Designation: D 3776 – 96 (Reapproved 2002)

Standard Test Method for Mass Per Unit Area (Weight) of Fabric[1]

This standard is issued under the fixed designation D 3776; 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 covers the measurement of fabric mass per unit area (weight) and is applicable to most fabrics.

1.2 There are four approved options:

1.2.1 *Option A*—Full Piece, Roll, Bolt or Cut (Section 7).

1.2.2 *Option B*—Full Width Sample (Section 8).

1.2.3 *Option C*—Small Swatch of Fabric (Section 9).

1.2.4 *Option D*—Narrow Fabrics (Section 10).

1.3 The values either in SI units or U.S. customary units are regarded as standard. U.S. customary units may be approximate.

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]

D 123 Terminology Relating to Textiles

D 1776 Practice for Conditioning Textiles for Testing

D 3773 Test Methods for Length of Woven Fabric

D 3774 Test Methods for Width of Woven Fabric

2.2 *Other Standard:*

ANSI/ASQC Z1.4 Inspection by Attributes[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *weight, n—as used with fabrics,* mass per unit area.

3.1.1.1 *Discussion*—Fabric mass per unit area is expressed either as grams per square metre (ounces per square yard), or grams per linear metre (ounces per linear yard). Fabric mass is also sometimes expressed inversely as linear metres per kilograms (yards per pound) with the fabric width stated.

3.2 For definitions of other textile terms used in these test methods, refer to Terminology D 123.

4. Summary of Test Methods

4.1 Fabric mass is calculated from the mass of a specimen the length and width of which have been measured as directed in one of the procedures in Test Method D 3773 and D 3774.

5. Apparatus

5.1 *Scale*, with a capacity and sensitivity sufficient to weigh the full piece, roll, bolt, or cut units to within ±0.1 % of their gross mass. The accuracy of the scale should be certified by a recognized authority.

5.2 *Balance*, having a capacity and sensitivity to weigh within ±0.1 % of the mass of the specimens being tested.

5.3 *Cutting Die*, either square or round with an area of at least 13 cm^2 or 4 $in.^2$

6. Conditioning

6.1 Condition test specimens as directed in Practice D 1776.

6.2 All weighing tests should be made in the standard atmosphere for testing textiles (20 ± 1°C (70 ± 2°F), 65 ± 2 % RH), after the specimens have been conditioned in the same atmosphere. It may be impractical to condition the specimens in Option A or nonconditioned testing may be agreed upon by the purchaser and supplier. When the full rolls or bolts of fabric cannot be properly conditioned in a reasonable time with available facilities, perform the tests without conditioning and report the actual conditions prevailing at the time of the test. Such results may not correspond with the results obtained after testing adequately conditioned specimens in the standard atmosphere for testing textiles.

7. Option A—Full Piece, Roll, Bolt, or Cut

7.1 *Significance and Use*

7.1.1 Option A for the determination of mass per unit area of woven fabrics may be used for acceptance testing of commercial shipments since it has been used extensively in the trade.

7.1.2 In case of a dispute arising from differences in reported test values when using Test Methods D 3776 for acceptance testing of commercial shipments, the purchaser and the supplier should conduct comparative tests to determine if

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[1] These test methods are under the jurisdiction of ASTM Committee D13 on Textiles and are the direct responsibility of Subcommittee D13.60 on Fabric Test Methods, Specific.

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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 National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

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 which are as homogeneous as possible and which 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 student's *t*-test for unpaired data and an acceptable probability level chosen by the two parties before 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.

7.2 *Sampling*—As a lot sample for acceptance testing, take at random the number of rolls of fabric as directed in an applicable material specification or other agreement between the purchaser and the supplier. Consider rolls of fabric to be the primary sampling units. Consider the rolls of fabric in the lot sample as the laboratory sample and as the test specimens.

7.3 *Procedure*:

7.3.1 Measure the length of the full piece, roll, bolt, or cut by the hand procedure in Test Method D 3773.

7.3.2 Measure the width by the tension-free alternative of Option A of Test Method D 3774.

7.3.3 Weigh the fabric, with shell and holder, if any, to the nearest 0.1 % of its mass.

7.3.4 Weigh the holder, if any, to the nearest 0.1 % of its mass.

7.4 *Calculations*:

7.4.1 Determine the net weight of the fabric by subtracting the weight of the holder from the total weight.

7.4.2 Dimensions and mass may all be determined in SI units and mass per unit area calculated using Eq 1, Eq 2, or Eq 3, as follows:

$$g/m^2 = 10^3 M/LW \quad (1)$$

$$g/m = 10^3 M/L \quad (2)$$

$$m/kg = L/M \quad (3)$$

where:

M = mass of fabric, in kilograms,
L = length of fabric, in metres, and
W = width of fabric, in metres.

