Designation: D4751 – 16

Standard Test Methods for Determining Apparent Opening Size of a Geotextile[1]

This standard is issued under the fixed designation D4751; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 These test methods cover the determination of the apparent opening size (AOS) of a geotextile either by dry-sieving glass beads through a geotextile (Method A) or by using a capillary porometer (Method B).

1.2 Method B will not be used in lieu of Method A unless the prequalification procedure specified in this standard is followed.

1.3 These test methods show the values in both SI units and inch-pound units. SI units is the technically correct name for the system of metric units known as the International System of Units. Inch-pound units is the technically correct name for the customary units used in the United States. The values in inch-pound units are provided for information only.

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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C136/C136M Test Method for Sieve Analysis of Fine and Coarse Aggregates

D1331 Test Methods for Surface and Interfacial Tension of Solutions of Paints, Solvents, Solutions of Surface-Active Agents, and Related Materials

D1776/D1776M Practice for Conditioning and Testing Textiles

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

D4439 Terminology for Geosynthetics

D6767 Test Method for Pore Size Characteristics of Geotextiles by Capillary Flow Test

E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

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

3. Terminology

3.1 *Definitions:* For general geosynthetics terms used in this standard, refer to Terminology D4439.

3.2 *Definitions:*

3.2.1 *apparent opening size* (AOS), O_{95}, *n—for a geotextile*, a property that indicates the approximate largest particle that would effectively pass through the geotextile.

3.2.1.1 *Discussion*—While the same "O95" symbol is used both in these test methods for defining the AOS of a geotextile as well as in Test Method D6767 for determining the pore size of geotextiles by capillary flow, they are not necessarily equivalent. The O95 values are defined in terms of their respective test methods. Therefore the AOS version of the O95 value that is determined with Method B may not be identical to the O95 value determined per Test Method D6767.

4. Summary of Test Methods

4.1 *Glass Bead Dry-Sieving Method A*—A geotextile specimen is placed in a sieve frame, and sized glass beads are placed on the geotextile surface. The geotextile and frame are shaken laterally so that the jarring motion will induce the beads to pass through the test specimen. The procedure is repeated on the same specimen with various size glass beads until its apparent opening size has been determined. This method is considered the referee method in the case of inter-laboratory disputes involving Method B.

4.2 *Capillary Porometer Method B*—A geotextile specimen is subject first to an air flow test, where the air flow rate and pressure are measured. Then the same specimen is wetted with mineral oil and subject to an increasing air pressure while measuring the resulting flow rate. The opening sizes are calculated from this data using standard capillary theory and the specific algorithm defined in these test methods.

4.2.1 The apparent opening size of a geotextile is defined in terms of the dry-sieving test method. This method includes a

[1] These test methods are under the jurisdiction of ASTM Committee D35 on Geosynthetics and is the direct responsibility of Subcommittee D35.03 on Permeability and Filtration.

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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.

procedure for correlating the porometer test data to the Method A results so that Method B is qualified to generate values equivalent to the glass bead dry-sieving Method A.

5. Significance and Use

5.1 Using a geotextile as a medium to retain soil particles necessitates compatibility between it and the adjacent soil. This test method is used to indicate the apparent opening size in a geotextile, which reflects the approximate largest opening dimension available for soil to pass through.

5.2 Test Methods D4751 for the determination of opening size of geotextiles is acceptable for testing of commercial shipments of geotextiles. Current estimates of precision, between laboratories, have been established.

5.3 Apparent Opening Test results obtained using Method A may differ from test results obtained with Method B. It is the intent of this test method to confirm the equivalency of the Method B results before permitting the use of this alternative. Laboratories electing the use of Method B must first determine any bias that exists between the two methods and document a reliable correlation in accordance with this test method.

5.3.1 The correlation between the Method B results and the Method A results must be established and meet the requirements of this test method for every different geotextile product type tested with Method B. Geotextiles from different manufacturers or with different nominal unit weights are considered different products. A minimum of three test results must be compared with all three satisfying the established correlation.

