A Technical Guidance Manual: Terminology, Index, & Performance Testing Procedures for Rolled Erosion Control Products

1. BACKGROUND

Standardization of the rolled erosion control products (RECPs) industry continues to occur at a rapid pace. This progress is especially prevalent in the last three to five years with multiple guidelines being developed by the Erosion Control Technology Council (ECTC) and ASTM International (ASTM). Standards development has included methods to determine relevant index/physical properties and performance thresholds of RECPs. Specific standards have been developed for temporary degradable products including; open weave textiles (OWTs), mulch control nets (MCNs), and erosion control blankets (ECBs) and long-term, non-degradable turf reinforcement mats (TRMs). Many standards noted in this document were originated by the ECTC then submitted, reviewed, balloted and approved as ASTM standardized test methods. Prior to ECTC standardization efforts: agencies and independent, commercial laboratories often utilized differing protocols, yielding variability in results. This resulted in confusion to users and specifiers of RECPs.

Several factors contribute to the complexity and challenging nature of RECP standards development. First, RECP materials differ significantly in composition, components and technologies. Further, stakeholders within the erosion control industry recognize, embrace and utilize various techniques to qualify and quantify performance thresholds. Finally, correlation of test results to field performance should be conducted by experienced laboratory and field personnel. The recent standardization advancements by ECTC and ASTM has reduced variability in the data collected with respect to RECPs and reduced the confusion once associated with RECPs.

This document was developed by the ECTC to aid in the understanding and use of the most recent terminology, index/physical property test methods, and performance research for RECPs. It is intended to assist engineers, geologists, soil scientists, landscape architects, contractors, research facilities within the erosion control industry in the selection of RECPs.

2. FOREWORD

During 1994 and 1995, ECTC sponsored an experimental program establishing standardized applications of various index test methods used to characterize RECPs. Further, the ECTC established consensus-based terminology for the RECP industry. The ECTC in 2003 also worked diligently with the National Transportation Product Evaluation Program (NTPEP) to establish a system of testing and quality control through the use of select index properties based on independent product review and testing. This guidance manual is the result of these efforts and provides terminology, index testing, and performance research guidance for both degradable and non-degradable RECPs.

It should be emphasized that the test instructions within this document are not a replacement to the governing test standard, but should be used in concert with the standard to

assist the user in generating valid and repeatable test results. Where specific test standards are not available, sufficient detail is provided to assist the user in the performance of a test and/or test result determination.

The ECTC continues the process of developing new test methods and terminology designed to better serve the erosion control industry.

3. STANDARD TERMINOLOGY FOR ROLLED EROSION CONTROL PRODUCTS

3.1 ECTC Standardized Definitions for RECPs

3.1.1 Rolled erosion control product (RECP); A temporary degradable or long-term non-degradable material manufactured or fabricated into rolls designed to reduce soil erosion and assist in the growth, establishment and protection of vegetation.

3.1.2 Mulch-control netting (MCN); A planar woven natural fiber or extruded geosynthetic mesh used as a temporary degradable rolled erosion control product to restrain loose fiber mulches.

3.1.3 Open weave textile (OWT); A temporary degradable rolled erosion control product composed of processed natural or polymer yarns woven into a matrix, used to provide erosion control and facilitate vegetation establishment.

3.1.4 Erosion control blanket (ECB); A temporary degradable rolled erosion control product composed of processed natural or polymer fibers mechanically, structurally or chemically bound together to form a continuous matrix to provide erosion control and facilitate vegetation establishment.

3.1.5 Turf reinforcement mat (TRM); A rolled erosion control product composed of non-degradable synthetic fibers, filaments, nets, wire mesh and/or other elements, processed into a permanent, three-dimensional matrix of sufficient thickness. TRMs, which may be supplemented with degradable components, are designed to impart immediate erosion protection, enhance vegetation establishment and provide long-term functionality by permanently reinforcing vegetation during and after maturation. Note: TRMs are typically used in hydraulic applications, such as high flow ditches and channels, steep slopes, stream banks, and shorelines, where erosive forces may exceed the limits of natural, unreinforced vegetation or in areas where limited vegetation establishment is anticipated.

3.2 Definition & Categorization of Products by Functional Longevity

3.2.1 Temporary degradable; A rolled erosion control product composed of biologically, photochemically or otherwise degradable materials that temporarily reduce soil erosion and enhances the establishment of vegetation.

3.2.2 Long-term non-degradable; A rolled erosion control product composed of non-degradable materials that furnishes erosion protection and extends the erosion control limits of vegetation for the design life of a project.

3.2.3 Ultra-short term products; A rolled erosion control product designed to last three months or less. They are used in areas where vegetation can be quickly

established and will be mowed soon after installation. The netting and bonding materials (e.g. stitching thread) on ultra-short term products degrade quickly to prevent entanglement with mowing equipment.

3.2.4 Short-term products; A rolled erosion control product designed to provide erosion protection for longer than three months and up to 12 months. This is basically one growing season for the establishment of vegetation.

3.2.5 Extended-term products; A rolled erosion control product designed to provide erosion protection for longer than 12 months and up to 24 months. These products are used in areas where vegetation establishment may take up to two full growing seasons. These products are often used in semi-arid locations.

3.2.6 Long-term products; An rolled erosion control product designed to provide erosion protection for longer than 24 months and up to 36 months.

3.2.7 Permanent products; A rolled erosion control product designed to last more than 36 months. This category is typically made up of TRMs.

3.3 General Terminology

3.3.1 Atmosphere for testing rolled erosion control products; Air maintained at a relative humidity of 65±5% and temperature of 21±2 degrees C (70 ±4 degrees F).

3.3.2 Tensile strength: The resistance to deformation developed for a specific material and subsequent modulus and elongation when subjected to tension by an external force.

3.3.3 Specimen: A specific portion of a material or laboratory sample upon which a test is performed or which a measurement is taken for that purpose.

