ITEM 207.2401--09 – ANCHORED REINFORCED VEGETATION SYSTEM
SHALLOW PLANE INSTABILITY REPAIR

DESCRIPTION:

This Work shall consist of construction of a permanent Anchored Reinforced Vegetation System (ARVS) Shallow Plane Instability Repair as specified in the contract documents, at location shown in the plans or as directed by the Engineer. The Contractor shall select the method of excavation and anchor driving equipment to meet the performance requirements specified herein.

This Work includes removal of trees, shrubs, and other vegetation to existing ground level: smoothing/scaling/re-grading in accordance with the details shown in the Plans; applying topsoil, seed, and soil amendments; providing and placing drainage elements as shown in the plans or as directed by the Engineer; placing a High Performance Turf Reinforcement Mat (HPTRM), installing earth percussion anchors to the specified minimum length and spacing indicated on the Plans and herein; attaching bearing plates and nuts; performing anchor testing.

MATERIALS:

All components of the ARVS System were designed and shall be furnished by Propex, Inc., 496 Litz Lane, Tazewell, Virginia 24651, Telephone: (276) 970-6612, as part of the FHWA Experimental Features Program being utilized on this project. No substitutions for other systems or stabilization techniques will be allowed.

A. High Performance Turf Reinforcement Mat – (HPTRM)

1. HPTRM shall be a lofty three dimensional woven polypropylene geosynthetic specially designed for shallow plane instability repair and surface erosion control. Matrix shall be composed of monofilament yarns woven into a uniform configuration of resilient pyramid-like projections. HPTRM should exhibit very high interlock and reinforcement capacity with both soil and root systems. It should also demonstrate the combination of high tensile strength, flexibility and UV resistance. Turf Reinforcement Mats loosely held together by stitched or glued netting, or composites of any type, shall not be allowed.

2. The HPTRM shall meet the following requirements:

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Units</th>
<th>Property Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness</td>
<td>ASTM D-6525</td>
<td>mm</td>
<td>10.2</td>
</tr>
<tr>
<td>Resiliency</td>
<td>ASTM D-6524</td>
<td>Percent</td>
<td>80</td>
</tr>
<tr>
<td>Flexibility</td>
<td>ASTM D-6575</td>
<td>cm-mg(avg)</td>
<td>615,000</td>
</tr>
<tr>
<td>Mass Per Unit Area</td>
<td>ASTM D-6566</td>
<td>g/m²</td>
<td>455</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>ASTM D-6818</td>
<td>kN/m</td>
<td>58.4 x 43.8</td>
</tr>
<tr>
<td>Tensile Elongation</td>
<td>ASTM D-4595</td>
<td>Percent</td>
<td>25</td>
</tr>
<tr>
<td>Light Penetration (% Passing)</td>
<td>ASTM D-6567</td>
<td>Percent</td>
<td>10</td>
</tr>
<tr>
<td>UV Resistance</td>
<td>ASTM D-4355</td>
<td>percent</td>
<td>86 at 10,000 hrs</td>
</tr>
</tbody>
</table>

1. These materials shall conform to the following Minimum Average Roll Values (MARV) for physical properties, as derived from quality control testing performed by a Geosynthetic Accreditation Institute – Laboratory Accreditation Program (GAI-LAP) accredited laboratory.
3. Manufacturing Quality Control (MQC) testing for the HPTRM shall be performed at a laboratory accredited by GAI-LAP for tests required for the turf reinforcement mat with the following minimum acceptable testing frequency:

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Test Frequency Tests / m² of production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass Per Unit Area</td>
<td>ASTM D5261</td>
<td>1/20,000</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>ASTM D5035</td>
<td>1/20,000</td>
</tr>
<tr>
<td>Tensile Elongation</td>
<td>ASTM D5035</td>
<td>1/20,000</td>
</tr>
<tr>
<td>Light Penetration</td>
<td>ASTM D6567</td>
<td>1/20,000</td>
</tr>
</tbody>
</table>

B. Earth Percussion Driven Anchors

1. Type 2 Percussion anchors are made of corrosion resistant aluminum alloy, gravity die cast and heat treated to give considerable increase in mechanical strength and durability both during installation and in service, connected to a stainless steel tendon to enhance corrosion resistance particularly at the soil/air interface. The Type 1A anchors are made of ductile iron and are galvanized to provide for long term service life, and are connected to a galvanized threaded rod by a swiveling shackle.

