



# Standard Practice for Tests to Evaluate the Chemical Resistance of Geogrids to Liquids<sup>1</sup>

This standard is issued under the fixed designation D 6213; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This practice covers the procedures for testing of geogrids for chemical resistance to liquids.

1.2 This practice describes methods for measuring changes in physical and mechanical properties caused by immersion in test solutions that may be representative of anticipated end-use conditions.

1.3 This practice describes procedures for required and recommended testing of geogrids.

1.4 Evaluation or interpretation of test data is beyond the scope of this practice.

1.5 This practice is intended to be used in conjunction with D 5322, or D 5496, or both. The scope of this practice is limited to testing and reporting procedures for unexposed and exposed geogrid coupons.

1.6 *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 and health practices and determine the applicability of regulatory limitations prior to use.* Specific precautionary statements are given in Section 7.

## 2. Referenced Documents

### 2.1 ASTM Standards:

D 76 Specifications for Tensile Testing Machines for Textiles<sup>2</sup>

D 883 Terminology Relating to Plastics<sup>3</sup>

D 1238 Test Method for Flow Rates of Thermoplastics by Extrusion Plastomer<sup>3</sup>

D 1600 Terminology for Abbreviated Terms Relating to Plastics<sup>3</sup>

D 4439 Terminology for Geosynthetics<sup>4</sup>

D 4595 Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method<sup>4</sup>

D 4603 Test Method for Determining the Inherent Viscosity

of Poly(ethylene terephthalate) (PET)<sup>5</sup>

D 5322 Practice for Immersion Procedures for Evaluating the Chemical Resistance of Geosynthetics to liquids<sup>4</sup>

D 5496 Practice for In-Situ Immersion Procedures for Evaluating the Chemical Resistance of Geosynthetics to Liquids<sup>4</sup>

## 3. Terminology

### 3.1 Definitions:

3.1.1 *chemical resistance, n*—for geosynthetics, the extent to which a material or product retains its original physical and chemical characteristics as a function of immersion in, or contact with, a foreign substance. **(D 5747, D-35)**

3.1.2 *coating, n*—a liquid, liquefiable or mastic composition that is converted to a solid protected, decorative, or functional adherent film after application as a thin layer. **(D 16, D-1)**

3.1.3 *coupon, n*—a portion of a material or laboratory sample, from which multiple specimens can be taken for testing. **(D 5747, D-35)**

3.1.4 *composite, n*—a material made up of distinct parts which contribute, either proportionately, or synergistically, to the properties of the combination. **(E 375, D-20)**

3.1.5 *geogrid, n*—a reinforcing geosynthetic comprised of integrally connected elements with in-plane apertures between elements. **(D 4439, D-35)**

3.1.6 *geosynthetic, n*—a planar product manufactured from polymeric material used with soil, rock, earth, or other geotechnical engineering related material as an integral part of a man made project, structure, or system. **(D 4439, D-35)**

3.1.7 *inherent viscosity*—the quotient of the natural logarithm of relative viscosity by the concentration, that is in  $\eta_{rel}/c$ . **(D 1695, D-1)**

3.1.8 *integral, adj*—in geosynthetics, forming a necessary part of the whole; a constituent. **(D 4439, D-35)**

3.1.9 *relative viscosity*—the ratio of the viscosity of a solution to that of the pure solvent. **(D 1695, D-1)**

3.1.10 *melt index, n*—the flow rate of PE material when measured in accordance with Test Method D 1238.

3.1.11 *polyester, n*—a polymer in which the repeated structural unit in the chain is of the ester type. **(D 883, D-20)**

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee D-35 on Geosynthetics and is the direct responsibility of Subcommittee D35.02 on Endurance Properties.

Current edition approved Dec. 10, 1997. Published June 1998.

<sup>2</sup> Annual Book of ASTM Standards, Vol 07.01.

<sup>3</sup> Annual Book of ASTM Standards, Vol 08.01.

<sup>4</sup> Annual Book of ASTM Standards, Vol 04.13.

<sup>5</sup> Annual Book of ASTM Standards, Vol 08.03.