3.3.4 Stiffness: A resistance to bending.

3.3.5 Specific gravity: The ratio of the density of the substance in question to the density of a reference substance at specified conditions of temperature and pressure.

3.3.6 Performance test; A test that simulates as closely as practicable selected conditions experienced in the field and which can be used in design.

3.3.7 Yarn: A generic term for continuous strands of textile fibers or filaments used to form a textile fabric.

3.3.8 Machine direction: The direction in the plane of the fabric parallel to the direction of manufacture.

3.3.9 Transverse direction: The direction in the plane of the fabric perpendicular to the direction of manufacture. It is often referred to as the "cross-machine direction".

3.3.10 Warp: (1) The yarn running the length of the fabric in the machine direction. (2) The sheet of yarns wound together or a beam for the purpose of weaving or knitting. (3) Often referred to as the "machine direction".

3.3.11 Weft: (1) The yarn running the length of the fabric perpendicular to the machine direction when manufacturing woven or knitted fabrics. (2) Often referred to as the "cross-machine direction".

3.3.12 Porosity: The ratio of the volume of air or void contained within the boundaries of a material to the total volume expressed as a percentage.

3.3.13 Polyolefin: A family of polymeric materials that includes polypropylene and polyethylene.

3.3.14 Natural: A class name of various general fibers, of animal, mineral or vegetable origin.

3.3.15 Absorption: The process by which a liquid is drawn into and tends to fill permeable pores in a porous solid body, also, the increase in mass of a porous solid body resulting from penetration of a liquid into its permeable pores.

3.3.16 Geosynthetic; A product manufactured from polymeric material used with soil, rock, earth, or other geotechnical engineering material as an integral part of a man-made project, structure, or system.

3.3.17 Geotextile; A permeable geosynthetic material comprised solely of textiles.

3.3.18 Index test; A test procedure that may contain a known bias but which may be used to establish an order for a set of specimens with respect to the property of interest.

3.3.19 Lot: A unit of production, or a group of other units or packages, taken for sampling or statistical examination, having one or more common properties and being readily separable from other similar units.

3.3.20 Sample: A portion of material, which is taken for testing or for recorded purposes and used in the laboratory as a source of individual specimens.

3.3.21 Bench-scale test methods are designed to establish guidelines, requirements, and procedures for evaluating the effect of RECPs on seed germination and vegetation enhancement, to protect soil (sand) from hydraulically induced shear stress, and to protect soils from simulated rainfall (rain splash) and minimal runoff induced erosion. Bench-scale test methods **are not** intended to replace full-scale simulation or field testing in acquisition of performance values that are required in the design of erosion control measures utilizing RECPs or any erosion control material.

4. TESTING GUIDANCE

4.1 Bench-scale test; a test procedure allowing for the testing of non-index parameters on a sufficiently small scale to be conducted in a laboratory. Bench-scale test methods are designed to establish guidelines, requirements, and procedures for evaluating the effect of RECPs on seed germination and vegetation enhancement, to protect soil (sand) from hydraulically induced shear stress, and to protect soils from simulated rainfall (rain splash) and minimal runoff induced erosion. Bench-scale test methods **are not** intended to replace full-scale simulation or field testing to determine performance values that are required in the design of erosion control measures utilizing RECPs or any erosion control material.

Bench-Scale Index Testing	ASTM Designation	Standardized Test Method
ECTC Test Method 2 - Rain Splash	**Under Review By ASTM Technical Committee**	Standard Index Test Method For The Determination Of Unvegetated Rolled Erosion Control Product (RECP) Ability To Protect Soil From Rain Splash And Associated Runoff Under Bench-Scale Conditions
ECTC Test Method 3 - Shear Stress Resistance	**ASTM D7207**	Standard Test Method For Determination Of Unvegetated Rolled Erosion Control Product (RECP) Ability To Protect Sand From Hydraulically-Induced Shear Stresses Under Bench-Scale Conditions
ECTC Test Method 4 – Germination	**Under Review By ASTM Technical Committee**	Standard Index Test Method For Determination Of Rolled Erosion Control Product (RECP) Ability To Encourage Seed Germination And Plant Growth Under Bench-Scale Conditions

4.2 Performance testing: A testing procedure that simulates as closely as practicable selected conditions experienced in the field and which can be used in design. Any erosion control material's permissible shear stress/performance must be established by large-scale research. Independent laboratories used to establish permissible shear stress, erosion control effectiveness on slopes and design values for RECP manufacturers include, but are not limited to Utah State University, Logan, Utah and Colorado State University, Fort Collins, Colorado.

Performance testing is conducted to determine critical design parameters or the maximum stability thresholds of a rolled erosion control product. A variety of programs and protocols have been developed and utilized. Standardized protocols have been utilized as well as specialized protocols. Typically, RECPs are tested in slope/rainfall applications and concentrated flow/channelized applications. Vegetated and unvegetated conditions are considered for channelized testing. The Performance Testing Critical Parameter Table presents a summary of testing conducted on product categories and critical parameters evaluated during testing.

Performance Testing Critical Parameters

RECP Category	Unvegetated		Vegetated
	Rainfall/Slope	Channelized	Channelized
Erosion Control Blankets	Product Integrity Cover Factor (RUSLE)	Product Integrity, Maximum, Stable Velocity and Shear Stress, Product Roughness (Resistance to Flow)	N/A
Turf Reinforcement Mats	Product Integrity Cover Factor (RUSLE)	Product Integrity Maximum Stable Velocity and Shear Stress, Product Roughness (Resistance to Flow)	Maximum Stable Velocity and Shear Stress, (Overall Performance of Reinforced Vegetation)

4.2.1 Performance testing of RECPs should be conducted utilizing installations that mimic recommended field application as closely as possible. Thus, stapling pattern, anchor trenching, seam construction and other installation details are installed identically as in field conditions.

