INTERNATIONAL

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Standard Guide for Use and Application of Geosynthetic Reinforcement Reduction Factor Test Results[1]

This standard is issued under the fixed designation D8105; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide presents a description of how to use test results from reduction factor test reports for reinforcement geosynthetics. It is based solely on testing and reporting requirements as established in American Association of State Highway and Transportation Officials (AASHTO) standard AASHTO R 69-15, Standard Practice for Determination of Long-Term Strength for Geosynthetic Reinforcement. AASHTO R 69-15 is used to determine the long-term allowable material strength, T_{al}, that is solely product property performance dependant.

1.2 This guide is intended to assist designers and users of reinforcement geosynthetics when reviewing reports of reduction factor testing efforts. This guide is not intended to replace education or experience, or other alternative design procedures. This guide is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. Not all aspects of this guide may be applicable in all circumstances. The word "standard" in the title of this document means only that the document has been approved through the ASTM consensus process.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D4355/D4355M Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc-Type Apparatus

D4595 Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method

D4603 Test Method for Determining Inherent Viscosity of Poly(Ethylene Terephthalate) (PET) by Glass Capillary Viscometer

D5262 Test Method for Evaluating the Unconfined Tension Creep and Creep Rupture Behavior of Geosynthetics

D5721 Practice for Air-Oven Aging of Polyolefin Geomembranes

D5818 Practice for Exposure and Retrieval of Samples to Evaluate Installation Damage of Geosynthetics

D6637/D6637M Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method

D6992 Test Method for Accelerated Tensile Creep and Creep-Rupture of Geosynthetic Materials Based on Time-Temperature Superposition Using the Stepped Isothermal Method

D7409 Test Method for Carboxyl End Group Content of Polyethylene Terephthalate (PET) Yarns

2.2 *AASHTO Standard:*[3]

AASHTO R 69-15 Standard Practice for Determination of Long-Term Strength for Geosynthetic Reinforcement

[1] This guide is under the jurisdiction of ASTM Committee D35 on Geosynthetics and is the direct responsibility of Subcommittee D35.01 on Mechanical Properties.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American Association of State Highway and Transportation Officials (AASHTO), 444 N. Capitol St., NW, Suite 249, Washington, DC 20001, http://www.transportation.org.

2.3 *ISO Standards:*[4]

ISO EN 13437 Geotextiles and Geotextile-Related Products—Method for Installing and Extracting Samples in Soil, and Testing Specimens in Laboratory

ISO EN 13438 Geotextiles and Geotextile-Related Products—Screening Test Method for Determining the Resistance to Oxidation

3. Terminology

3.1 *Definitions:*

3.1.1 *product line*—a series of products manufactured using the same manufacturing equipment and procedures. The base polymer/fiber and additives for all products in the line come from the same source or are purchased or manufactured by the supplier using the same polymer/fiber material and additive specifications, or both. Manufacturers using multiple sources for base polymer/fiber may document through performance testing that the resulting end-product performance is the same. Provided this definition is met, it should be feasible to interpolate between the products actually tested to the products not specifically tested for a given test property.

3.1.2 *reduction factor*—in design, a calculated factor based on results of testing, to determine the reduced property of a geosynthetic product due to degradation over a period of time, or damage as installed.

3.2 *Abbreviations:*

3.2.1 RF_{CR}—a reduction factor that accounts for the effect of creep on tensile strength at the end of a specified design life, resulting from long-term sustained tensile load applied to the geosynthetic.

3.2.2 RF_D—a reduction factor that accounts for the strength loss caused by chemical degradation of the polymer used in the geosynthetic reinforcement (for example, oxidation of polyolefins, hydrolysis of polyesters, etc.), and the effects of biological degradation or microbial organism attack.

3.2.3 RF_{ID}—a reduction factor that accounts for the damaging effects of placement and compaction of soil or aggregate over the geosynthetic during installation.

3.2.4 $T_{baseline}$—the unexposed, as-manufactured tensile strength for the product sample used for product evaluation.