NOTE 1—The correlation should be confirmed for a particular product by comparing a minimum of three test results when there are changes in the manufacturing of a specific pre-qualified geotextile.

5.4 In case of a dispute arising from differences in reported test results when using Test Method D4751 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 homogeneous as possible and that are from a lot of material of the type in question. The test specimens should then be randomly assigned in equal numbers to each laboratory for testing. The average results from the two laboratories should be compared using Students *t*-test for unpaired data and an acceptable probability level chosen by the two parties before 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 the light of the known bias.

5.4.1 In the event that the dispute involves test results produced with the capillary porometer, Method A is considered the referee method for Test Methods D4751.

6. Sampling

6.1 *Sampling of Planar Geotextiles:*

6.1.1 *Lot Sample*—For routine quality control testing, divide the product into lots and take the lot sample as directed in Practice D4354, Section 7, Procedure B—Sampling for Quality Assurance Testing. For Specification Conformance testing, sample as directed in Practice D4354, Section 6, Procedure A—Sampling for Specification Conformance.

6.1.2 *Laboratory Sample*—As a laboratory sample for acceptance testing, take a full width swatch 1-m (1-yd) long from the end of each roll of fabric in the lot sample, after first discarding a minimum of 1 m (1 yd) of fabric from the very outside of the roll.

6.1.3 *Test Specimens*—Cut five specimens from each swatch in the laboratory sample with each specimen being cut to fit the appropriate specimen holder for Method A or the porometer sample holder for Method B. Cut the specimens from a single swatch spaced along a diagonal line on the swatch.

6.2 *Sampling of Circular-Knitted Sock Geotextiles:*

6.2.1 For a lot sample for manufacturer's quality control (MQC) testing, divide rolls of Circular, Knitted Sock Geotextile Fabric into lots and take the lot sample as directed in Practice D4354, Section 7, Procedure B—Sampling for Quality Assurance Testing. For a Lot Sample for Specification Conformance Testing, sample as directed in Practice D4354, Section 8, Procedure C—Sampling for Specification Conformance.

6.2.2 *Laboratory Sample*—To obtain a laboratory sample for MQC testing of the Circular-Knitted Sock Geotextile, follow the procedure below:

6.2.2.1 Apply the knitted sock Geotextile sample over the outside of the corresponding diameter of a 406 mm (16 in.) length of perforated tubing or reasonable facsimile having the same diameter as the pipe material for which the sock is intended.

6.2.2.2 Tie a knot in each end of the fabric so as to fully encase the pipe in the fabric.

6.2.2.3 Using the knot from one end of the fabric, suspend the geotextiles encased pipe vertically. Gently suspend a 1.13 kg (2.5 lb) weight from the bottom to ensure intimate contact with the perforated pipe. See Fig. 1a. Allow the suspended pipe with weight to hang for 2 min.

NOTE 2—Pipes with diameters larger than 75 to 150 mm (3 to 6 in.) may require heavier weights to ensure intimate contact between the pipe and sock material.

6.2.2.4 For Method A, using a flexible 203 mm (8 in.) diameter round template as a guide, trace a circle on the surface of the fabric using an indelible marker. See Fig. 1c. Remove the fabric from the pipe section by untying or cutting off the knots at one or both ends in the fabric. Cut the fabric tube in a lengthwise direction at a position opposing the drawn circle, taking care to not cut the fabric within the circle. If so desired, the length of the specimen may be shortened by cutting the fabric in a cross wise direction, taking care not to cut the fabric closer than 75 mm (3 in.) from the outside of the circle. The result will be a planar specimen of more or less rectangular shape with a circle drawn approximately in its center.

6.2.2.5 For Method B test specimens, affix an adhesive-backed foil to the fabric which has a 25-mm diameter hole die cut from the center, and a sufficient outside diameter to exceed the outside diameter of the porometer sample holder. This foil must be rigid enough to preserve the geometry of the material produced by this technique. The five foil-taped porometer specimens are then cut with the porometer specimen die, positioning the 25-mm opening in the center.