Product research is often conducted by university or private laboratories which may develop specialized procedures to evaluate an RECP in a particular application. However, standardized protocols have been developed to evaluate the critical parameters listed in ASTM Performance Standards Table below. Standardized protocols are continually evolving to represent the best state of the practice information available. Currently, ASTM International maintains two performance testing standards applicable to RECPs. ASTM D6459 is utilized to evaluate rainfall/slope conditions. ASTM D6460, is utilized to evaluate channelized flow conditions. Both standards apply specifically to ECBs and unvegetated conditions, however, both are under evaluation to include TRMs and/or vegetated conditions. The ASTM Performance Standards are summarized in the table below.

ASTM Performance Standards

Large-Scale Performance Property	Standardized Test Method	
	ECBs	TRMs
Standard Test Method for Determination of Erosion Control Blanket (ECB) Performance in Protecting Hillslopes from Rainfall-Induced Erosion	ASTM D6459	Under Review by ASTM
Standard Test Method for Determination of Erosion Control Blanket (ECB) Performance in Protecting Earthen Channels from Stormwater-Induced Erosion	ASTM D6460	Under Review by ASTM

4.2.2 Summary of ASTM Procedures

4.2.2.1 Rainfall/Slope – ASTM D6459

The objective of testing under ASTM D6459 is to determine the soil loss in a protected condition (with RECP) compared to a bare soil condition. Testing is conducted on a standardized plot size and with one of three standard soil types in a protected and unprotected condition. Bare soil and protected plots are tested without the presence of vegetation. Each plot is subjected to a substantially identical series of simulated rainfall events. Soil mobilized from each plot is captured and weighed. A comparison of the rainfall events (measured intensity, volume and duration) and soil mobilized yields the primary parameter of interest, a Cover Factor (C Factor) suitable for use within the Revised Universal Soil Loss Equation (RUSLE) design methodology.

4.2.2.2 Channelized Flow – ASTM D6460

The objective of testing under the current ASTM D6460 is to determine the maximum hydraulic forces that may be exerted on an RECP as a flexible channel liner in an unvegetated condition. An RECP is considered to have failed once the average soil loss under the product has exceeded one-half inch. Similar to D6459, D6460 testing is typically conducted in conjunction with an unprotected reference plot. Each plot is subjected to a series of simulated channel flows. During the execution of each test, flow velocity, flow depth and discharge are measured. At the conclusion of each test, the topography of the bed surface is quantified to determine the net erosion over the system. At the conclusion of the series of flows, shear stress (tractive force) is computed and compared to the soil loss measured. Evaluation of the data allows for a determination of the maximum shear stress and velocity achieved prior to one-half inch of soil loss. Further, the resistance to flow (roughness quantified as Manning's n) is computed from test data. Information derived from testing is suitable for use within the state of the practice design for flexible channel liners, United States Federal Highway Administration Hydraulic Engineering Circular 15 (HEC-15).

4.2.2.3 Other Protocols

In addition to nationally recognized protocols, state-specific evaluation processes have been utilized. State regulatory agencies will employ a program of evaluating the index properties and/or subject products to field evaluation or trials. Additionally, individual states have developed laboratory performance based programs required to maintain conformance. In particular, Texas Department of Transportation (TX DOT) has developed and required testing through its laboratory system and protocols (Texas Transportation Institute (TTI)). Other states require testing in accordance with the TX DOT standards, as a refereed, standardized testing procedure. In contrast to ASTM performance standards, TX DOT procedures are specific to conditions and design processes mandated by the state of Texas. Thus, the results are not universal and may or may not be indicative of product performance in other conditions. Further, TX DOT protocols do not yield results necessary for design with state of the practice methodologies. TX DOT utilizes three protocols in a standardized evaluation of RECPs. Texas Department of Transportation Protocols Table below summarizes the TX DOT protocols.

Texas Department of Transportation Protocols

	Protocol 1	Protocol 2	Protocol 3
Erosion Control Blankets	Vegetation Germination	Rainfall/Slope 3:1 or 2:1 gradient; sand and clay soils	Vegetated Channel Evaluation
Turf Reinforcement Mats	Vegetation Germination	Rainfall/Slope 3:1 or 2:1 gradient sand and clay soils	Vegetated Channel Evaluation

4.3 Index properties provide designers with the means to assess product quality while ensuring product conformance to specifications.

Index Property	Standardized Test Method	
	Temporary Degradable (OWTs, MCNs, and ECBs)	Long-term Non-degradable (TRMs)
Mass/Unit Area	ASTM D6475	ASTM D6566
Compression	Not Applicable	ASTM D6454
Thickness	ASTM D5199	ASTM D6525
Tensile Strength & Elongation	ASTM D5035	ASTM D6818
Water Absorption	ASTM D1117/ECTC	ASTM D1117/ECTC
Swell	ECTC Guidelines	Not Applicable
Stiffness/Flexibility	ASTM D1388	ASTM D6575
Resiliency	ASTM D1777/ECTC	ASTM D6524
Light Penetration/Ground Cover	ECTC Guidelines	ASTM D6567
Smolder Resistance	ECTC Guidelines	Not Applicable
Ultraviolet (UV) Resistance*	Not Applicable	ASTM D4355*

*ASTM D1682 (4 inch strip) Tensile Strength and % Strength Retention of material following 500 hrs exposure in Xenon-Arc Weatherometer.