3.1.12 *polyolefin, n*—a polymer prepared by the polymerization of an olefin(s) as the sole monomer(s). (D 883, D-20)

3.1.13 *sample, n*—a portion of a lot of material that is taken for incubation, testing, or for record purposes. (D 123, D-13)

3.1.14 *specimen, n*—a specific portion of a material or laboratory sample upon which a test is performed or which is taken for that purpose. (D 4439, D-35)

#### 4. Summary of Practice

4.1 This practice defines test methods and procedures for evaluating the resistance of geogrids to liquid exposure by monitoring physical and chemical properties of geogrid coupons after immersion in a test liquid. The physical condition of the geogrid is monitored as a function of cumulative exposure time by means of visual observations, and mechanical and chemical property tests.

#### 5. Significance and Use

5.1 This practice is intended to provide a list of standard procedures for test programs investigating the chemical resistance of a geogrid to a liquid. This practice should be used in the absence of other specifications required for the particular situation being addressed.

5.2 This practice is intended to provide a basis of standardization for those wishing to compare or investigate the chemical resistance of a geogrid. It should be recognized that chemical resistance is a user judgment evaluation and that this practice does not offer procedures for interpreting the results obtained from test procedures contained in this practice. As a practice, this does not produce a test result.

5.3 This practice is for the chemical resistance assessment of geogrids and is written in parallel to similar practices for geomembranes, geotextiles, geonets, and geopipes. Each practice is to be considered individually for the geosynthetic under investigation and collectively for all geosynthetics exposed to the potentially harsh chemical environment under consideration.

#### 6. Apparatus

6.1 *Tensile Testing Machine*—A constant-rate-of-extension (CRE) or constant-rate-of-traverse (CRT) type with autographic recorder conforming to the requirements of Specification D 76 shall be used.

6.2 *Testing Clamps*—These clamps shall be sufficiently wide to grip the entire rib specimen and with appropriate clamping power to prevent slipping or crushing (damage). The suggested style of clamp is wedge action type, commonly available from the manufacturer of the tensile testing machine.

6.3 All other required equipment is specified in the referenced test method standards. Refer to the appropriate standards for a description of the apparatus necessary to perform those tests.

#### 7. Hazards

7.1 Geogrids may be exposed to liquids that may contain hazardous chemicals. Appropriate precautions must be taken when handling hazardous waste, chemicals, and the immersion solutions. Protective equipment suitable for the chemicals being used must be worn by all personnel handling or exposed

to the chemicals. Particular care should be taken when opening storage vessels at elevated temperatures due to the increased volatility of organics and the increased activity of acids and bases. Care must also be taken to prevent the spilling of hazardous materials and provisions must be made to clean up any accidental spills that do occur.

7.2 Before carrying out any test, safety precautions and disposal procedures for hazardous waste, chemicals or immersion liquids, and any contaminated geogrid materials should be identified and implemented to provide full protection to all personnel and to comply with applicable disposal regulations.

#### 8. Sample Preparation

8.1 Sample product as received.

#### 9. Sampling

9.1 *Geogrid*:

9.1.1 Determine the number and dimensions of the test specimens according to the requirements of property tests, listed in Section 14, to be performed, the duration of the immersion, and the number of test intervals.

9.1.2 *Sample*—Sample in accordance with the respective test methods selected for the geogrid.

9.1.3 *Coupons*—Cut coupons from geogrid sample representative of the geogrids being evaluated so as to provide a sufficient number of specimens for each chosen property test and test interval. Discard any coupons that contain scratches or other imperfections that might affect the test results, and cut replacement coupons.

9.1.4 Mix the selected coupons in a random fashion and re-select coupons for the immersion and baseline testing.

9.1.5 *Specimens*—After exposure, test specimens are cut from the coupons.

9.1.6 Interrelationship between product, sample, coupon, and specimen is illustrated in Fig. 1.

9.2 *Test Liquid*—Follow procedures established in Practice D 5322, Section 6.

#### 10. Conditioning Before Immersion

10.1 *Geogrids*—Condition samples at  $21 \pm 2^\circ\text{C}$  ( $70 \pm 4^\circ\text{F}$ ) and a relative humidity between 50 and 70 % for not less than 40 h prior to weighing or baseline testing and immersion, or all of these.

