Designation: D6241 – 22a

# Standard Test Method for Measuring Static Puncture Strength of Geotextiles and Geosynthetic-Related Products Using a 50 mm Probe[1]

This standard is issued under the fixed designation D6241; 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 test method is an index test used to measure the force required to puncture a geotextile and geotextile-related products with a 50 mm diameter cylindrical probe. The dimensions of the probe provide a multidirectional force on the geotextile.

NOTE 1—This test is also commonly known as CBR Puncture Test.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 *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.*

1.4 *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]

D76/D76M Specification for Tensile Testing Machines for Textiles

D123 Terminology Relating to Textiles

D1776/D1776M Practice for Conditioning and Testing Textiles

D1883 Test Method for California Bearing Ratio (CBR) of Laboratory-Compacted Soils

D4354 Practice for Sampling of Geosynthetics and Rolled Erosion Control Products (RECPs) for Testing

D4439 Terminology for Geosynthetics

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

NOTE 2—Test Method D1883 describes a mold (CBR mold) that can be used for this test method.

## 3. Terminology

3.1 *Definitions*—For definitions of other textile terms used in this test method, refer to Terminology D123. For definitions of other terms relating to geosynthetics used in this test method, refer to Terminology D4439.

## 4. Summary of Test Method

4.1 A test specimen is clamped without tension between circular plates and secured in a tensile or compression testing machine, or both. A force is exerted against the center of the unsupported portion of the test specimen by a cylindrical steel probe attached to the load indicator until rupture occurs. The maximum force is the value of puncture strength.

## 5. Significance and Use

5.1 Puncture using a 50 mm probe is applicable to determine the index strength resistance and deformation of a particular geotextile or geotextile-related products.

5.2 This test method is considered satisfactory for acceptance testing of commercial shipments of geotextiles.

5.3 In case of a dispute arising from differences in reported test results when using this test method for acceptance testing of commercial shipments, the purchaser and the supplier should conduct comparative tests to determine if there is a statistical bias between their laboratories. Competent statistical assistance is recommended for the investigation of bias. As a minimum, the two parties should take a group of test specimens that are as homogeneous as possible and that are from a lot of the type in question. The test specimens then should be randomly assigned in equal numbers to each laboratory for testing. The average results from the two laboratories should be compared using Student's t-test for unpaired data and an acceptable probability level chosen by the two parties before

[1] This test method 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.

the testing is begun. If a bias is found, either its cause must be found and corrected, or the purchaser and the supplier must agree to interpret future test results in light of the known bias.

5.4 This test method is not applicable to materials that are manufactured in sizes that are too small to be placed into the test apparatus in accordance with the procedures in this test method. Furthermore, it is not appropriate to separate plies of a geosynthetic or geocomposite for use in this test method.

## 6. Apparatus

6.1 *Testing Machine*—Types of tensile machines covered in this test method are constant-rate-of-extension or constant-rate-of-traverse, with autographic recorder conforming to the requirement of Specification D76/D76M.

6.2 *Probe*—A polished steel cylinder at least 150 mm long, with a flat diameter of 50 ± 1 mm and a radial edge of 2.5 ± 0.5 mm. See Fig. 1.

6.3 *Clamping Apparatus,* consisting of concentric plates with an internal diameter of 150 mm (5.9 in.), capable of clamping the specimen to prevent slippage. The external diameter is suggested to be 250 mm (9.8 in.). The diameter of the holes used for securing the ring clamp assemblage is suggested to be 11 mm (7⁄16 in.) and equally spaced at a diameter of 220 mm (8.7 in.). The clamping surfaces of the ring plates shall be machined to limit slippage to less than 5 mm; see Note 3. It is suggested that 9.5 mm (3⁄8 in.) bolts be welded to the bottom plate so that the top plate can be placed over the bolts and nuts and easily tightened. A guide block may be used to help seat the material being clamped. Other clamps that eliminate slippage are acceptable. See Figs. 2-4.