2. Anchor Components
   a. Anchor Heads: Type 1A and 2 Anchor Heads shall meet the requirements of ASTM A 536-1999. Type 1A and 2 Anchor Heads will be hot-dipped galvanized and shall meet the requirements of NYSDOT Standard Specification Section 719-01, Galvanized Coating and Repair Methods, Type I."
   
   b. Shackles: Shackles shall meet the requirements of ASTM A27/A27M-08, Standard Specification for Steel Castings, Carbon, for General Application. Shackles will be hot-dipped galvanized and shall meet the requirements of NYSDOT Standard Specification Section 719-01, Galvanized Coating and Repair Methods, Type I.

   c. Tendons: Stainless Steel Cable tendons shall be made of Grade 316 Stainless Steel or greater. Threaded Rod tendons shall meet the requirements of ASTM A36, Standard Specification for Carbon Structural Steel or ASTM A307-07b, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength. Threaded Rod tendons will be zinc coated and shall meet the requirements of ASTM B633-07, Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel."

e. Bolts, Nuts and Washers: Bolts, Nuts and Washers shall be made of Grade 5 steel or greater.

f. Load Bearing Plates: Load Bearing Plates shall meet the requirements of ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Alloy-Coated (Galvannealed) by the Hot-Dip Process.

C. Endomycorrhizal Inoculum:

1. Endo (arbuscular) mycorrhizal inoculum shall consist of spores, mycelium and mycorrhizal root fragments in a solid carrier suitable for handling by hydroseeding equipment. The carrier shall be the material in which the inoculum was originally produced and may include organic materials, calcinated clay or other approved materials consistent with mechanical application and with good plant growth.

2. Each endomycorrhizal inoculum shall carry a supplier’s guarantee of numbers of propagules per unit weight. Inoculum shall include one or more species of endomycorrhiza of the Genus GLOMUS. For each fungal species claimed by the supplier, the label shall include a certification for each species of endomycorrhizal fungus claimed and the certified propagule count of each species contained in the inoculum.

3. The endomycorrhizal inoculum shall contain the following species: 75% Glomus intraradices (containing at least two ecotypes suitable for use in the Northeastern US), and 25% Glomus etunicatum (Northeastern US ecotype).

D. Class IV Type B Erosion Control Material

Class IV Type B Erosion Control Material Soil stabilizer in the form of a polyacrylamide (PAM) and calcium solution.

CONSTRUCTION DETAILS:

The Contractor shall review the available subsurface information and visit the site to assess the site geometry, equipment access conditions, and location of existing structures and above-ground facilities. The Contractor is responsible for verifying the location of all utilities prior to starting the Work and to maintain uninterrupted service for those utilities designated to remain in service throughout the Work. The Contractor shall notify the Engineer of any utility locations different from those shown on the Plans that may require anchor relocations or slope design modification.
Prior to start of any slope repair activity, the Contractor and Engineer shall jointly inspect the site to observe and document the pre-construction condition of the site, existing structures, and facilities.

A. Construction Submittals

Submit five copies of the following information, in writing, to the Engineer for review and approval. Provide submittal items, lettered I through IV under 1, at least 15 calendar days prior to initiating the ARVS slope repair construction and submittal items 2 through 3 at least 15 calendar days prior to start of ARVS anchor installation or incorporation of the respective materials into the Work:

1. The proposed start date and detailed slope construction sequence including:
   a. Plan describing how surface water will be diverted, controlled and disposed of.
   b. Proposed methods and equipment for shaping/scaling/re-grading the slope.
   c. Information on space requirements for installation equipment; information on provisions for working in the proximity of underground facilities or utilities (if applicable).
   d. Proposed anchor driving methods and equipment including anchor type proposed to achieve the specified pullout resistance values and any variation of these along the slope alignment.

2. Proposed anchor testing methods.

3. Manufacturer Certificates of Compliance for the ARVS System

The Engineer will approve or reject the Contractor's submittal of the manufacturer certificates of compliance within 15 calendar days after receipt of a complete submission. The Contractor will not be allowed to begin slope construction or incorporate materials into the work until the submittal requirements are satisfied and are approved by the Engineer. Changes or deviations from the approved submittals must be resubmitted for approval.