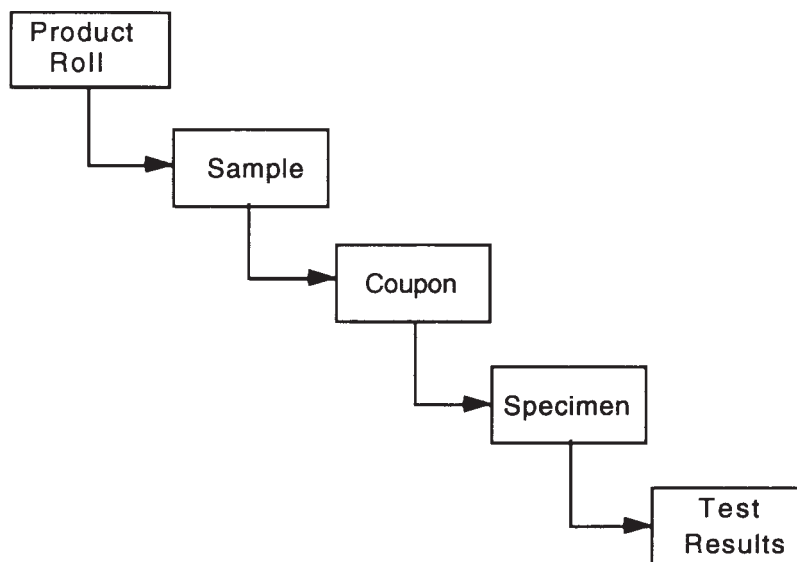
10.2 *Test Liquid*—Condition the test liquid (that is, immersion liquid) in the exposure tank, with stirring, for a period of not less than 24 h at a recommended immersion temperature in Practice D 5322 or Practice D 5496, or both.

#### 11. Procedure

11.1 *Geogrid*:

11.1.1 Immerse a sufficient number of coupons in the test solution as specified in Practice D 5322 or Practice D 5496, or both, to perform the required statistical testing for each immersion period called for in 11.4.

11.1.2 Immerse additional coupons for weight changes and volatile loss during each immersion period. Record the weight of the coupon to an accuracy of at least 0.1 % of the coupon's weight.



NOTE—Roll product is supplied by the manufacturer. Samples are cut from the roll product. Coupons are cut from samples and immersed in liquid. Specimens are cut from coupons for testing.

FIG. 1 Relationship Between Roll, Sample, Coupon, and Specimen

11.1.3 Remove the required and recommended number of coupons for testing at the prescribed test period. Elevated temperature coupons should be allowed to cool to room temperature in a sample of the immersion fluid. Rinse each coupon with de-ionized water and remove any visible liquid residue on the coupon surface by blotting lightly with water-absorbent, lint free paper towels. Coupons should be stored in a sealed container with minimum void volume so as to minimize moisture or volatile(s) loss, or both.

NOTE 1—The prescribed test period is to be determined by the parties involved.

NOTE 2—Coupons sealed in a zip-lock polyethylene bags and then placed within a container to shield against ultraviolet exposure has been an acceptable practice.

11.2 *Test Liquid*—Maintain test liquid chemistry and concentration as established in Practice D 5322 or Practice D 5496, or both.

11.3 *Test Specimen Preparation:*

11.3.1 Remove coupons, one at a time, from storage in the same order that they entered storage; that is, first in becomes first out.

11.3.2 Cut test specimens from coupons.

11.3.3 Between tests, specimens should be kept in an airtight container.

11.4 The tests to be performed on a geogrid are listed in Section 16. All tests should be completed on the exposed specimens after each test period. Only one set of tests must be completed on the unexposed specimens to establish a baseline of data. For the initial data base, twice as many specimens as listed below should be tested on the unexposed material in order to produce a statistical base.

11.5 Testing of the material exposed to the leachate must be done within 24 h of removal from the test solution.

12. Required Product Testing

12.1 *Visual Observations*—Written description of the samples before and after immersion. Visual appearance can help in the interpretation of the data and may explain anomalous test results. Appearance items to be considered may include change from original color, including any mottling, change in surface gloss, change in surface roughness, swelling or other change at the edges of the specimen, scratches, scoring, fracture initiation, or splitting of specimen into separate parts, and gross specimen changes such as wrinkling, dimensions, or noticeable curling.