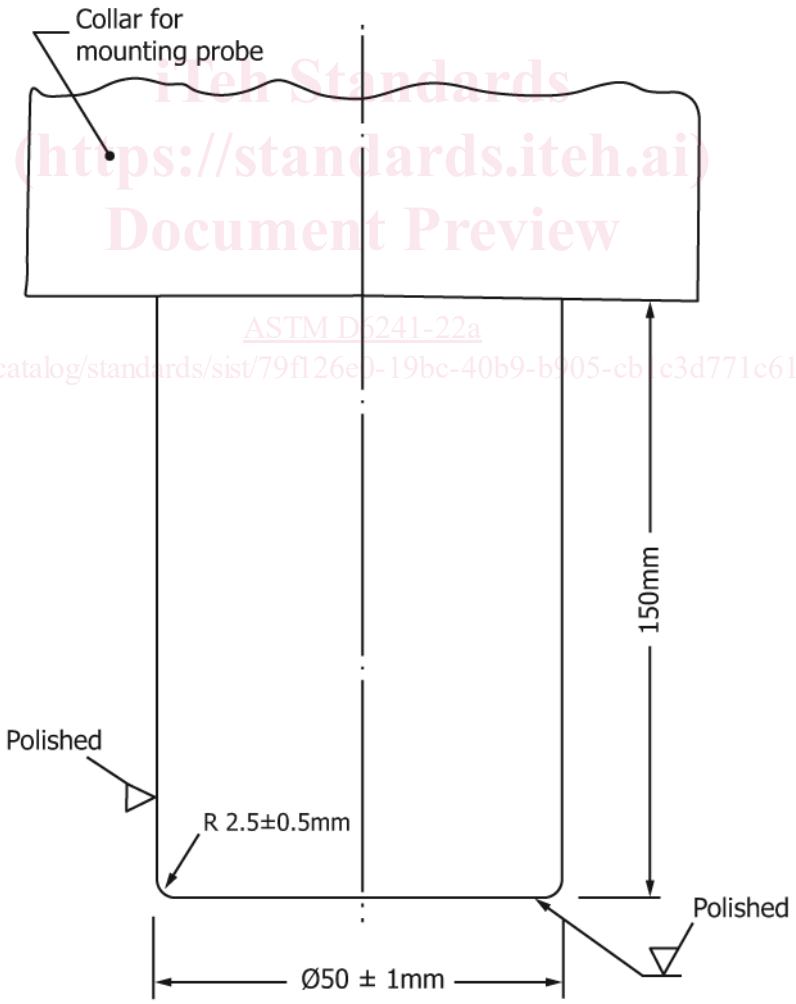
NOTE 3—Common methods of machining the grip surfaces of the clamping plates include: spiral or concentric serrations, knurling, grooves with rubber O-rings, or bonding sandpaper to the opposing surfaces.

## 7. Sampling and Selection of Specimens

7.1 *Lot Sample*—In the absence of other guidelines, divide the product into lots and take lot samples as specified in Practice D4354.

7.2 *Laboratory Sample*—Consider the units in the lot sample as the units in the laboratory sample. For the laboratory






NOTE 1—All dimensions are in millimetres.
NOTE 2—This diagram is not to scale.

**FIG. 1 Probe**

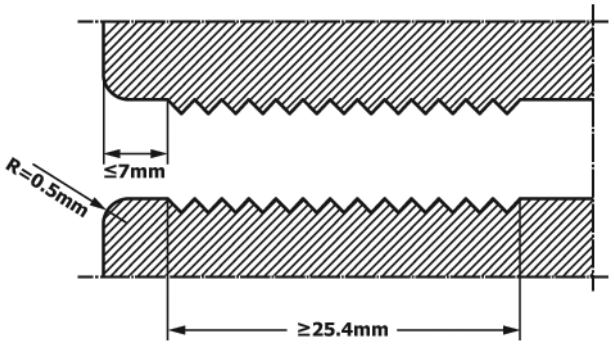



FIG. 2 Example of Serrated Surfaces

sample, take a full-width sample of sufficient length along the selvage or edge of the roll so that the requirements of 7.3 – 7.5.2 can be met. Exclude the inner and outer wraps of the roll or any material containing folds, crushed areas, or other distortions not representative of the sample lot.