Fig 1a

Square Template with Hole Cut in It Fig 1b

Fig 1c

Round Template Fig 1d

FIG. 1

6.3 *Lot Sample for Specification Conformance Testing*—Sample as directed in Practice D4354, Section 8, Procedure C—Sampling for Purchaser's Specification Conformance Testing.

6.3.1 *Laboratory Sample*—To obtain a laboratory sample of the Circular Knitted Geotextile Fabric for acceptance testing of each lot of pipe, follow this procedure:

6.3.1.1 Select a 3 m (10 ft) section on each lot of the sock covered pipe to be tested.

6.3.2 Using a length of string, twine or cord, secure the fabric to the pipe at each end of the 3 m (10 ft) pipe section that was chosen in 6.3.1.1 in order to prevent the sock fabric from contracting lengthwise when the sock covered pipe sample is removed from the roll or pipe section. Remove the 3 m (10 ft) sock covered pipe section from the roll or pipe section by cutting the pipe at each end of the 3 m (10 ft) sample, outside of the ties.

6.3.3 *Test Specimens*—With the fabric still secured to the pipe sample, using a flexible 203 mm (8 in.) diameter round template for Method A, draw five 203-mm (8-in.) diameter circles at various locations around the circumference of each laboratory sample, equally spaced along its length, and not closer than 100 mm (4 in.) from either end of the pipe sample. For Method B, affix adhesive-backed foil to the fabric which has a 25-mm diameter hole die cut from the center, and a sufficient outside diameter to exceed the outside diameter of the porometer sample holder. This foil must be rigid enough to preserve the geometry of the material produced by this technique. The five foil-taped porometer specimens are then cut with the porometer specimen die, positioning the 25-mm opening in the center.

6.3.3.1 Remove the ties from the laboratory sample and remove the fabric from the pipe.

6.3.3.2 When securing specimens by wedging between two sieve frames cut the laboratory sample in a cross wise direction to create 5 specimens taking care not to make these cuts closer tan 75 mm (3 in.) from the outside of the circle. Continue to prepare the specimens by cutting the fabric in a lengthwise direction at a position opposing the circle. Care must be taken not to cut through the circle. The result will be the creation of 5 planar fabric specimens of more or less a rectangular shape with a circle drawn at its center.

METHOD A—DRY-SIEVING WITH GLASS BEADS

7. Specimen Preparation

7.1 Weigh the Method A test specimens and then submerge them in distilled water for 1 h at the standard atmosphere for testing. Bring the specimens to moisture equilibrium in the atmosphere for testing geosynthetics. Equilibrium is considered to have been reached when the change in the mass of the specimen in successive weight measurements made at intervals of not less than 2 h does not exceed 0.1 g.

7.2 The drying process may be accelerated with the use of a fan. The specimens shall not be dried in an oven or by exposing them to elevated temperatures above the standard laboratory atmosphere for geosynthetic testing.

NOTE 3—It is recognized that in practice, geosynthetic materials are frequently not weighed to determine when moisture equilibrium has been reached. While such a method cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing geosynthetics for a reasonable period of time before the specimens are tested. A time of at least 24 h has been found acceptable in most cases. However, certain fibers may contain more moisture upon receipt than after conditioning. When this is known, a preconditioning cycle, as described in Practice D1776/D1776M, may be agreed upon by the contractual parties.

8. Apparatus

8.1 *Mechanical Sieve Shaker*—A mechanical sieve shaker, which imparts lateral and vertical motion to the sieve, causing the particles thereon to bounce and turn so as to present different orientations to the sieving surface, should be used. The sieve shaker should be a constant frequency device utilizing a tapping *arm* to impart the proper motion to the glass beads.[3]

NOTE 4—Care should be given to the cork or rubber contact point on shakers when the vertical motion comes from an arm striking the cork or rubber. Excessive wear on the cork or rubber could affect the motion imparted to the glass beads and, therefore, the test result.

