



**SPECIAL PROVISIONS
FOR
ENGINEERED EARTH ARMORING SOLUTION**

**Webster County
TAP-R-C094(123)--8T-94**

**Effective Date
October 19, 2021**

THE STANDARD SPECIFICATIONS, SERIES OF 2015, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

157194.01 DESCRIPTION.

A. General.

The work for this section shall consist of furnishing all materials, equipment, and labor necessary for the installation of a High Performance Turf Reinforcement Mat (HPTRM) and engineered earth anchors as an Engineered Earth Armoring Solution for surficial slope stability and/or slope erosion protection.

B. Submittals.

1. Qualifications: The following documentation shall be submitted to the Engineer for review and approval prior to installation.
 - a. A Certificate of Compliance (COC) stating the name of the HPTRM manufacturer, product name, style, chemical compositions of filaments or yarns and other pertinent information to fully describe the HPTRM. The COC shall state that the furnished HPTRM meets the requirements of the specification and shall be attested to by a person having legal authority to bind the Manufacturer.
 - b. The Manufacturer's Manufacturing Quality Control (MQC) Program to assure compliance with the requirements of the specification.
 - c. Documentation of full scale flume testing demonstrating the required performance when subjected to at least 0.5 hours of continuous flow for the unvegetated HPTRM with Engineered Earth Anchors, partially vegetated HPTRM, and fully vegetated HPTRM.
2. Engineered Earth Anchor Testing: The following documentation shall be submitted to the Engineer for review and approval prior to installation.
 - a. The Contractor's baseline establishment testing program to demonstrate the engineered earth anchor's holding capacity at each discrete area of the engineered earth armoring solution meets the design requirements. The baseline establishment testing program shall consist of the following at a minimum:

- Install one anchor at a location designated by the Engineer, setting the anchor at an appropriate embedment depth, and loading the anchor under constant tension.
 - Measure the depth of initial embedment (after setting the anchor), and commence loading through use of a crane, jack, or similar apparatus. Loading must be recorded using an in-line transducer (load cell) or Dillon scale. Spring/pulley type devices are not acceptable for load measurements.
 - Loads shall be recorded at tendon displacements of every 1 inch, until a load cannot be sustained (indicating impending pull-out), or displacement beyond a minimum embedment as specified by the Engineer has been achieved.
- b.** The baseline establishment test results shall be submitted to the Engineer by the Contractor and reviewed by the manufacturer. Prior to commencing full installation, the Engineer must inform the Contractor in writing of sufficient holding capacity demonstrated by the test.
 - c.** Documentation from the Engineer to the Contractor stating who will perform and the frequency of additional quality control load testing during the installation following the initial baseline test in each discrete area.
 - d.** A corrective action plan providing guidance should any subsequent quality control load testing results fall below a specific tolerance required by the Engineer and/or manufacturer. The Contractor shall cease installation immediately until such time that the Engineer has consulted with the manufacturer.
- 3.** Certifications: The certification documentation for all items listed in the materials section of this special provision shall be submitted to the Engineer for review and approval prior to installation.

C. Handling and Storage.

- 1.** HPTRM labeling, shipment and storage shall follow ASTM D 4873.
- 2.** Product labels shall clearly depict the manufacturer or supplier name, style name, and roll number.
- 3.** Each shipping document shall include a notation certifying that the material is in accordance with the manufacturer's certificate.
- 4.** Each HPTRM roll shall be wrapped with a material that will protect the RECP from damage due to shipment, water, sunlight, and contaminants. Individual roll wrapping will be not be required for HPTRMs exceeding the UV Resistance requirements per ASTM D 4355 in Section 2.2.A.6. The protective wrapping shall be maintained during periods of shipment and storage.
- 5.** During storage, HPTRM rolls shall be elevated off the ground and adequately covered to protect them from the following: Site construction damage, extended exposure to UV radiation, precipitation, chemicals that are strong acids or strong bases, flames, sparks, temperatures in excess of 160°F and any other environmental condition that might damage the HPTRM.

D. Drainage Control.

- 1.** The Contractor shall provide and maintain adequate site drainage to remove and dispose of all surface water and groundwater entering the excavation, or other parts of the Work.
- 2.** Surface water during construction shall be diverted or otherwise prevented from entering excavated areas to the greatest extent practicable without causing damage to adjacent property.

E. Quality Assurance Sampling, Testing and Acceptance.

1. A HPTRM shall be subject to sampling and testing to verify conformance with this specification. Sampling for testing shall be in accordance with ASTM D 4354.
2. Acceptance shall be in accordance with ASTM D 4759 based on testing of either conformance samples obtained using Procedure A of ASTM D 4354 or based on manufacturer's certifications and testing of quality control samples obtained using Procedure B of ASTM D 4354.