7.3 Remove test specimens from the laboratory sample in a randomly distributed pattern across the width with no specimen taken nearer the selvage or fabric edge than 1/20 of the fabric width or 150 mm (6 in.), whichever is smaller, unless otherwise specified.

7.4 *Test Specimens*—From each unit in the laboratory sample, cut the specimens so that the edge of the specimen will extend beyond the edge of the clamp by 10 mm (0.39 in.) in all directions.

7.5 *Number of Specimens*—Unless otherwise agreed upon, as when provided in an applicable material specification, take a number of test specimens per laboratory sample such that the user may expect at the 95 % probability level that the test result is not more than 5.0 % of the average above or below the true average of the sample. Determine the number of specimens per sample as follows:

7.5.1 *Reliable Estimate of v*—When there is a reliable estimate of $v$ based upon extensive past records for similar materials tested in the user's laboratory as directed in this test method, calculate the required number of specimens as follows:

$$n = \left(\frac{tv}{A}\right)^2 \quad (1)$$

where:

$n$ = number of test specimens (rounded upward to a whole number),
$v$ = reliable estimate of the coefficient of variation for individual observations on similar materials in the user's laboratory under conditions of single-operation precision, %,
$t$ = the value of Student's $t$ one-sided limits, a 95 % probability level, and the degrees of freedom associated with the estimate of $v$, and
$A$ = 5.0 % of the average, the value of the allowable variation.

7.5.2 *No Reliable Estimate of v*—When there is no reliable estimate of $v$ for the user's laboratory, the equation given in 7.5.1 should not be used directly. Instead, specify the fixed number of ten specimens. The number of specimens is calculated using $v$ = 9.5 % of the average. These values for $v$ are somewhat larger than usually found in practice. When a reliable estimate of $v$ for the user's laboratory becomes available, the equation given in 7.5.1 usually will require fewer than the fixed number of specimens.

NOTE 4—Some geosynthetics are known to have different characteristics on the two sides as a result of the manufacturing process or treatment applied to them. In these cases, these types of materials will require to be tested separately on each side to consider a complete test.

## 8. Conditioning

8.1 Bring the specimens to moisture equilibrium in the atmosphere for testing geotextiles. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 h does not exceed 0.1 % of the mass of the specimen. In general practice, the industry approaches equilibrium from the "as-received" side.

NOTE 5—It is recognized that in practice, geotextiles materials 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. At least 24 h has been found acceptable in most cases. However, certain fibers may exhibit slow moisture equalization rates from the "as-received" wet side. When this is known, a preconditioning cycle, as described in Practice D1776/D1776M, may be agreed upon between contractual parties.

## 9. Procedure

9.1 Select the load range of the testing machine such that the rupture occurs between 10 and 90 % of the full-scale load.

9.2 Center and secure the test specimen between the clamping rings, without tension, ensuring that the test specimen extends to or beyond the outer edges of the clamping rings.

9.3 Mark the test specimen along the inside circumference of the clamping rings. This allows for a measurement of potential slippage of the specimen at the end of the test.

9.4 Ensure the clamping ring with the specimen is centered relative to the probe loading area.

9.5 Test at a machine speed of 50 mm/min (approximately 2 in./min) until the puncture rod completely ruptures the test specimen.