8.2 *Pan, Cover, and 200-mm (8-in.) Diameter Sieves.*

8.3 *Spherical Glass Beads* in size fractions in accordance with Table 1. It is only necessary to have on hand the bead size fractions necessary for the range of geotextiles for which testing is anticipated. The sizing of all beads shall be verified prior to each use by sieving on the pairs of sieves shown in Table 1. Prepare at least 50 g of each size fraction to be used prior to beginning the test. Bead sizes to be used in this test method are shown in Table 1.

8.4 *Balance,* having a capacity adequate for the mass of samples anticipated and accurate to ±0.05 g.

[3] The sole source of supply of the apparatus known to the committee at this time is W.S. Tyler, Inc., 8200 Tyler Blvd., Mentor, OH 44060. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend.

TABLE 1 Glass Bead Sizes

Bead Size Range				Bead Size Designation[A]	
Passing		Retained			
mm	Sieve Number[B]	mm	Sieve Number[B]	mm	Sieve Number
2.0	10	1.70	12	1.7	12
1.4	14	1.18	16	1.18	16
1.00	18	0.850	20	0.850	20
0.710	25	0.600	30	0.600	30
0.500	35	0.425	40	0.425	40
0.355	45	0.300	50	0.300	50
0.250	60	0.212	70	0.212	70
0.180	80	0.150	100	0.150	100
0.125	120	0.106	140	0.106	140
0.090	170	0.075	200	0.075	200

[A] The designated bead size is the "retained on" size of the sieve pair used to size the beads. For example, beads designated No. 40 are beads that pass the No. 35 sieve and are retained on the No. 40 sieve. These beads are typically sold as 35-40 beads.
[B] See Specification E11.

8.5 *Static Elimination,* to prevent the accumulation of static electricity when the beads are shaken on the surface of geotextile. Commercially available devices or anti-static sprays are acceptable.

8.6 *Pan,* for collecting sieved beads.

8.7 *Flexible Rubber Template,* either a square shaped flexible rubber template with a 203-mm (8-in.) diameter hole cut in it, or a 203-mm (8-in.) diameter template, constructed from a durable, yet flexible material such as rubber or neoprene. This template is used to trace the 203-mm (8-in.) diameter circles on the geotextile fabric for mounting into the sieves described in 8.2. (See Fig. 1.)

9. Procedure

9.1 Run the test at the atmosphere for testing geotextiles in such a manner that static electricity is prevented from affecting test results. If standard atmosphere cannot be maintained and static electricity is noticed, two methods are available that will prevent static electricity:

9.1.1 Install static eliminating devices equally spaced about the circumference of sieve and one on center of cover, or

9.1.2 Apply commercially available anti-static spray uniformly to the geotextile.

9.2 Secure the geotextile in such a way that it is taut, without wrinkles or bulges. The geotextile must not be stretched or deformed such that it changes or distorts the openings in the fabric. Two systems may be used to secure the geotextiles sample:

9.2.1 Wedge between two sieve frames.

9.2.2 Secure with the perimeter seal device inside the sieve frame.

NOTE 5—For knitted sock geotextiles, some manipulation of the specimens may be necessary to ensure that the marked out circle is fitted to the sieve frame properly.

9.3 Prior to use, sieve the glass beads in the laboratory to verify size of beads.

NOTE 6—All size glass beads are sieved through a single specimen of geotextile unless the geotextile has an average thickness equal to or greater than 2.3 mm (0.091 in.). A geotextile of this thickness or greater (especially nonwovens) may trap beads within the layers of the fabric, which may pass through the specimen when testing with a different bead size, thus creating an error in the test results. In the case of the thicker geotextiles, a different specimen may be used for each bead size; however, it should be noted in the report that different specimens were used.

9.4 Start with the smallest diameter glass beads that will be tested. Place 50 g of one size glass beads on the center of the geotextile.

9.5 Place cover and pan on sieve frame and place in shaker. Shake sieves for 10 min.

9.6 Place the glass beads still on the surface of the specimen in a pan and weigh. Include beads that fall off as a result of turning the specimen over and tapping the rims of the sieves.

NOTE 7—This step provides information concerning the amount of glass beads trapped within the geotextile and the amount of any beads lost during testing.