4.3.1 Index test methods for temporary **degradable** products.

Test Method	Section
Thickness	5.4
Resiliency	5.5
Mass per Unit Area	5.7
Water Absorption	5.10
Swell	5.11
Stiffness	5.12
Light Penetration	5.13
Smoldering Resistance	5.14
Tensile Properties	5.15

4.3.2 Index test methods for long-term **non-degradable** products.

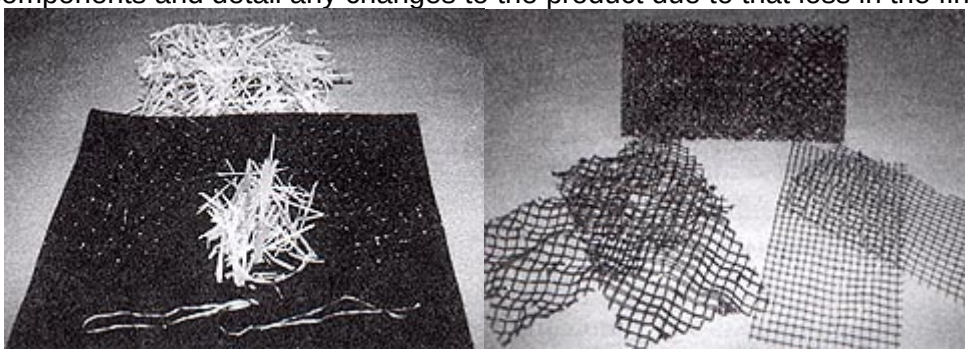
Test Method	**Section**
Thickness	5.4
Resiliency	5.5
Density	5.6
Mass Per Unit Area	5.7
Porosity	5.8
Open Volume Per Unit Area	5.9
Stiffness	5.12
Light Penetration	5.13
Tensile Properties	5.15
Compression Behavior	5.16

5. DESCRIPTION OF INDEX PROPERTY TEST METHODS

5.1 General Sampling

Perform RECP sampling in accordance with ASTM D 4354.

Note 1: As most rolled erosion control products are constructed from several component materials, sampling of the bulk product must be performed in such a way as to maintain the structural integrity of the product. This is true not only for generating a test sample, but also for the generation of individual test specimens from the sample for testing. Experience has shown that careless handling of materials may result in loss of component fibers, yarns and/or stitching, and bias of test results. Note any loss of material components observed during sample and test specimen preparation. Report the mass of lost components and detail any changes to the product due to that loss in the final report.



Rolled erosion products and their component materials.

Note 2: Procedures found to be successful for cutting test specimens from RECPs include the use of hot knifes to seal the edges of non-degradable test specimens and the use of bags and slip supports to keep all RECP specimen components together during sample preparation. The method of specimen cutting should be included with reported data.

Hot Knife Specimen Preparation of non-degradable RECP.

Bags used as slip supports during specimen cutting.

5.2 Field Sampling

Scope: This field sampling protocol provides a procedure for securing a laboratory sample from a single product roll of rolled erosion control products. The sample must be representative of the roll and appropriately sized for the required test procedures.

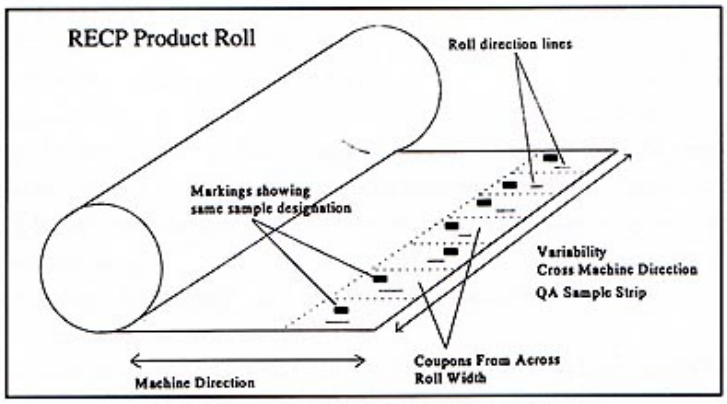
Note 3: Most products vary in physical properties in the transverse or fill direction. For this reason it is appropriate to secure a sample from across the roll width.

5.2.1 Procedure

5.2.1.1 All samples must be marked with identification information, including manufacturer's name, style number, unique roll number, lot number and date sampled. For most samples, it is very important to mark roll direction and the top of product. This is usually done with an arrow pointing in the machine direction an indicator of the top of the specimen. The use of indelible markers or tags is recommended. Make sure that any cut sample pieces that are separate are marked appropriately.

5.2.1.2 Most conformance testing requires the lab to sample the material randomly across the roll width (refer to individual test standards for details). When this is required, a section of material representing the entire roll width must be shipped. Alternately, cut panels can be shipped so long as they represent random locations across the roll. Make sure that each panel is marked for identification.

5.2.1.3 Samples should be rolled in a durable, protective wrap so as to prevent possible damage. Be sure that the means of identification cannot be removed or damaged through the shipping process. Always use a packing list or chain of custody to indicate where the sample came from and instructions for testing or other handling.



ECTC Technical Guidance Document - TASC 00197

5.3 Conditioning

5.3.1 Prior to testing, bring test specimens to moisture equilibrium in the atmosphere for testing rolled erosion control products (relative humidity of 65 + 5 % and temperature of 21 + 2°C). Equilibrium is considered to have been reached when the increase in mass of the test specimen in successive weighings, made at intervals of not less than 2 hours, does not exceed + 0.1 % of the mass of the test specimen. In general practice, the sample approaches equilibrium from the "as-received" side.

Note 4: It is recognized that in practice rolled erosion control products frequently are not weighed to determine when moisture equilibrium has been reached. While such a procedure cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing for a reasonable period of time before the specimens are tested. A time of at least 24 hours has been found acceptable in most cases. However, certain fibers may exhibit slow moisture equilibration rates from the "as-received" wet side. When this is known, a preconditioning cycle, in accordance with Practice D 1776, may be agreed upon between the contractual parties.

5.4 Thickness

5.4.1 Erosion control blankets – determine according to ASTM D5199.

5.4.2 Turf reinforcement mats – determine according to ASTM D6525 with the following exceptions.

5.4.1.1 Conditioning - In addition to required moisture and temperature equilibration, allow test specimens to reach equilibrium stress condition by allowing 24 hours "stress free" storage in the standard atmosphere for testing. Stress free condition shall be facilitated when sample material is not folded or rolled, and free of thermal or mechanical stress.