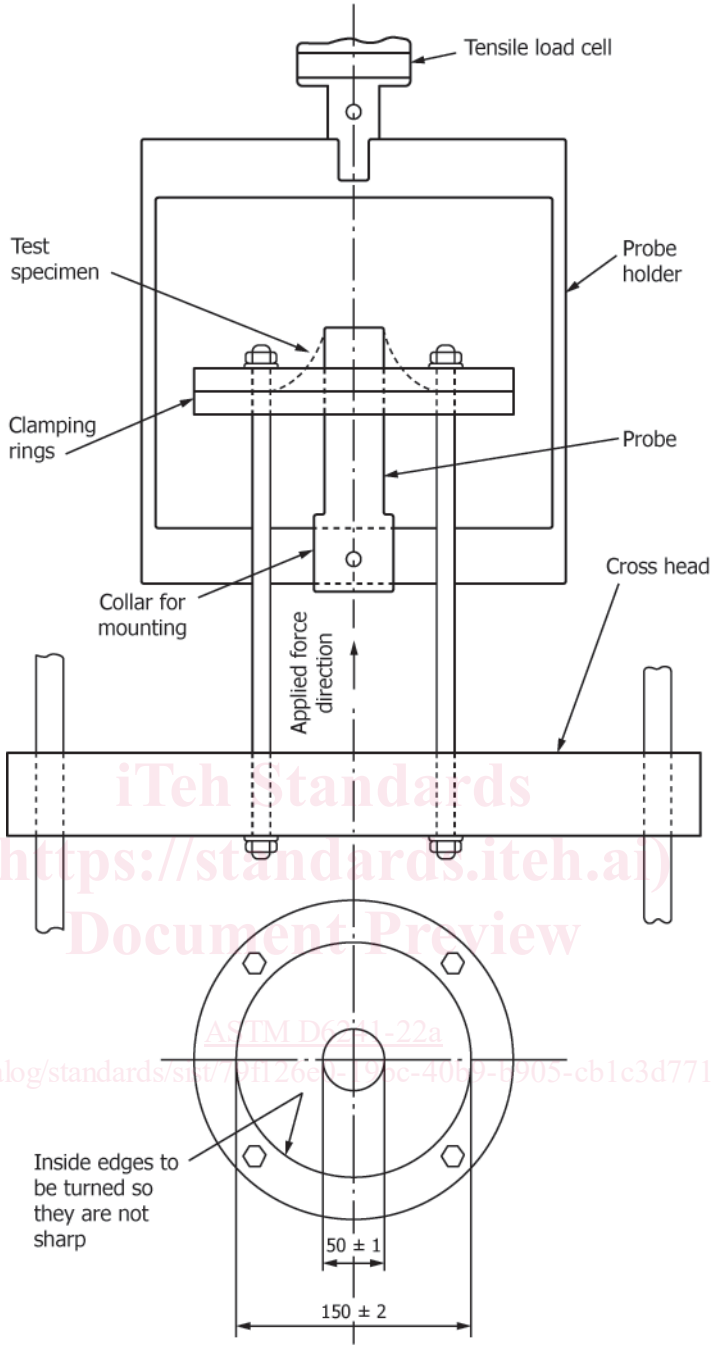
9.6 Record any slippage of the specimen at the end of the test. If slippage exceeds 5 mm, the test on that specimen should be discarded, and a new specimen should be obtained.

9.7 Record the puncture strength and, if requested by the client, the peak displacement recorded on the instrumentation during the test. For the testing of composite geotextiles, there may be a double peak. If so, the initial peak value should be reported even if the second peak is higher than the first one.

NOTE 6—A toe correction should be necessary when displacement reporting is required.

## 10. Calculation

10.1 Calculate the average of the puncture strength for all test results as read directly from the recording instrument.






NOTE 1—All dimensions are in millimetres.
NOTE 2—This diagram is not to scale.

**FIG. 3 Typical Arrangement for Test on Tensile Testing Machine**

10.2 When requested by the client, calculate the average of displacement at peak for all test results.

## 11. Report

11.1 State the following information:

11.1.1 The material was tested in accordance with Test Method D6241.

11.1.2 Report the number of specimens tested and the manner in which the specimens were conditioned.

11.1.3 The material or product sample description and the method of sampling used.

11.2 Report the following information:

11.2.1 The method of holding the test specimen in the clamping device.

11.2.2 The average puncture strength, and if requested by the client, the total displacement at peak of each of the specimens tested.