9.7 Weigh the glass beads that pass through the specimen, and record data. (See Fig. 2 for a sample worksheet which can be used to record the desired data).

9.8 Repeat 9.3 through 9.7 using the next larger bead size fraction. Repeat the trial using successively larger bead size fractions until the weight of beads passing through the specimen is 5 % or less. Perform the trials such that the percent passing decreases from a value greater than 5 % to a value less than or equal to 5 %.

9.9 Repeat 9.2 – 9.8 for all five specimens.

10. Calculation

10.1 For each size of beads tested with each specimen, compute to the nearest percent by weight of the beads passing through the specimen using Eq 1:

$$B = 100\,P/T \tag{1}$$

where:

B = beads passing through specimen, %,
P = mass of glass beads in the pan, g, and
T = total mass of glass beads used, g.

10.2 Record calculations and percent beads passing (see Fig. 2).

10.3 Assign the AOS for each specimen as the size designation in millimetres (see 8.3) of the beads of which 5 % or less pass. These AOS values are in millimetres, and are taken from the "Bead Size Designation" column of Table 1.

10.4 Determine the AOS in millimetres by averaging the five AOS values obtained in 10.3.

10.5 Determine the sample AOS, expressed in terms of sieve number, as the number of the U.S. Sieve (see the sieve number column under Bead Size Designation of Table 1) having nominal opening, in millimetres, equal to or next larger than the AOS, in millimetres, obtained in 10.4.

11. Plotting

11.1 It is often desirable due to variability among the five test specimen results to determine the AOS value by plotting the percentage of beads passing the specimen versus the bead size for each of the bead sizes used for each specimen. When plotting is desirable, proceed as follows:

11.1.1 For each specimen, plot the values of Percent Passing (Ordinate) versus Bead Size, mm (Abscissa) on semi-log graph. Draw a straight line connecting the two data points representing the bead sizes that are immediately on either side of the 5 % passing ordinate. The particle size in millimetres (abscissa) at the intersection of the straight line plotted and the 5 % passing ordinate is the AOS of the specimen in millimetres, that is, the theoretical bead size that would result in exactly 5 % passing the specimen.

11.1.2 Determine the sample AOS, in millimetres, by averaging the five AOS values obtained by the graphic interpolation in 11.1.1.

11.1.3 *Optional:* When requested, determine the sample AOS, expressed in terms of sieve number, as the number of the U.S. Sieve (see the sieve number column under Bead Size Designation of Table 1) having nominal opening, in

DETERMINATION OF APPARENT OPENING SIZE OF GEOTEXTILE

DATE: _____
TEST BY: _____
COMP BY: _____
CHECK BY: _____

Range (mm) US Std Mesh	Minimum Dia. (mm)	Wt. F+G* W/ Beads	Wt. F+G	Wt. Beads	% Retained	Wt. Pan W/ Beads	Wt. Pan	Wt. Beads	% Passing	Wt. F+G Before	Wt. F+G After	Wt. Retained in Geotextile	% Retained in Geotextile
2.0 – 1.70	1.70												
1.4 – 1.18	1.18												
1.0 – .850	.850												
.710 – .60	.600												
.50 – .425	.425												
.355 – .30	.300												
.25 – .212	.212												
.18 – .15	.150												
.125 – .106	.106												
.09 – .075	.075												

GEOTEXTILE DESCRIPTION: _____

* F=FRAME
G=GEOTEXTILE

FIG. 2 Sample Worksheet

millimetres, equal to or next larger than the AOS, in millimetres, obtained in 11.1.1.

12. Report

12.1 Report that the specimens were tested as directed in Test Method D4751 Method A. Describe the material or product sampled and the method of sampling used.

12.1.1 For report formats that do not incorporate the phrase in 12.1 on the same page as the reported test values, (that the specimens were tested in accordance with Method A), use the following test method designation: ASTM D4751(A). Where the acronym "AOS" is used in a report of the Method A results, use the acronym "AOS-A."