157194.02 MATERIALS.

Materials for construction of engineered earth armoring solution shall be furnished new and without defects. Defective materials shall not be used but shall be removed from the job site by and at the expense of the Contractor. Materials for engineered earth armoring solution shall consist of the following:

A. HPTRM.

1. A three-dimensional, high tensile strength, long term non-degradable lofty woven polypropylene RECP specially designed for erosion control applications that exhibits very high interlock and reinforcement capacity with both soil and vegetative root systems.
2. A homogeneous woven matrix composed of Trilobal monofilament yarns heat-set and woven into uniform configuration of resilient pyramid-like projections to improve interlock and minimize yarn displacement around anchors and pins, which also results in greater flexibility for improved conformance to uneven surfaces.
3. A material not comprised of layers, composites, or discontinuous materials, or otherwise loosely held together by stitched or glued netting.

4. Material Properties:

Property	Test Method	Test Parameters	Units	Property Requirement
Thickness ¹	ASTM D-6525	Minimum	in	0.40
Light Penetration ¹ (% Passing)	ASTM D-6567	Maximum	percent	10
Tensile Strength ¹	ASTM D-6818	Minimum	lb/ft	4000 x 3000
Tensile Elongation ¹	ASTM D-6818	Maximum	percent	40 x 35
Resiliency ¹	ASTM D-6524	Minimum	percent	80
Flexibility ^{2,3}	ASTM D-6575	Maximum	in-lb	0.534
UV Resistance ²	ASTM D-4355	Minimum	percent	90 at 3000 hrs ⁴ 90 at 6000 hrs
Carbon Footprint ²	ISO 14064-3 GHG Protocol PAS 2050:2011	Maximum	Kg CO2e	2.7 per 1 m ²

Note:

1. Minimum Average Roll Value (MARV).
2. Typical Value.
3. A smaller value for flexibility denotes a more flexible material.
4. Third party / Independent Testing values must be provided showing UV resistance testing for two consecutive years including most recent year.

B. Securing Pins and Engineered Earth Anchor.

1. Securing pins should be a minimum of 0.20 inch diameter steel with a 1.5 inch steel washer at the head of the pin.
2. Length: 12 to 24 inches as depicted on the drawings to provide sufficient ground penetration for pullout resistance.
3. Heavier metal securing pins and/or stakes may be required in rocky soils
4. Depending on soil pH and design life of the securing pin, galvanized or stainless steel securing pins may be required.
5. Performance Properties:

Performance Property	Value
Ultimate Assembly Strength	2800 lbs
Ultimate Cable Strength	3700 lbs
Typical Working Load*	2000 lbs
Minimum Embedment Depth	6.0 ft.
Maximum Embedment Depth	12.0 ft.

157194.03 CONSTRUCTION.

A. Preparation.

1. The area(s) to be treated with the engineered earth armoring solution shall be cleared, grubbed, graded and compacted as indicated on the construction plans and technical specifications or as directed by the Engineer.
2. The placement of new fill or addressing a sloughed slope may require soil placed to be keyed into the existing slope and compacted in horizontal lifts per the Engineer. To ensure compaction at the face of the slope, the slope face may be over-built, compacted in lifts, and then regraded or trimmed to the final grade. All fill shall be placed and compacted per the project's earthwork technical specifications.
3. The subgrade shall be uniform and smooth. Large rocks, soil clods, vegetation, and other sharp objects shall be removed prior to installation of the HPTRM. This will assist in the HPTRM maintaining direct contact with the soil surface.
4. Construct a perimeter trench around the area(s) limits to be treated with the engineered earth armoring solution as follows:
 - a. Excavate a Crest of Slope (COS) trench a minimum of 3 feet horizontal over the crest of the slope when possible. Trench dimensions shall be 12 inches wide by 12 inches deep.
 - b. Excavate a Toe of Slope (TOS) trench a minimum of 3 feet horizontal over the crest of the slope when possible. Trench dimensions shall be 12 inches wide by 12 inches deep.
 - c. Excavate a side trench perpendicular to the contours at each end of the area to be treated (longitudinal limits). Trench dimensions shall be 6 inches minimum wide by 6 inches minimum deep.

B. Vegetation Establishment.

1. Establish permanent vegetation, where feasible, to assist in the long-term performance of the Engineered Earth Armoring Solution and the control of erosion.
2. A site specific soil test shall be conducted to determine the recommended soil amendments required to establish permanent vegetation.
3. The type and method of vegetation establishment should be unique to the projects geometry, location, climate, season, topography, soils, seed type, etc. and shall be as directed per one of the following:
 - a. Construction plans
 - b. Technical Specifications
 - c. Manufacturer's engineered earth armoring solution submittal
 - d. As directed by the Engineer
4. Water and/or irrigate seeded/sodded areas as needed to establish and maintain permanent vegetation until the desired vegetative density has been achieved.
5. Rubber-tired or rubber-tracked vehicles shall be used, and sharp turns avoided. No heavy and/or metal-tracked equipment or sharp turns shall be permitted on the installed engineered earth armoring solution. Foot traffic and construction equipment shall be avoided over the TRM if loose or wet soil conditions exist.