B. Pre-Construction Meeting

A pre-construction meeting will be scheduled by the Engineer at least one week in advance and held prior to the start of slope construction. The Engineer, prime Contractor, anchor installation Contractor, and an experienced ARVS System manufacturer’s representative shall attend the meeting. Attendance is mandatory. The pre-construction meeting will be conducted to clarify the construction requirements for the work, to coordinate the construction schedule and activities, and to identify contractual relationships and delineation of responsibilities between the prime Contractor and the various Subcontractors, particularly those pertaining to slope excavating/scaling/shaping.
C. HPTRM Construction Requirements

1. Site Drainage Control - Provide positive control and discharge of all surface water that will affect construction of the slope to be stabilized. Maintain all pipes or conduits used to control surface water during construction. Repair damage caused by surface water.

2. Excavation - Perform the slope construction and excavation sequence in accordance with the Plans and approved submittals.

3. Re-grade and compact areas to be treated with ARVS as indicated on the project plans.

4. Excavation, Face Protrusions, Voids or Obstructions - Remove all or portions of cobbles, boulders, rubble or other subsurface obstructions encountered at the slope final excavation face which will protrude and prevent the ARVS from being installed flush to the surface. Determine method of removal of face protrusions, including method to secure remnant pieces left behind the excavation face and for promptly backfilling voids with suitable material resulting from removal of protrusions extending behind the excavation face. Notify the Engineer of the proposed method(s) for removal of face protrusions at least 24 hours prior to beginning removal. Removal of face protrusions and backfilling of voids or over-excavation is considered incidental to the work.

5. The contractor shall prepare the slope face for hydroseeding. The contractor shall incorporate the following amendments into the hydroseeding slurry:

   ➢ Endomycorrhizal inoculum (See below for specification and rate.) This inoculum shall be added to the hydroseeding slurry to be applied under the HPTRM mat. It is permissible to include the inoculum in the slurry applied over the mat, but not necessary.
   ➢ NOTE: Endomycorrhizal inoculum is a live material: it shall be transported and stored in vehicles, containers, and in application equipment with a temperature of less than 32°C (90°F).
   ➢ Application Rates: Inoculum shall be applied at the rate of 8,900,000 live propagules per hectare (3,600,000 live propagules per acre / 890 live propagules per square meter) based on the supplier or an analysis returned by an independent laboratory.
   ➢ Lime: 2.25 kg/m2.
   ➢ Class IV Type B PAM soil stabilizer and calcium solution, at the manufacturer’s recommended rate.

6. The basic seed mix is to be Slope Repair Seed Mix (See Mix #4 in the Supplemental Landscape Development Sheets). No phosphorous fertilizers shall be used.
7. The Soil moisture around the seed must be maintained for about 1 to 2 weeks. If project requires seeding and soil filling on top of the mat, 50% of seed mix is to be installed prior to installation of HPTRM, 25% to be installed on top of the HPTRM prior to < 12 millimeter of soil fill, and 25% to be broadcasted on top of the finished installation.

8. Cut initial anchor trench at the top of slope (see Plan for details).

9. Secure HPTRM in the trench and roll material down the slope.

10. Install all HPTRM along slope with 150 millimeter side overlaps (minimum). Ensuring enough coverage that the earth percussion anchors penetrate both layers.

11. Install pins on the face of the slope per the construction details and begin driving anchors across the top of slope per the detail(s). Offset the second row of anchors to create a checkerboard effect.

12. Repeat the process and work down the slope one row at a time. This will help secure the HPTRM tight to the slope surface.

13. When the HPTRM does not run the entire length of the slope, an overlap joint will be created by shingling the top roll over the bottom a minimum of 300 millimeters.

14. Once all rows of anchors have been installed, place the HPTRM in a terminal toe trench and secure as shown in the plans or the installation guidelines.

15. Re-seed and soil fill on top of the mat (50 millimeters max). If the slope is deemed to steep by the Manufacturer’s Representative for soil filling on top of the mat, alternate methods for vegetation establishment shall be considered. Such methods are to include but are not limited to hydro-seeding, mulches, or bonded fiber matrixes and shall be approved by the Engineer.

