Standard Practice for

Determination of Long-Term Strength for Geosynthetic Reinforcement

AASHTO Designation: R 69-20[1]

Technical Subcommittee: 4e, Joints, Bearings, and Geosynthetics

Release: Group 2 (June)

American Association of State Highway and Transportation Officials
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INTRODUCTION

Through this protocol, the long-term strength and stiffness of geosynthetic reinforcements can be determined. This protocol contains test and evaluation procedures to determine reduction factors for installation damage, creep, and chemical/biological durability, as well as the method to combine these factors to determine the long-term strength. The long-term strength and stiffness values determined from this protocol can be used as input values for geosynthetic structure designs conducted in accordance with *AASHTO LRFD Bridge Design Specifications* and related Federal Highway Administration (FHWA) design guidelines. The long-term strength and stiffness values determined from this protocol can also be compared to the required design strength and stiffness values provided in the contract for the geosynthetic structure(s) in question to determine whether the selected product meets the contract requirements. This protocol can be used for product qualification or acceptance (e.g., for inclusion in a Qualified Products List), or for verification to facilitate periodic review of products for which the long-term strength has been previously determined using this standard practice.

1. SCOPE

1.1. This protocol has been developed to address polypropylene (PP), polyethylene (PE or HDPE), and polyester (PET) geosynthetics. See Section 3.1 for definitions of geosynthetic reinforcement and types of geosynthetics addressed in this standard practice. For other geosynthetic polymers [(e.g., polyamide (PA) or polyvinyl alcohol (PVA)], the installation damage and creep protocols provided herein are directly applicable. While the chemical and biological durability procedures and criteria provided herein may also be applicable to other polymers (for example, hydrolysis testing as described in Annex C is likely applicable to PA and PVA geosynthetics), additional investigation will be required to establish a detailed protocol and acceptance criteria for these other polymers. These other polymers may be considered for evaluation using this protocol once modifications to the chemical/biological durability aspects of this protocol have been developed and are agreed on by the approval authority.

1.2. The values stated in SI units are to be regarded as the standard.

1.3. *This standard may involve hazardous materials, operations, and equipment. This standard does not propose to address all safety problems associated with its usage. It is the duty and responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

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2. REFERENCED DOCUMENTS

2.1. *AASHTO Standards and Specifications*:

- T 96, Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
- *AASHTO LRFD Bridge Design Specifications*

2.2. *ASTM Standards*:

- D1248, Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
- D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)
- D2837, Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
- D3045, Standard Practice for Heat Aging of Plastics Without Load
- D3083, Specification for Flexible Poly (Vinyl Chloride) Plastic Sheeting for Pond, Canal, and Reservoir Lining (withdrawn 1998)
- D4101, Standard Classification System and Basis for Specification for Polypropylene Injection and Extrusion Materials
- D4355/D4355M, Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc-Type Apparatus
- D4595, Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method
- D4603, Standard Test Method for Determining Inherent Viscosity of Poly(Ethylene Terephthalate) (PET) by Glass Capillary Viscometer
- D5261, Standard Test Method for Measuring Mass per Unit Area of Geotextiles
- D5262, Standard Test Method for Evaluating the Unconfined Tension Creep and Creep Rupture Behavior of Geosynthetics
- D5322, Standard Practice for Laboratory Immersion Procedures for Evaluating the Chemical Resistance of Geosynthetics to Liquids
- D5818, Standard Practice for Exposure and Retrieval of Samples to Evaluate Installation Damage of Geosynthetics
- D6637/D6637M, Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method
- D6992, Standard Test Method for Accelerated Tensile Creep and Creep-Rupture of Geosynthetic Materials Based on Time-Temperature Superposition Using the Stepped Isothermal Method
- D7409, Standard Test Method for Carboxyl End Group Content of Polyethylene Terephthalate (PET) Yarns

2.3. *Other Standards*:

- ISO 13438:2004(en), Geotextiles and geotextile-related products—Screening test method for determining the resistance to oxidation
- GRI-GG8, Determination of the Number Average Molecular Weight of PET Yarns Based on a Relative Viscosity Value
- ISO 10319:2008, Geosynthetics—Wide-width tensile test
- ISO/DIS 10722:2007, Geosynthetics—Index test procedure for the evaluation of mechanical damage under repeated loading. Part 1: Installation in granular materials

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- ISO/FDIS 9080:2012, Plastic piping and ducting systems—Determination of long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation

3. TERMINOLOGY

3.1. *Definitions*:

3.1.1. *apertures*—the open spaces formed between the interconnected network of longitudinal and transverse ribs of a geogrid.

