ soils, the Engineer may require that some vegetation be left in place. If directed in the Plans or by the Engineer, cut trees to within 6 inches of the existing surface, and leave the stumps in place. Remove fallen trunks, limbs, etc. greater than 3 inches in diameter.

145-4.3.2 Backfill Placement: Use materials meeting the requirements of 145-3.3. Perform work in accordance with an approved QC Plan meeting the requirements of 105-3 and Section 120 for Embankment, all Contract Documents, and any other applicable specification requirements.

145-4.3.3 Geosynthetic Placement: Meet the requirements of 145-4.2.2 except as noted herein. Position and orient the geosynthetics over prepared surfaces with the machine direction perpendicular to the embankment alignment. Place a geotextile filter of a type recommended by the designer of the geosynthetic system under the reinforcement geosynthetic.

Cut and overlap geosynthetics as necessary to accommodate curves. Overlaps shall be a minimum of 3 feet, unless specified otherwise in the Contract Documents for a particular application. Make any overlaps in geosynthetics in the same direction that embankment will be spread. Ensure geosynthetic sections do not separate at overlaps during construction. Pull the geosynthetic material tight by hand to a tension that removes all slack and wrinkles or as recommended by the supplier. To reduce overlaps, the geosynthetic material may be sewn together in accordance with the supplier's recommendations. Sew the seams with thread meeting the chemical requirements and minimum seam strength requirements for the application.

145-4.3.4 Repairs: Meet the requirements of 145-4.2.4.

145-4.4 Geosynthetic Reinforced Embankment: This subsection specifies requirements for geosynthetics used to provide structural support of traffic loads over the life of the pavement. This reinforcement application involves a relatively shallow flexible pavement substructure (embankment/subgrade/base profile) that is constructed over unsuitable soils that are at or near the ground surface.

145-4.4.1 Preparation: Remove all existing vegetation and all unsuitable foundation materials as shown in the Plans. Prepare the foundation in accordance with Section 110 and 120 or to the limits shown in the Contract Documents.

145-4.4.2 Backfill Placement: Use materials meeting the requirements of 145-3.4. Perform work in accordance with an approved QC Plan meeting the requirements of 105-3, Section 120 for Embankment, Section 160 for Stabilization, Section 200 for Rock Base, and Section 204 for Graded Aggregate Base, all Contract Documents, and any other applicable specification requirements. Spread backfill material over the reinforcement geosynthetic in the direction of the geosynthetic overlaps. Place the first lift of backfill materials over the reinforcement geosynthetic to a minimum thickness of 4 inches. Place backfill material in a manner to avoid any damage or disturbance to the geosynthetic reinforcement material

145-4.4.3 Geosynthetic Placement: Meet the requirements of 145-4.3.3.

145-4.4.3 Repairs: Meet the requirements of 145-4.2.4.

145-5 Certification.

For geosynthetic materials, submit to the Engineer the product label with the manufacturer's name, product name, style number, roll dimension and LOT number at least fourteen days prior to placement. In addition, provide two 8-inch by 10-inch samples of

geosynthetic materials for product identification to the Engineer. The acceptance of the geosynthetic material is subject to the approval of the State Materials Office (SMO).

For backfill materials, submit to the Engineer a signed and sealed certification by a Professional Engineer registered in the State of Florida, that the pH meets the requirements of 145-3.

145-6 Acceptance Program.

145-6.1 General Requirements:

145-6.1.1 Equipment Comparison: Meet the requirements of 120-10.1.1.

145-6.1.2 Initial Production LOT: Meet the requirements of 120-10.1.2 except as modified herein.

145-6.1.3 Density over 105%: Meet the requirements of 120-10.1.3 except as modified herein.

145-6.2 Quality Control Tests:

145-6.2.1 Geosynthetic Reinforced Soil Slopes:

145-6.2.1.1 Maximum Density Determination: Collect enough material to split and create three separate samples. Determine test locations, including stations and offsets, using the Random Number generator approved by the Department. Retain the Verification and Resolution samples for the Department until the Engineer accepts the LOTs represented by the samples. Determine modified Proctor maximum density and optimum moisture content by sampling and testing the material in accordance FM 1-T 180.

When compacting A-3 or A-2-4 materials to meet the optional acceptance criteria in 145-6.2.1.4, determine the maximum density in accordance with FM 1-T099.

145-6.2.1.2 Soil Classification and Organic Content Testing: Perform soil classification tests on the sample collected in 145-6.2.1.1, in accordance with AASHTO T 27 and FM 1-T011, AASHTO T89, AASHTO T90, and FM 1-T267. Classify the soil in accordance with AASHTO M145 to determine compliance with soil utilization requirements as specified in Standard Plans, Index 120-001. Meet the testing parameters set forth in 145-3.2.1.

145-6.2.1.3 pH Testing: Perform pH testing in accordance with FM 5-550 and meet the pH test criteria set forth in 145-3.2.1.

145-6.2.1.4 Density Testing Requirements: Meet the requirements of 120-10.1.4.2 except as modified herein. For select backfill, obtain a density in each LOT of at least 95% of the maximum density as determined by FM 1-T180.

Alternatively, for A-3 and A-2-4 backfill materials, obtain a minimum density of 100% of the standard Proctor maximum dry density as determined by FM 1-T099.

The combined width from both reinforced fill volume and retained fill material may be considered the same LOT if both volumes comprise the same material and both are compacted with the same procedure, lift thickness, equipment, and compacting effort.

145-6.2.1.5 Frequency: Conduct sampling and testing at a minimum frequency listed in the table below. The Engineer will perform verification sampling and tests at a minimum frequency listed in the table below.