Note 5: Rolled erosion control products or folded samples of products may retain residual compression after being unrolled. This residual compression has been found, in some cases, to bias thickness test results. A period of 24 hours has been found satisfactory for relaxation of compressed rolled materials.

5.4.1.2 Apparatus - The applied normal force shall be 2 kPa (2.9 psi).

5.5 Resiliency

5.5.1 Erosion control blankets – determine according to ECTC modified ASTM D1777.

5.5.2 Turf reinforcement mats – determine according to ASTM D6524.

5.6 Specific Gravity and Density

5.6.1 Determine the specific gravity and density of rolled erosion control products according to ASTM D792, Test Method A.

5.6.2 The report shall include the individual values along with the average and standard deviation.

Note 6: Test specimens used to determine the density of a material must have a mass of 1 to 50 grams. When measuring thin reinforcement scrim materials, experience has shown that a large specimen size (generally measuring 127 mm x 127 mm (5 in. x 5 in.) gently folded and gripped by a clip serves to meet the mass requirements while providing an easily managed specimen. Samples having components representing different polymers should be characterized by determining the density of each component. The presence of organic fibers in an RECP may limit the ability to conduct this test because of the fibers inherent ability to absorb moisture.

5.7 Mass per Unit Area

5.7.1 Erosion control blankets – determine mass per unit area according to ASTM D6475.

5.7.2 Turf reinforcement mats - determine the mass per unit area according to ASTM D6566.

5.8 Porosity

5.8.1 Determine mass per unit area in accordance with ASTM D6475 (ECBs) or D6566 (TRMs).

5.8.2 Determine density in accordance with ASTM D792.

5.8.3 Determine thickness in accordance with Section 5.4.

5.8.4 Calculation

$$\text{porosity, } n = 100\,(1 - m/pt)$$

n = porosity, in %

m = mass/unit area, g/cm^2 (as determined in ASTM D 5261)

p = density, g/cm^3 (as determined in ASTM D 792)

t = thickness, cm (as determined in Section 8)

5.8.5 Report

5.8.5.1 Report the open volume per unit area and denote whether it was calculated from published minimum, minimum average roll or typical values. If the value was obtained from a single test, denote that fact.

5.9 Open Volume per Unit Area

5.9.1 Procedure

5.9.1.1 Determine thickness in accordance with Section 8.

5.9.1.2 Determine porosity in accordance with Section 12.

5.9.2 Calculation

open volume per unit area, $N = t \times n \times 1296$ (in^2/yd^2) or 10,000 (cm^2/m^2)

N = open volume/unit area (in^3/yd^2) or (cm^3/m^2)

t = thickness (inches) or (cm)

n = porosity (%)

5.9.3 Report

5.9.3.1 Report the open volume per unit area and denote whether it was calculated from published minimum, minimum average roll or typical values. If the value was obtained from a single test, denote that fact.

5.10 Water Absorption

5.10.1 Determine the water absorptive capacity according to ASTM D1117, Section 5.4 "Absorptive Capacity Test (for Larger Test Specimens)", as modified below.

5.10.2 Apparatus

5.10.2.1 Galvanized screen, tared, measured 230 mm x 230 mm (9 in. x 9 in.) and constructed of No. 17 wire.

5.10.2.2 Pan, 76 mm (3 in) deep by 254 mm (10 in) wide by 254 mm (10 in) long.

5.10.2.3 Pan, tared, shallow, lightweight, and large enough to hold the galvanized screen).

5.10.3 Test Specimen

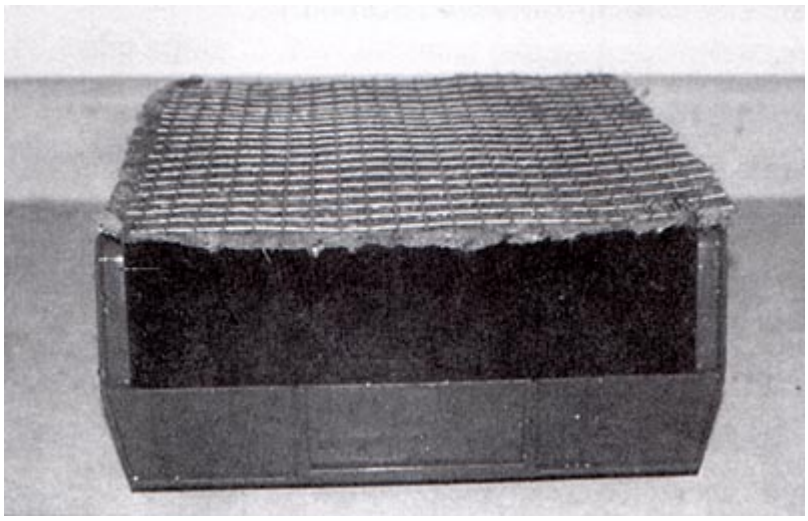
5.10.3.1 Prepare three specimens measuring 203 mm x 203 mm (8 in x 8 in) cut at approximately equally spaced intervals across the sample.

5.10.4 Procedure

5.10.4.1 Weigh each test specimen to the nearest 0.1 g and place it on a tared 230 mm by 230 mm (9 in x 9 in) galvanized wire screen. Place the specimen on the screen in such a way as to preserve specimen integrity and avoid the loss of specimen components. Place another tared screen having the same dimensions on top of the specimen and place both screens and specimen in the 76 mm (3 in) deep pan containing water at 21 ± 2 degrees C and about 64 mm (2.5 in) deep. Allow the specimen to soak in the water for 24 ±0.25 hours.

5.10.4.2 After the soaking period, remove the specimen by removing the screens with the specimen between them and placing above the water on supports placed at the edge of the screens. Allow the specimen and screens to drip-drain in a horizontal position for 10 ±0.1 min.