3.1.2. d_{50}—the grain size at 50 percent passing by weight for the backfill.

3.1.3. *effective design temperature*—the temperature that is halfway between the average yearly air temperature and the normal daily air temperature for the warmest month at the geosynthetic structure site.

3.1.4. *geogrid*—geosynthetic formed by a regular network of integrally connected elements with apertures greater than 6.3 mm (¼ in.) to allow interlocking with surrounding soil, rock, earth, and other surrounding materials to function primarily as reinforcement.

3.1.5. *geostrip*—polymeric material in the form of a strip (also sometimes called a polymer strap) of width not more than 200 mm (8 in.), used in contact with soil or other materials in geotechnical and civil engineering applications, or both.

3.1.6. *geosynthetic reinforcement*—geogrids, geostrips, and geotextiles that reinforce soil or aggregate for retaining walls, soil slopes, and embankments.

3.1.7. *geotextile*—permeable geosynthetic comprised solely of textiles.

3.1.8. *HDPE*—high-density polyethylene.

3.1.9. *hydrolysis*—the reaction of water molecules with the polymer material, resulting in polymer chain scission, reduced molecular weight, and strength loss.

3.1.10. *in-isolation testing*—geosynthetic testing in which the specimen is surrounded by air or a fluid (not soil).

3.1.11. *installation damage*—damage to the geosynthetic, such as cuts, holes (geotextiles only), abrasion, fraying, etc., created during installation of the geosynthetic in the backfill soil.

3.1.12. *load level*—for creep or creep-rupture testing, the load applied to the test specimen divided by T_{lot}, the short-term ultimate strength of the lot or roll/coil of material used to form the creep testing.

3.1.13. *MARV*—the minimum average roll value for the geosynthetic, defined as two standard deviations below the mean for the product (i.e., 97.5 percent of all test results will meet or exceed the MARV). For practical purposes, from the user's viewpoint, the average for a sample taken from any roll/coil in the lot shipped to the job site should meet or exceed the MARV.

3.1.14. *minimum value*—the lowest sample value from documented manufacturing quality control test results for a defined population from one test method associated with one specific property.

3.1.15. *MSE*—mechanically stabilized earth.

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3.1.16. *oxidation*—the reaction of oxygen with the polymer material, initiated by heat, UV radiation, and possibly other agents, resulting in chain scission and strength loss.

3.1.17. *PET*—polyester.

3.1.18. *postconsumer recycled material*—polymer products sold to consumers that have been returned by the consumer after use of the products for the purpose of recycling.

3.1.19. *PP*—polypropylene.

3.1.20. *primary and secondary products*—for product line characterization purposes, the primary product is the product in which the full suite of index and performance level tests are conducted to characterize the product line, whereas the secondary products are those used to characterize the consistency of the properties throughout the range of products included in the line (or to facilitate the interpolation of those properties to products in the line not specifically tested) using a limited suite of index and performance level tests.

3.1.21. *product line*—a series of products manufactured using the same polymer (including stabilizers) in which the polymer for all products in the line comes from the same source and/or is purchased or manufactured by the geosynthetic manufacturer using the same property and material specifications for the base polymer plus additives, the manufacturing process is the same for all products in the line, and the only difference is in the product weight/unit area or number of fibers contained in each reinforcement element.

3.1.22. *product qualification testing*—testing used to establish the acceptability of the product or product line by an agency prior to shipment or use of the product in a specific project (e.g., as the basis for adding the product to the agency's qualified or approved products list).

3.1.23. *product verification testing*—testing used to verify that the product or product line has not changed since being tested for product qualification (e.g., as the basis for allowing the product or product line to remain on the agency's qualified or approved products list).

3.1.24. *QPL*—qualified products list.

3.1.25. *RF*—combined reduction factor to account for long-term degradation due to installation damage, creep, and chemical/biological aging.

3.1.26. RF_{CR}—strength reduction factor to prevent long-term creep rupture of the reinforcement.

3.1.27. RF_D—strength reduction factor to prevent rupture of the reinforcement due to long-term chemical and biological degradation.

3.1.28. RF_{ID}—strength reduction factor to account for installation damage to the reinforcement.

3.1.29. *sample*—a portion of material that is taken for testing or for record keeping purposes, from which a group of specimens can be obtained to provide information that can be used for making statistical inferences about the population(s) from which the specimens are drawn.

3.1.30. *specimen*—a specific portion of a material or laboratory sample on which a test is performed or that is taken for that purpose.

3.1.31. *survivability*—the ability of a geosynthetic to survive a given set of installation conditions with an acceptable level of damage.

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