3.2.5 T_{ult}—the ultimate wide-width tensile strength of the reinforcement determined per Test Method D4595 or D6637/D6637M.

4. Significance and Use

4.1 The long-term material strength of geosynthetic reinforcement material is a critical design parameter for many civil engineering projects including, but not limited to, reinforced wall structures and reinforced slopes. Geosynthetic reinforcement products are produced using a variety of polymeric materials and using a variety of manufacturing procedures. Accordingly, product-specific testing using representative produced products is recommended for establishment of long-term material strength for products used as reinforcement in structures.

4.2 The primary use of the test results obtained from a reinforcement testing program is to determine the available long-term (that is, end of design life, typically 75 years) material strength, T_{al}, of the reinforcement. The available long-term strength, T_{al}, is calculated as follows:

$$T_{al} = \frac{T_{ult}}{RF_{ID} \times RF_{CR} \times RF_D} \quad (1)$$

4.3 This long-term geosynthetic reinforcement strength concept is illustrated in Fig. 1. As shown in the figure, some strength losses occur immediately upon installation, and others occur throughout the design life of the reinforcement. Much of the long-term strength loss does not begin to occur until near the end of the reinforcement design life.

4.4 The value selected for T_{ult}, for design purposes, is the minimum average roll value (MARV) for the product. This minimum average roll value, denoted as T_{MARV}, accounts for statistical variance in the material strength. Other sources of uncertainty and variability in the long-term strength result from

[4] Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, http://www.iso.org.

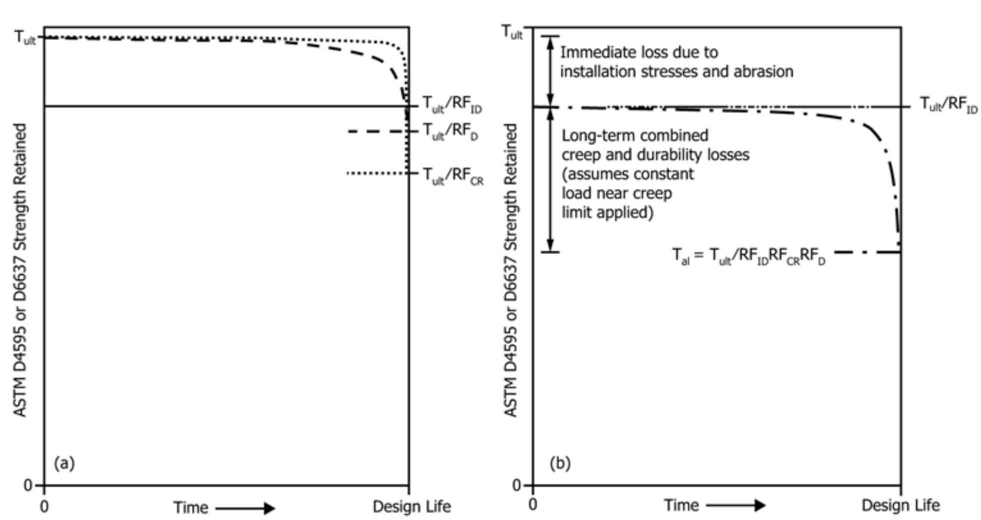


FIG. 1 Long-Term Geosynthetic Strength Concepts

installation damage, creep extrapolation, and the chemical degradation process. It is assumed that the observed variability in the creep rupture envelope is 100 % correlated with the short-term tensile strength, as the creep strength is typically directly proportional to the short-term tensile strength within a product line. Therefore, the MARV of T_{ult} adequately takes into account variability in the creep strength.

4.5 In accordance with AASHTO R 69-15, the test program results provided in geosynthetic reinforcement design reduction factor test reports are focused on characterization of the product line, specifically testing representative products within the product line to accomplish that characterization.

4.6 The guidelines provided in this document explain how to use the test data to characterize the entire product line with regard to long-term strength and durability properties.