12.2 *Tensile Testing Options:*

12.2.1 *Rib Tensile Test (Option 1):*

12.2.1.1 Calibrate and balance the tensile testing system.

12.2.1.2 Mount the specimen centrally in the clamps and tighten sufficiently to prevent damage to the specimen.

12.2.1.3 Set the CRE to be 50 mm/min. (2 in./min.).

12.2.1.4 Rebalance the test system and initiate the test by starting the testing machine and continue running until rupture occurs. Record and report the tensile vs. elongation response up to, and including failure.

12.2.1.5 Repeat 12.2.1.2-12.2.1.4 until ten acceptable breaks have been obtained.

NOTE 3—If a specimen slips in the jaws, breaks at the edge of, or within the jaws, or if for any reason attributed to faulty operation, the results fall markedly below the average of the set of specimens, discard the result and test another specimen.

12.2.1.6 See 14.1 for calculating rib tensile strength.

12.2.2 *Wide Width Tensile Test (Option 2)*—Use Test Method D 4595, but modify for geogrids (that is, adjusted for width and gage length).

12.3 *Resin Properties:*

12.3.1 *Polyolefin Geogrids:*

12.3.1.1 *Melt Index:*

12.3.1.2 *Polyethylene*—Use Test Method D 1238 Condition 190/2.16.

12.3.1.3 *Polypropylene*—Use Test Method D 1238 Condition 230/2.16.

12.3.2 *Polyester Geogrids*:

12.3.2.1 *Inherent Viscosity*—Use Test Method D 4603 to evaluate the fibrous polyester substrate.

**13. Recommended Product Testing**

13.1 *Visual Observations*—Photographic record.

13.2 Record additional properties, such as stress and strain at peak and failure, as agreed upon between the parties involved.

**14. Calculation**

14.1 *Rib Tensile Strength*:

14.1.1 From the test data generated in 12.2, the average ultimate rib tensile strength “ $T_{rib}$ ” is calculated as:

$$T_{rib} = \sum_{i=1}^n T_i/n \tag{1}$$

where:

- $T_{rib}$  = average ultimate rib strength in kN (lb.),
- $T_i$  = ultimate test strength for each rib in kN (lb.), and
- $n$  = total number of test specimens (minimum of ten).

14.1.2 From the test data generated in 12.2, the average ultimate rib elongation, “ $E_{rib}$ ” is calculated as:

$$E_{rib} = \sum_{i=1}^n E_i/n \tag{2}$$

where:

- $E_{rib}$  = the average ultimate elongation in mm (in.),
- $E_i$  = ultimate test elongation for each rib in mm (in.), and
- $n$  = total number of test specimens (minimum of ten).

**15. Report**

15.1 State that the immersion procedure was performed as directed in Practice D 5322 or Practice D 5496.

15.2 *Geogrid*:

15.2.1 Describe the geogrid and its condition (for example, any imperfections such as scratches) prior to its immersion in the test liquid.

15.2.2 Describe the method used to sample the geogrid for evaluating chemical resistance to a test liquid.

15.3 *Conditioning*—Describe the conditioning of samples and test liquid.

15.4 *Test Liquid*:

15.4.1 Identify the chemistry of the test liquid (that is, immersion solution) and its concentration.

15.4.2 Describe the procedure for maintaining the chemistry and uniformity in concentration of the test liquid.

15.5 Report which test procedures, and any deviations from the procedures, that were used for evaluating the geogrid.

15.6 Report all raw data, averages, and standard deviations.

**16. Test Summary**

16.1 Table 1 summarizes the testing program outlined in this practice. Shading indicates required testing; non shading indicates recommended testing.

**17. Keywords**

17.1 chemical resistance; geogrids; geosynthetics; liquid waste

**TABLE 1 Testing Program Summary**

NOTE 1—Boldface indicates required testing; non-boldface indicates recommended testing.

Property Material	Polyolefin Geogrids	Polyester Geogrids
Visual Observations	<b>Section 12.1</b>	<b>Section 12.1</b>
	Written      Photographic	Written      Photographic
Mechanical Properties	<b>Section 12.2.1</b>	<b>Section 12.2.1</b>
	<b>Section 14.1</b>	<b>Section 14.1</b>
	or	or
	<b>Section 12.2.2</b> <b>Section 14.1</b>	<b>Section 12.2.2</b> <b>Section 14.1</b>
Melt Index	<b>Section 12.3.1</b>	Not Applicable
Inherent Viscosity	Not Applicable	<b>Section 12.3.2</b>

*ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.*

*This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.*

*This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org).*