5.10.4.3 After drip-draining, place the screens and the wet specimen in the tared pan and weight the pan and its contents to the nearest 0.1 g.



Horizontal drip-drain of soaked specimen.

5.10.5 Calculation and Report

5.10.5.1 Calculate the amount of water held by the specimen by subtracting the sum of the weights of the weighing pan, screens, and dry specimen from the total weight.

5.10.5.2 Report the absorptive capacity as the ratio of water held by the specimen to the weight of the original dry specimen. Report the average of the three values found as the absorptive capacity.

5.11 Swell

5.11.1 This method covers the determination of the percentage swell in water of degradable rolled erosion control products.

5.11.2 This method determines the percentage swell in thickness of the sample after it has been immersed in water for 24 hours.

5.11.3 Apparatus

5.11.3.1 Two pieces of non-corrosive household window screen measuring 127mm x 127 mm (5 in. x 5 in.).

5.11.3.2 A shallow pan measuring 305 mm x 305 mm (12 in. by 12 in.) and containing two 76 mm (3 in.) high rigid blocks.

5.11.3.3 A balance accurate to 0.01 gram.

5.11.3.4 Thickness device consistent with Section 8.1.2

5.11.4 Test Specimens - Ten, 102 mm x 102 mm (4 in. by 4 in.) specimens handled in a manner to avoid loss of loose filler and weaving components.

5.11.5 Conditioning - Condition as in Section 8.1.1.

5.11.6 Procedure

5.11.6.1 For each specimen, raise the presser foot on the thickness device and place the specimen flat between the presser foot and the anvil.

5.11.6.2 Gently release the presser foot and allow it to rest on the specimen for 5 seconds.

5.11.6.3 Record the initial thickness, Ti, to the nearest .0254 mm (0.001 in.).

5.11.6.4 Place the specimen between the two No. 17 gage wire mesh screens that have been soaked in water for a minimum of 1 hour. Connect the

screen corners loosely to hold the test specimen in place without compressing the specimen material.

5.11.6.5 Immerse the test specimen in the screen assembly in de-ionized water for 24 ± 0.25 hours.

5.11.6.6 After the soaking period, remove the assembly from the water, rest it upon the blocks and allow it to drip-drain in a horizontal position for 10 minutes.

5.11.6.7 Remove the specimen from the screen and measure its thickness, Tf.
Note 7: Care should be exercised to maintain specimen integrity and preserve all material components during removal from screen supports. Lost specimen fibers, threads or other components may significantly impact final results.

5.11.6.8 Calculate the percent thickness change as follows:

% Thickness Change = 100((Tf-Ti)/Ti)

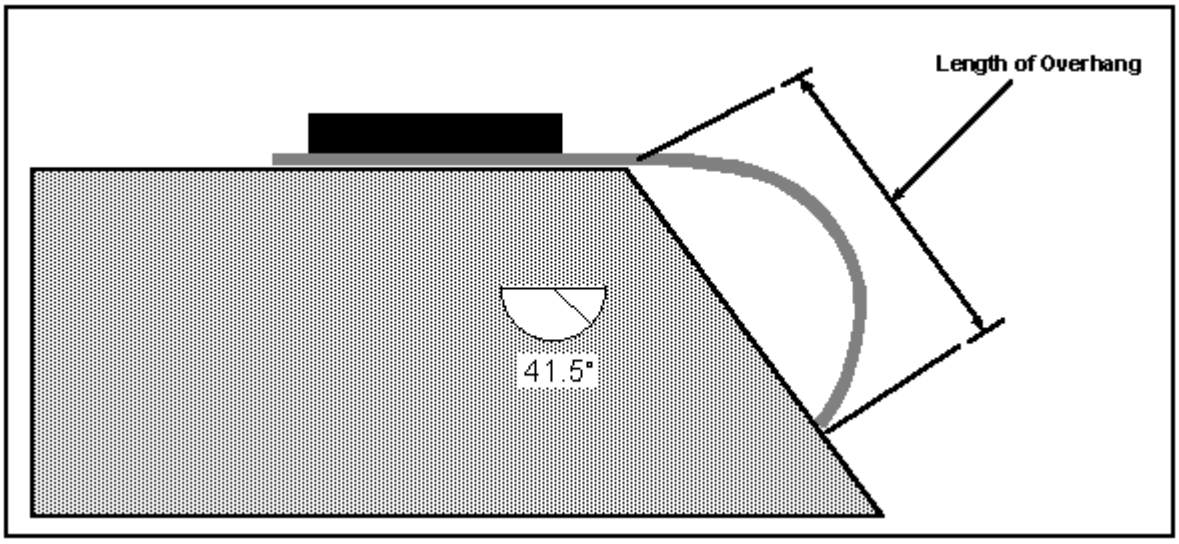
5.11.6.9 Repeat the procedure for all ten test specimens.

5.11.7 Report the percent change in thickness for each specimen along with the average and standard deviation of the test set.

5.12 Stiffness

5.12.1 Erosion control blankets – determine stiffness according to ASTM D1388.

5.12.2 Turf reinforcement mats – determine stiffness according to ASTM D6575.

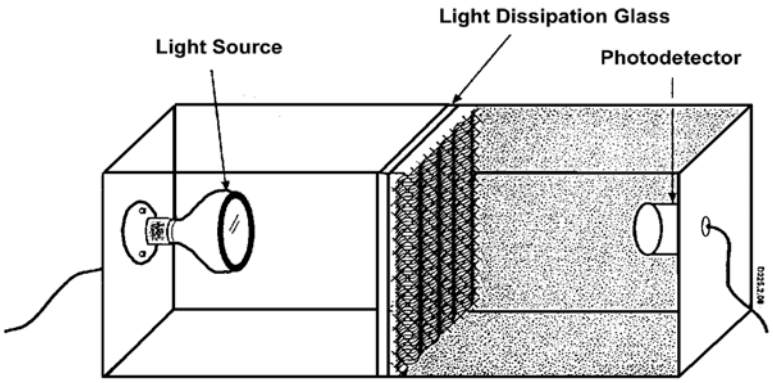


Stiffness Testing Apparatus (Cantilever Method)

5.13 Light Penetration

5.13.1 Erosion control blankets – determine the light penetration according to ECTC Guidelines.

5.13.2 Turf reinforcement mats – determine the light penetration according to ASTM D6567.



Light Penetration Test Apparatus

5.14 Smolder Resistance

5.14.1 Scope - This method details a procedure for the determination of the smoldering resistance of degradable rolled erosion control products.