5. Use of Geosynthetic Reinforcement Reduction Factor Test Data

5.1 A comprehensive test report for geosynthetic reinforcement reduction factors, developed in accordance with AASHTO R 69-15, provides both index test and performance test results. A summary of specific guidelines in AASHTO R 69-15 for the application of the test results to develop reduction factors is provided in the sections that follow.

5.2 *Determination of RF_{ID}:*

5.2.1 The determination of RF_{ID}, performed in accordance with Practice D5818, can either be targeted to a characteristic backfill particle size that is consistent with a project's designated reinforced soil backfill material, or, RF_{ID} can be targeted to the characteristic reinforced backfill particle size for a project-specific backfill. The installation damage test results can be used for either approach.

5.2.2 The effect of installation damage on the tensile strength of a geosynthetic reinforcement product is assessed by comparing the damaged strength of the product (that is, the strength of the product after exhuming it from the soil after it has been installed) to the roll-specific tensile virgin (that is, undamaged) strength of the product sample used for this installation damage evaluation. This undamaged tensile strength measured prior to installation is termed $T_{baseline}$, and is considered the baseline tensile strength for the product sample used for this evaluation in the test program.

5.2.3 The degree of installation damage is quantified in AASHTO R 69-15 using the following equation:

$$P = \frac{T_{dam}}{T_{baseline}} \times 100 \tag{2}$$

where:

P = the percentage of strength retained after exposure to installation (that is, installation damage),

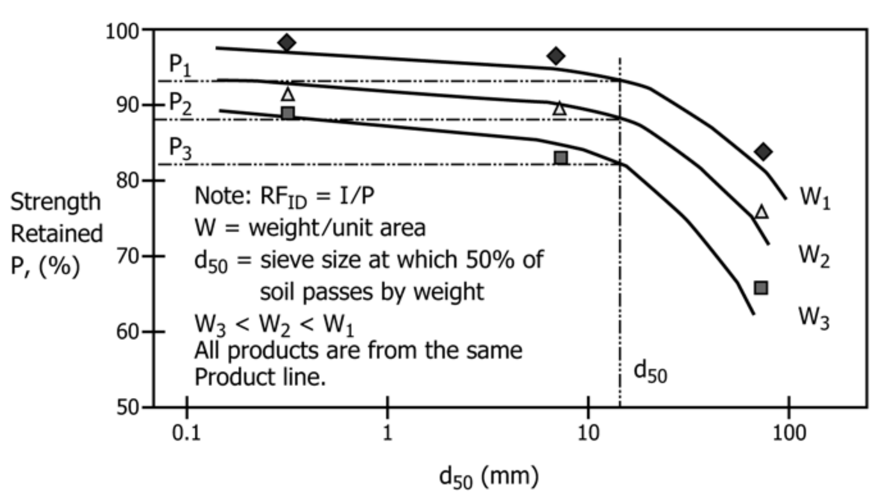
T_{dam} = the tensile strength of the material after exposure to installation (that is, in a damaged condition), and

$T_{baseline}$ = the roll-specific tensile strength of the material used in the installation damage tests. This "baseline" strength is the strength prior to exposing the material to installation.

5.2.4 All three values for each product and condition tested, and associated statistics, are provided in a test report. Example installation damage test results are provided in Figs. 2 and 3.

5.2.5 Note that some products will not always have a strong relationship between the weight or strength of the product and the degree of measured installation damage that is illustrated in Figs. 2 and 3. For example, the robustness of the coating or polymer structure may control the degree of damage observed.

5.2.6 Figs. 4 and 5 provide an example of this. Trend lines for the mean, upper bound, and lower bound for the combination of all the products in the product line tested are shown in Fig. 4 to illustrate the general trend in the data. From these trend lines, a mean or minimum value at a characteristic gradation parameter such as d_{50} can be determined as illustrated in Figs. 4 and 5. The installation reduction factor can



From AASHTO R 69-15.

FIG. 2 Example of Installation Damage Data for Several Products That Represent a Product Line, from Testing, When a Strong Relationship Between a Product Index Property and Strength Retained is Observed