12.2 Report the following information:

12.2.1 Results in written form indicating the bead size ranges used in millimetres.

12.2.2 If requested, plots of bead size versus percentage beads passing for each specimen will be provided (as described in Section 11).

12.2.3 The average determined from five specimens as the apparent opening size (AOS = A) in millimetres.

12.2.4 Type of sieve shaker used.

12.2.5 When requested, express the AOS in terms of sieve number. The AOS expressed this way shall be the number of the U.S. Standard Sieve (see Specification E11) having nominal openings, in millimetres, next larger than or equal to the AOS, in millimetres.

12.2.6 Any deviation from the described test method.

METHOD B—CAPILLARY POROMETRY

13. Apparatus

13.1 *Clean Gas Pressure Source,* with regulation (filtered air).

13.2 *Pressure Sensor*—Pressure measurements may be obtained with a digital pressure transducer, a U-Tube manometer or an Inclined manometer covering the necessary pressure range for the pore sizes under study and the wetting fluid used. The pressure sensor sensitivity shall be dictated by the range of pressures associated with the openings sizes. The bubble point pressure should be measured with an accuracy of ±5 Pascals.

13.2.1 Pressure sensor(s) must be installed immediately upstream (for example, within 12.5 mm) of the sample holder.

13.3 *Closed Specimen Holder:*

13.3.1 Specimen holder that fully confines the perimeter of the specimen to prevent any lateral pressure losses.

13.3.2 The specimen flow area shall be 25-mm (1.0-in.) diameter.

13.3.3 The filter holder should be checked for leaks by placing a geomembrane an impermeable membrane in the holder and increasing the pressure to the maximum capacity of the pressure sensor, and holding it for a period of one minute. The flow rate measured during this period must be zero indicating a leak-free seal.

13.4 *Metal Punch,* used to cut a suitable size geotextile from the test sample to fit the test specimen holder.

13.5 *Flow Rate Measurement Sensors*—The porometer should be equipped with sensors to measure the flow rate that have the capacity to achieve the flow rates necessary to derive the desired pore size distribution. The maximum flow rate measurement required will depend on the opening diameter and the dry air flow rate that corresponds to the smallest opening that can be determined on the geotextile type under test. The minimum sensitivity, that is, the detection threshold, is dictated by the flow rate that corresponds to the onset of flow at the bubble point. For some geotextiles, this value may be as low as 0.1 L/min.

13.5.1 A series of floating ball-type flow meters placed in a parallel arrangement to cover the ranges of flow rates is acceptable provided the minimum and maximum flow rate measurements can be obtained with an accuracy of 5 % or less of the measured value.

13.5.2 Digital flow meters are preferred for measurement of flow rates. Two or more digital flow meters of different capacities and sensitivities may be necessary to cover both the minimum detection value and the maximum dry specimen value. The accuracy of digital flow meters shall be 0.25 % of the maximum reading.

13.6 *In-line Fluid Trap,* for porometers which have the flow rate sensors downstream from the test specimen to protect the flow meters from being contaminated by the exhausted fluid.

13.7 *Appropriate Fittings, Hose, Connectors, Piping,* to assemble apparatus.

13.8 *Balance,* with a precision of 0.001 g.

13.9 *Wetting Fluid,* the standard wetting fluid for this test method is USP/FCC White Mineral Oil Heavy.

13.9.1 Measure the surface tension of the mineral oil in accordance with Test Methods D1331 for the first bottle obtained from each different reagent grade supplier. The surface tension should be measured with an accuracy of ±0.5 dynes/cm and reported for 20°C. This value shall be used in the calculation of the opening size.

14. Procedure

14.1 Place a dry geotextile sample disk in the specimen holder.

14.2 Place the specimen holder in the porometer, secure the holder, and apply gas pressure. The maximum pressure for the dry test must exceed the highest pressure that will subsequently be measured during the wet test.

14.3 For devices where the data is acquired by a computer, the pressure and flow rate data shall be recorded with an acquisition rate sufficient to capture the requisite values. Plot the air flow rate versus pressure.