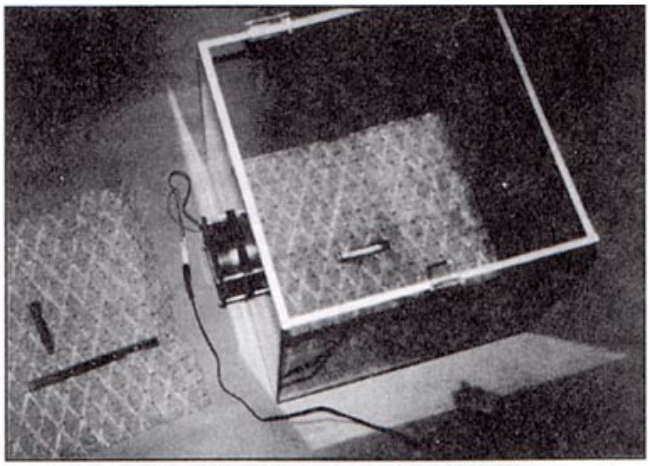
5.14.2 Summary - The distance between an extinguished cigarette and maximum smolder travel is measured to determine the smoldering resistance of the specimen.

5.14.3 Significance and Use - Degradable erosion control blanket materials may be susceptible to flammability caused by cigarettes. This is a concern during installation and use. This test method serves to provide an index reading of relative smolder resistance.

5.14.4 Apparatus

5.14.4.1 Fan capable of providing 50 feet per minute air velocity (recommended is Matsushita Electronics Model FBP-08B12L, 12 V dc brushless type).

5.14.4.2 Fire resistant square box having one cubic foot volume and two holes, three inches in diameter, bored through opposing walls and centered 3.5 inches above the bottom edge. Fan is installed in one hole. Hole opposite fan equipped with slotted cover plate attached flush against outer wall to act as a vent louvre. Additional cover plate is provided over fan opening to act as a restricting baffle to control flow and reduce turbulence.



Smolder Resistance Test Box

5.14.4.3 A 57 mm (2.25 in.) Camel Brand Unfiltered Cigarette.

5.14.4.4 Ruler accurate to 2.54 mm (0.1 in.).

5.14.5 Sampling - Sample test specimens from across the roll width to ensure representative specimen of the test material.

5.14.6 Test Specimens - Cut three, 305 mm x 305 mm (12 in. x 12 in.) test specimens. Handle the test specimens in a manner to avoid loss of loose filler and weaving components.

5.14.7 Conditioning - Condition test specimens for 12 hours in an air oven maintained at 45°C remove and equilibrate in laboratory test conditions for a minimum at 2 hours.

5.14.8 Procedure

5.14.8.1 Place test apparatus in hood or otherwise facilitate exhaust of generated smoke.

5.14.8.2 Place specimen flat on the base of the test box.

5.14.8.3 Set fan speed to facilitate an air velocity of 50 feet per minute across the center of the sample. Verify velocity with air velocity or wind speed meter.

5.14.8.4 Place a freshly lit cigarette in the center of the test specimen, with burning end facing the blower fan.

5.14.8.5 Allow the cigarette to burn completely and extinguish.

5.14.8.6 Upon extinguishment of the cigarette and sample, measure the maximum distance, in mm, of specimen smolder from the cigarette ashes.

5.14.8.7 Clean test apparatus and repeat test for each of two additional test specimens.

5.14.8.8 Report measurements developed for each test specimen as well as the average and standard deviation for the three specimen population.

5.15 Tensile Properties

5.15.1 Erosion control blankets – determine the breaking force and elongation in accordance with ASTM D5035.

5.15.2 Turf reinforcement mat – determine the breaking force and elongation in accordance with ASTM D6818.

5.15.3 Cut Strip test, except that the specimen size shall be 102 mm by 152 mm (4 in. by 6 in.). Cut strip test specimens representative of bulk material.

5.15.4 Perform testing using a loading rate of 300 ± 10 mm/min (12 ± 0.5 in./min) and initial grip separation (gage length) of 76 mm (3 in.).

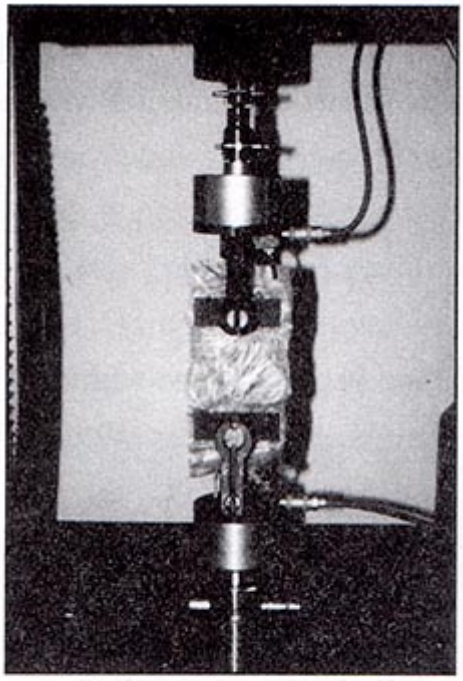
Note 8: ASTM D 5035 is considered an index test only. Results generated in accordance with this test may not correlate with tensile tests employing larger test specimens, such as ASTM D4595, or test specimens that have been soaked in water.