C. Installation.

1. Install HPTRM at elevations and alignments indicated.
2. Beginning at the lower elevation end (down gradient) area, place initial end of first roll of HPTRM into the COS trench and secure with securing pins and engineered earth anchors. The securing pins shall be placed at 12 inch intervals in between the engineered earth anchors at 4 foot intervals.
3. Unroll the HPTRM down the slope.
4. The securing pins provide for temporary tie-down of the HPTRM to aid with the installation of the engineered earth anchors and where applicable the establishment of vegetation. Secure the HPTRM initially with the securing pins driven flush with the HPTRM at the designated frequency based on the engineered earth armoring surficial slope stability or erosion control requirements.
5. Install the engineered earth anchors at the depth, spacing and loading based on the engineered earth armoring slope stability or erosion control requirements to permanently secure the HPTRM. Increased anchoring frequency may be required based on the baseline establishment tests required in Section 01.B.2.a
6. Position adjacent up gradient rolls in same manner, overlapping down gradient rolls a minimum of 3 inches until the armoring limits are completed.
7. Secure the overlaps with securing pins at 12 inch intervals in between the engineered earth anchors placed at intervals based on the engineered earth armoring surficial slope stability or erosion control requirements.
8. Secure the HPTRM end in the TOS and side (longitudinal limits) trenches with securing pins and engineered earth anchors. The securing pins shall be placed at 12 inch intervals in between the engineered earth anchors at 4 foot intervals.

9. Backfill and compact the trenches with specified soil or as directed by the earthwork technical specifications or as directed by the Engineer.
10. Alternate installation methods must be approved by the Engineer and manufacturer prior to execution.

D. Definitions.

1. Certificate of Compliance (COC): An official document certified by an authorized representative within the manufacturer's company that the manufactured synthetic turf reinforcement mat product(s) meet designated property values as manufactured in a facility having achieved ISO 9001:2015 certification, and tested in accordance with GAI-LAP procedures.
2. High Performance Turf Reinforcement Mat (HPTRM): A long-term, non-degradable RECP composed of ultraviolet (UV) stabilized, non-degradable, synthetic fibers, nettings and/or filaments processed into three-dimensional reinforcement matrices designed for immediate and permanent protection for erosion control applications where design flows exert velocities and shear stresses that exceed the limits of mature natural vegetation. The HPTRM MARV tensile strength per ASTM D-6818 is 3000 pounds per foot in the weakest principle direction.
3. Manufacturer: Entity that produces synthetic HPTRM products through a process directly utilizing obtained raw materials, in a facility owned and operated by said entity, using equipment and assemblies owned and operated by said entity, subject to a certified Manufacturing Quality Control (MQC) Program. Upon completion of production, the manufacturer may sell the HPTRM product(s) directly to the customer, or through a vendor entity.
4. Manufacturing Quality Control (MQC) Program: A certified and documented program initiated and operated by the manufacturer that outlines the operational techniques and activities which sustain a quality of the synthetic HPTRM product(s) that will satisfy given needs.
5. Minimum Average Roll Value (MARV): Property value calculated as typical minus two standard deviations. Statistically, it yields a 97.7% degree of confidence that any sample taken during quality assurance testing will exceed value reported.
6. Engineered Earth Anchor (Anchor): A device designed to permanently stabilize soil via a metal anchor, flexible or rigid tendon, and load bearing plate. The anchor and tendon are driven through the HPTRM to the specified depth, and then tensioned appropriately to load-lock the anchor for desired pull-out resistance.
7. Rolled Erosion Control Product (RECP): A temporary degradable or long-term non-degradable material manufactured or fabricated into rolls designed to protect the soil surface, reduce soil erosion and if needed assist in the growth, establishment and protection of vegetation.
8. Securing Pin: A device designed to temporarily hold the HPTRM in place during installation until the engineered earth anchors are installed, or the establishment of vegetation occurs.
9. Trilobal Monofilament Yam: A multi-dimensional polymer fiber consisting of a minimum of three points, providing increased surface area and grooves/channels along the fiber to capture additional moisture and sediment to enhance vegetative growth.
10. Typical Roll Value: Property value calculated from average or mean obtained from test data.
11. Vendor: An entity that provides engineered earth armoring solution product(s) to a customer, on behalf of an independent manufacturer. A vendor does not manufacture the actual engineered earth armoring solution product(s), and therefore is not subject to provisions of a certified MQC Program.

157194.04 METHOD OF MEASUREMENT.

Measurement is based on the number of square feet of Engineered Earth Armoring Solution installed as shown on the plans.

157194.05 BASIS OF PAYMENT.

Payment will be made at the unit bid price per square footage of Engineered Earth Armoring Solution extents. Included with this item is supply, deliver, storage, preparation, installation, and all labor, materials, and equipment necessary to install Engineered Earth Armoring Solution system as indicated on the plans and as recommended by the manufacturer and specified by the Engineer.