14.4 Reduce gas pressure and remove the geotextile from the holder.

14.5 Completely wet the geotextile by submerging it in the wetting liquid for a period of 1 h. Air bubbles should not be entrained in the wetting fluid and there should not be any air bubbles trapped in the test specimens. Shorter soaking periods may be used with comparative testing that demonstrates no effect on the test results.

14.6 Increase the pressure to the pressure required to obtain the O90 values. Specimens may be re-soaked with mineral oil and re-tested if necessary.

14.7 Reduce and shut off the air pressure, remove the geotextile specimen, and clean the holder for the next test.

14.8 Plot the fluid-wet air flow rate versus pressure on the same plot made for the dry air flow versus pressure data in accordance with 14.3.

15. Calculation of the O95 Opening Size Value

15.1 The calculation of opening size is based on the following equation:

$$O = C/P \tag{2}$$

where:

O = opening size in microns, µm,
C = correlation factor determined per Annex A1, and
P = pressure in Pascals (N/m^2) obtained during the wet test at the flow rate that is 5 % of the dry flow rate at the same pressure.

15.2 Determine the Method B test result in terms of the Designated Sieve Size in millimetres by taking the O95 result per 15.1 and assigning the next larger Designated Sieve Size in millimetres from the right-most column in Table 1.

16. Correlating Test Method B to Test Method A

16.1 This procedure must be performed on each different geotextile product prior to reporting the AOS. Geotextiles from different manufacturers and of different unit weights are considered different products. A minimum three test results must be compared, with all three results satisfying the established correlation.

16.2 Each test result comparison consists of five (5) Method A and five (5) Method B test specimens. Obtain the specimens adjacent to each other approximately as shown in Fig. 3.

16.3 Determine the Apparent Opening Size using Method A and the plotting method, with the test result in terms of a Designated Sieve Size in millimetres.

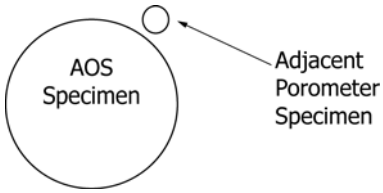

FIG. 3

16.4 Determine the AOS test result with Method B in terms of Designated Sieve Size in millimetres.

16.5 Repeat the above procedure on a minimum of three separate samples.

16.6 Compare the two test results, that is, the AOS values in terms of Designated Sieve Size in millimetres.

16.6.1 All three Method B test results must be identical to the test results for Method A.

16.6.2 In the event that a Method B test result differs from the Method A result, the source of the bias shall be investigated with a second set of five tests on the failing prequalification sample. The average of the ten test specimen results shall be compared. If this resolves the bias between the two methods, the number of test specimens required to test this particular product shall be increased from five to ten.

16.6.3 This correlation must be confirmed when there are any changes in the manufacture of the product such as the denier of the fibers, the proportion of fibers of different denier, or any other aspect of the manufacturing process.

16.6.4 If the source of the bias remains undetermined, the material shall not be tested with Method B.

16.6.5 A controlled list of the geotextile materials that are pre-qualified for performing AOS must be posted and visible near the porometer.

17. Report

17.1 1 Report that the specimens were tested as directed in Test Method D4751 Method B. Describe the material or product sampled and the method of sampling used.

TABLE 2 Precision

Statistic	Slit Film, Woven	Mono-filament, Woven	Needle-Punched, Nonwoven	Heat-Bonded, Nonwoven
Average AOS, mm	0.179	0.142	0.182	0.137
Within Laboratory Repeatability Limit, CV%Sr	8.3	3.4	4.0	5.9
Between Laboratory Reproducibility Limit, CV%SR	13.9	8.6	22.7	10.8
95 % Confidence Limit Within Laboratory Repeatability, CV%r	23.4	9.4	11.7	16.5
95 % Confidence Limit Between Laboratory Reproducibility, CV%R	39.1	24.2	63.4	30.2

17.2 For report formats that do not incorporate the phrase in 17.1 on the same page as the reported test values, (that the specimens were tested in accordance with Method B), use the following test method designation: ASTM D4751(B). Where the acronym "AOS" is used in a report of the Method B results, use the acronym "AOS-B."