Note 9: Erosion control blanket products are typically constructed from several component materials, including fibers, yarns, weaving, stitching and loose fill materials.

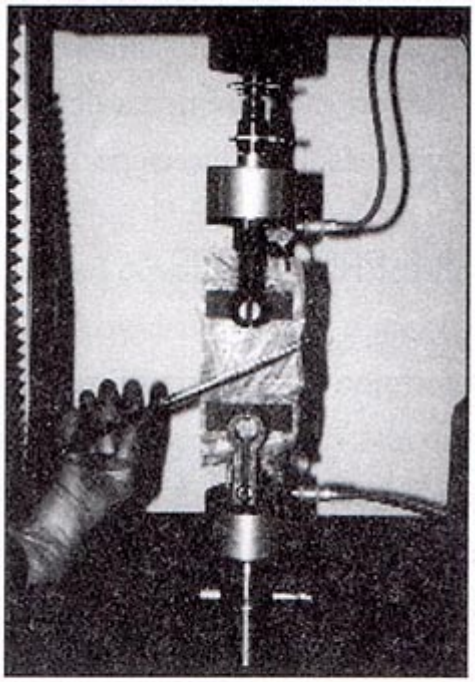
As any or each of the components may contribute to material tensile properties, it is mandatory to select tensile test specimens representative of the various components and their function within the bulk product. To this end, stitching(s) and other strength contribution components must be centered within the clamping mechanism prior to testing. Each tensile determination should be performed using the maximum number of strength contribution components

allowable within the tested region. Care must be taken to ensure that each specimen tested is the same in terms of material construction and configuration, i.e., includes the same number of ribs, yarns, stitching, or other strength contribution component.

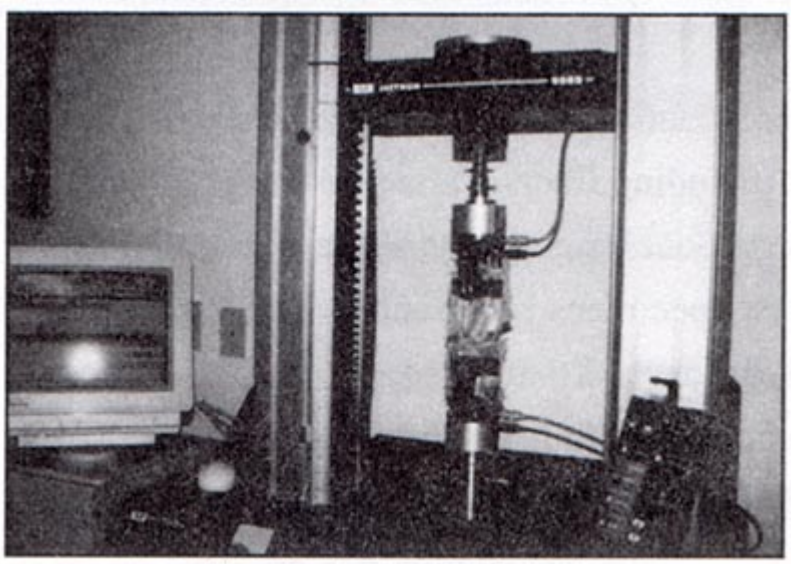
Note 10: Laboratory experience has shown that RECP materials are very sensitive to gripping procedures used during measurement of tensile properties. Great care must be taken to ensure uniform distribution of stress during tensile loading. Careful examination of material behavior during the test should be carried out to identify specimens exhibiting preferential or localized loading. If noted, these specimens should be discarded from the test population and additional specimens evaluated.



Slip support serves to guide undisturbed specimen into grips.



Slip support is cut to prevent tensile contribution.



Tensile test is initiated.

5.16 Compression Behavior

5.16.1 Determine the short-term compression behavior of turf reinforcement mats according to ASTM D6454.

6. REFERENCE DOCUMENTS

ASTM Method	Title
D543	Test Method for Resistance of Plastics to Chemical Reagents
D792	Specific Gravity and Density of Plastics by Displacement
D1117	Methods of Testing Nonwoven Fabrics
D1388	Test Methods for Stiffness of Fabrics
D1776	Standard Practice for Conditioning.
D1777	Standard Test Method for Measuring Thickness of Textiles
D4354	Standard Practice for Sampling of Geosynthetics for Testing
D4355	Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus
D4439	Standard Terminology for Geosynthetics
D4595	Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method
D5035	Test Method for Breaking Force and Elongation of Textile Fabrics
D5199	Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
D5261	Test Method for Measuring Mass per Unit Area of Geotextiles
D6454	Standard Test Method for Determining the Short-Term Compression Behavior of Turf Reinforcement Mats (TRMs)
D6475	Standard Test Method for Measuring Mass Per Unit Area of Erosion Control Blankets
D6459	Standard Test Method for Determination of Erosion Control Blanket (ECB) Performance in Protecting Hillslopes from Rainfall-Induced Erosion
D6460	Standard Test Method for Determination of Erosion Control Blanket (ECB) Performance in Protecting Earthen Channels from Stormwater-Induced Erosion
D6524	Standard Test Method for Measuring the Resiliency of Turf Reinforcement Mats
D6525	Standard Test Method for Measuring Nominal Thickness of Permanent Rolled Erosion Control Products
D6566	Standard Test Method for Measuring Mass Per Unit Area of Turf Reinforcement Mats
D6567	Standard Test Method for Measuring the Light Penetration of a Turf Reinforcement Mats
D6575	Standard Test Method for Determining Stiffness of Geosynthetics Used as Turf Reinforcement Mats
D6818	Standard Test Method for Ultimate Tensile Properties of Turf Reinforcement Mats
D7207	Standard Test Method for Determination of Unvegetated Rolled Erosion Control Product (RECP) Ability to Protect Sand from Hydraulically-Induced Shear Stresses under Bench-Scale Conditions