Table 145-2		
Test Name	Quality Control (QC)	Verification
Maximum Density	One per soil type	One per soil type
Density	One per LOT	One per four LOTs
Soil Classification, Gradation, LL & PI	One per soil type	One per soil type
Organic Content	One per soil type	One per soil type
pH	One per soil type	One per soil type

145-6.2.1.6 Test Selection and Reporting: Determine test locations including stations and offsets, using the random number generator approved by the Engineer. Do not use notepads or worksheets to record data for later transfer into the Earthwork Records System (ERS) section of the Department's database. Notify the Engineer upon successful completion of QC testing on each LOT.

145-6.2.2 Geosynthetic Reinforced Foundation Over Soft Soils: Meet the acceptance criteria for backfill and compaction requirements for embankment material in accordance with Section 120, all Contract Documents, and any other applicable specification requirements. In addition to the requirements of the applicable earthwork material, test for pH in accordance with FM 5-550 and meet the pH test criteria set forth in 145-3.2.1.

145-6.2.3 Geosynthetic Reinforced Embankment: Meet the acceptance criteria for backfill and compaction requirements for embankment material in accordance with Section 120, Stabilization requirements in accordance with 160, Rock Base requirements in accordance with Section 200, Graded Aggregate Base requirements in accordance with Section 204, all Contract Documents, and any other applicable specification requirements. In addition to the requirements of the applicable earthwork material, test for pH in accordance with FM 5-550 and meet the pH test criteria set forth in 145-3.2.1.

145-6.3 Department Verification: Meet the requirements of 120-10.1.5 except that the Engineer will conduct Verification tests to accept all materials and work associated with 145-6.2.

145-6.4 Payment for Resolution Tests: Meet the requirements of 120-10.1.7.

145-7 Verification Comparison Criteria and Resolution Procedures:

145-7.1 Geosynthetic Reinforced Soil Slopes:

145-7.1.1 Maximum Density Determination: The Engineer will verify the QC test results in accordance with the procedures specified in 120-10.4.1 except replace FM 1-T099 with FM 1-T180. If the Contractor selects the optional acceptance criteria, the Engineer will verify the QC test results of FM 1-T099 in accordance with 120-10.4.1.

145-7.1.2 Density Testing: Meet the requirements of 120-10.4.2.

145-7.1.3 Soil Classification, Organic Content, and pH Testing: The Engineer will verify the QC test results if the verification test results meet the limits set forth in 145-3.2.1 for gradation (AASHTO T27 and FM 1-T011), liquid limit (AASHTO T89), plasticity index (AASHTO T90), organic content (FM 1-T267), and pH (FM 5-550) testing. Otherwise, the Engineer will test the sample retained in 145-6.2.1.1. The State Materials Office (SMO) or an AASHTO accredited laboratory designated by the SMO will perform resolution testing.

If the resolution test result satisfies the required gradation limits, liquid limit, plasticity index, organic content, and pH, then the LOTs will be verified. If the resolution test results do not verify QC test results, then reconstruct the LOTs with acceptable material. The Engineer will perform new verification testing post reconstructing the LOTs.

145-7.2 Geosynthetic Reinforced Foundations Over Soft Soils: Meet the verification comparison criteria and resolution procedure for embankment material in accordance with Section 120. In addition, the Engineer will verify the QC tests results if the verification test results meet the limits set forth in 145-3.2.1 for pH in accordance with FM 5-550. Otherwise, the Engineer will follow the resolution procedures specified in 145-7.1.3.

145-7.3 Geosynthetic Reinforced Embankment: Meet the verification comparison criteria and resolution procedure for embankment material in accordance with Section 120, Stabilization requirements in accordance with 160, Rock Base requirements in accordance with Section 200, and Graded Aggregate Base with Section 204. In addition, the Engineer will verify the QC tests results if the verification test results meet the limits set forth in 145-3.2.1 for pH in accordance with FM 5-550. Otherwise, the Engineer will follow the resolution procedures specified in 145-7.1.3.

145-8 Method of Measurement.

145-8.1 Geosynthetic Reinforced Soil Slopes: The quantity to be paid for will be the plan quantity area, in square feet, of the projected vertical height of the slope face, measured from the top of slope to the finished graded surface at the toe of slope and from the beginning to end limits as shown in 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 slope elevation.

145-8.2 Geosynthetic Reinforced Foundations Over Soft Soils: The quantity to be paid for will be the plan quantity area, in square yards, of the embankment to be reinforced as shown in the Plans, regardless of the length or number of layers of geosynthetic within the reinforced soil volume, and including any reinforcement required below the original ground elevation.

145-8.3 Geosynthetic Reinforced Embankment: Meet the requirements of 145-8.2.

145-9 Basis of Payment.

145-9.1 Geosynthetic Reinforced Soil Slopes: Price and payment will be full compensation for all work, materials, and services specified in this Section, including geosynthetic materials, drainage materials, installation, testing, and required submittals. The cost and placement of all backfill material will be included in the pay quantity for embankment or borrow excavation, as applicable.

145-9.2 Geosynthetic Reinforced Foundations Over Soft Soils: Price and payment will be full compensation for all work, materials, and services specified in this Section, including geosynthetic materials, geotextile filter materials, facing materials, drainage materials, installation, testing, and required submittals. The cost and placement of all backfill will be included in the pay quantity for embankment or borrow excavation, as applicable.

145-9.3 Geosynthetic Reinforced Embankment: Meet the requirements of 145-9.2

145-9.4 Payment Items: Payment will be made under:

- | | | |
|---------------|----|------------------------------------------------------------------------|
| Item No. 145- | 1- | Geosynthetic Reinforced Soil Slopes - per square foot. |
| Item No. 145- | 2- | Geosynthetic Reinforced Foundations over Soft Soils - per square yard. |
| Item No. 145- | 3- | Geosynthetic Reinforced Embankment - per square yard. |