17.3 Report the following information:

17.3.1 The individual test specimen AOS-B values in terms of Designated Bead Size in millimetres.

17.3.2 The average sample opening size determined from the average of the AOS-B values for the five specimens.

17.3.3 The AOS-B test result for the sample, in terms of the Designated Sieve Number if requested.

17.3.4 When requested, the supporting correlation data obtained in accordance with Section 16 shall be provided for the product under test.

17.3.5 Manufacturer and model of the porometer used.

17.3.6 The manufacturer and measured surface tension of the wetting fluid used.

17.3.7 The Conversion Factor, C.

17.3.8 Any deviation from the described test method.

18. Precision and Bias

18.1 *Precision:*

18.1.1 *Interlaboratory Test Program*—An interlaboratory study of this test method using Method A was performed in 1999. Three sets (five test specimen each) which were randomly drawn from each of four materials, two woven and two nonwoven, were tested for apparent opening size in each of five laboratories. The design of the experiment, similar to that of Practice E691, and a within-between analysis of the data are given in an ASTM Research Report.[4]

18.1.2 *Test Result*—The precision information is given in Table 2. The precision values are for the apparent opening size test results using Method A and are in terms of coefficients of variation, CV%.

18.2 *Bias*—The procedure in Test Method D4751 for measuring the apparent opening size of geotextiles has no bias because the value of the apparent opening size can be defined only in terms of this test method.

18.3 The requirements set forth by this standard for establishing the correlation between the Method A and Method B results does not allow for any bias between the two methods. The use of Method B is not permitted whenever a bias exists with Method A.

19. Keywords

19.1 apparent opening size; capillary porometer; geotextile; glass beads; sieve

[4] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D35-1006.

ANNEX

(Mandatory Information)

A1. DEVELOPING THE CORRELATION CONSTANT C

A1.1 The correlation constant is shown below, and shall be determined empirically by performing a series of tests on coupled sets of test results for a minimum of five different geotextile samples spanning the range of opening sizes to be tested.

A1.2 Plot the Method A AOS test results as the average bead size in microns obtained with the plotting method on the Y-axis versus the average O95 pressure in Pascals on the X-axis. These two values are based on the averages for five test specimens obtained per 16.2.

A1.3 Using an iterative procedure, determine the constant "C" that best fits the plotted data.

$$O = C/P \quad \text{(A1.1)}$$

where:

O = opening size in microns, μm,
C = correlation factor determined per Annex A1, and
P = pressure in Pascals (N/m^2) obtained during the wet test.

APPENDIX

X1. PROCEDURE: CLEANING AOS BEADS

X1.1 Collect the glass beads (spheres) in a container.

X1.2 Pass the beads through a sieve with a large enough opening that all of the beads will pass, such as a #20. This step is to remove any large impurities (fuzz, lint, etc).

X1.3 Place these pre-sieved beads in a separate container marked "Pre-Sieved Beads."

X1.4 Place a coffee filter in a #4 sieve.

X1.5 Over a sink, wet the coffee filter using a spray bottle with de-ionized water.

X1.6 Pour a layer of glass beads approximately 6-mm (¼-in.) thick onto the filter.

X1.7 Use deionized water to rinse the glass beads on the filter, then decant water. The glass beads will typically sink. A lot of the floating matter such as fuzz, lint, etc., can be decanted off. Rinse 3 times.

X1.8 Use isopropyl alcohol to rinse glass beads in setup. This helps drive off water and any remaining finishes.

X1.9 After the alcohol has settled, remove the coffee filter with glass beads, and place into a container labeled "Cleaned Beads."

X1.10 Repeat X1.4 – X1.9 until all beads have been cleaned.

X1.11 Place the container(s) of cleaned beads in an oven at 110 ± 5°C and allow them to dry overnight.

X1.12 After the beads have cooled, separate them into their respective Designated Sieve sizes per 8.3.