D. Earth Percussion Anchor Installation

Determine installation method necessary to achieve the anchor pullout resistance(s) specified herein or on the Plans and in accordance with the anchor testing acceptance criteria in the Anchor Testing section. The number and location of the anchor verification tests will be as indicated herein. The Engineer may add, eliminate, or relocate anchors to accommodate actual field conditions. Cost adjustments associated with these modifications shall be made in accordance with the General Provisions of the Contract. The cost of any redesign, additional material, or installation modifications resulting from actions of the Contractor shall be borne by the Contractor.
1. Installation - The installation of the anchors shall be made at the locations, orientations, and lengths shown on the Plans or as directed by the Engineer. Select installation equipment and methods suitable for the ground conditions described in the geotechnical report and shown in the boring logs. Select anchors required to develop the specified pullout resistance. Where hard driving conditions such as rock, cobbles, boulders, or obstructions are described elsewhere in the contract documents or project Geotechnical Report, other suitable driving equipment and anchors capable of driving through such materials, shall be used.

2. Anchor Installation Tolerances - Anchor location tolerances are:

- Anchor head location deviation from plan design location; anchors on seams will be offset along the seam first while other anchors may be offset 300 millimeters in any direction.
- Location tolerances are applicable to only one anchor and not accumulative over large slope areas.
- Anchors which do not satisfy the specified tolerances due to the Contractor's installation methods will be replaced at no additional cost. Anchors which encounter unanticipated obstructions during driving shall be relocated, as approved by the Engineer.

3. No more than 50 millimeters of projection of the anchor assembly from the HPTRM will be permitted. The protruding dowel shall be removed and the hex nut ratcheted down tight.

E. Earth Percussion Anchor Field Testing, Acceptance, or Rejection

1. Anchor Testing Frequency and Acceptance - Anchor testing will be performed on 3 percent of the total anchors in a defined location. The locations shall be designated by the Engineer. The Contractor will load test the selected anchor to determine if the load developed exceeds the design load within the tolerances of the anchor rod extension specified for this project. For this Slope Stabilization Project, the design load shall be 180 kgs for Type 1A anchors. These Loads shall be achieved at a pullout distance less than 300 millimeters. The design load for Type 2 anchors shall be 45 kgs and be achieved at a pullout distance less than 150 millimeters. Loads shall be measured by a Dillion #2500 ED Junior electronic dynamometer or equivalent capable of measuring tension up to 2500 pounds. The dynamometer shall be attached securely to a loading device and be capable of securing the threaded anchor to it to avoid slippage. Loads shall be applied utilizing a loading device, such as a jack or similar mechanism, that allows for slowly applying force to the threaded anchor rod in small increments and is capable of holding the load to allow the reading on the dynamometer to stabilize. The loading device will be set up so that loads can be applied longitudinally in the line of the threaded rod. All slack in the test setup should be removed prior "zeroing" the dynamometer and commencing the test. During testing, the contractor will be required to record the load at 25 millimeters
increments of pullout. If the anchor test does not meet the criteria, it shall become sacrificial and shall be replaced with an additional anchor installed within 300 millimeters of the original location and re-tested at no additional cost.

2. Verification Test Anchors - The Engineer will evaluate the results of each anchor test. Installation methods which do not satisfy the anchor testing requirements shall be rejected. The Contractor shall propose alternative methods and install replacement anchors. Replacement anchors shall be installed and tested at no additional cost. The Engineer may require the Contractor to test some or all of the installed anchors in the immediate vicinity of the failed anchor test to verify that adjacent previously installed anchors have sufficient load carrying capacity. Contractor modifications may include, but are not limited to; the installation of additional anchors, modifying the installation method; reducing the anchor spacing from that shown on the Plans and installing more anchors at a reduced capacity; or installing anchors with longer rods. Installation and testing of additional anchors or installation of additional or modified anchors as a result of anchor test failure(s) will be at no additional cost.

3. Anchor Installation Records - Records documenting the anchor construction will be maintained by the Engineer, unless specified otherwise. The Contractor shall provide the Engineer with as-built drawings showing as-built anchor locations.

**METHOD OF MEASUREMENT:**

**ARVS System** will be measured in place to the nearest square meter, for ARVS System satisfactorily installed.

The ARVS System, consisting of H PTRM, pins, earth percussion anchors, will be measured to the nearest square meter. Seams and overlaps will be measured as a single layer.

**BASIS OF PAYMENT:**

The square meter bid price of ARVS shall include the costs of all labor, materials, material tests, field tests, equipment, and incidentals necessary to complete the installation of the ARVS stabilized slope.

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