7.4.3 Calculate the mass per unit area, mass per linear yard, or linear yards per pound to three significant figures, unless otherwise specified, using Eq 4, Eq 5, Eq 6, or Eq 7, as follows:

Mass per unit area:

$$oz/yd^2 = 576M/LW \quad (4)$$

Mass per yard:

$$oz/yd = 16M/L \quad (5)$$

Linear yards per pound:

$$yd/lb = L/M \quad (6)$$

$$yd/lb = 16 \text{ oz/yd} \quad (7)$$

where:

M = mass of fabric, in pounds,
L = length of fabric, in yards, and
W = width of fabric, in inches.

7.4.4 If preferred, convert the U.S. customary units to SI units using Eq 8, Eq 9, or Eq 10, as follows:

$$\text{Mass, } g/m^2 = oz/yd^2 \times 33.906 \quad (8)$$

$$\text{Mass, } g/m = oz/yd \times 31.000 \quad (9)$$

$$m/kg = yd/lb \times 2.016 \quad (10)$$

8. Option B—Full Width Sample

8.1 *Significance and Use*:

8.1.1 This procedure is applicable to a full-width sample cut from a full piece, roll, bolt, or cut. Unless otherwise specified, these results will include selvages and will be on the basis of conditioned fabric.

8.1.2 Option B is not recommended for the acceptance testing of commercial shipments, since Option A is regularly used for that purpose.

8.2 *Sampling*:

8.2.1 *Lot Sample*—As a lot sample for acceptance testing, take at random the number of rolls of fabric as directed in an applicable material specification or other agreement between the purchaser and the supplier. Consider the roll of fabric to be the primary sampling units.

8.2.2 *Laboratory Sample*—From each roll or piece in the lot sample, cut—don't tear—at least one laboratory sample the full width of the fabric and at least 250 mm (10 in.) in length. The cut edges must be a straight line, free of indentations or bulges, unless both edges have been made to trace parallel filling yarns. In this procedure the complete laboratory sample is used as the specimen.

8.3 *Procedure*:

8.3.1 Measure the length of the conditioned specimen by the hand procedure of Test Method D 3773.

8.3.2 Measure the width by the tension-free alternative of Option A of Test Method D 3774.

8.3.3 Weigh the specimen in grams on a scale or balance to the nearest 0.1 % of its mass (weight).

8.4 *Calculations*:

8.4.1 Calculate the mass per unit area, mass per linear yard, or linear yards per pound to three significant figures, unless otherwise specified, using Eq 11, Eq 12, Eq 13, or Eq 14, as follows:

Mass per unit area:

$$oz/yd^2 = 45.72G/L_sW \quad (11)$$

Mass per linear yard:

$$oz/yd = 1.27G/L_s \quad (12)$$

Linear yards per pound:

$$yd/lb = 16/\text{oz per linear yd} \quad (13)$$

$$yd/lb = 12.6L_s/G \quad (14)$$

where:

G = mass of specimen, in grams,
L_s = length of specimen, in inches, and
W = width of specimen, in inches.

8.4.2 If preferred, convert the U.S. customary units to SI units using Eq 4, Eq 5, or Eq 6 in 7.4.3.

8.4.3 Alternatively, dimensions and mass may all be determined in SI units and calculated using Eq 15, Eq 16, or Eq 17, as follows:

Mass per unit area:

$$g/m^2 = 10^6 G/L_s W \quad (15)$$

Mass per linear metre:

$$g/m = 10^3 G/L_s \quad (16)$$

Linear metres per kilogram:

$$m/kg = L_s/G \quad (17)$$

where:

G = mass of specimen, g
L_s = length of specimen, mm, and
W = width of specimen, mm.

9. Option C—Small Swatch of Fabric

9.1 *Significance and Use*:

9.1.1 This procedure is applicable when a small swatch of fabric is sent to the laboratory to be used as the test specimen. The results are considered to be applicable to the sample only and not necessarily to the lot from which the sample was taken.

9.1.2 Measurements by this method do not include selvages and should be reported as such, unless a selvage allowance is specified.

9.1.3 Option C is not recommended for acceptance testing of commercial shipments since Option A is regularly used for that purpose.

9.2 *Sampling*—Option C is used only when limited fabric is available and should not be used for acceptance sampling. Prepare such specimens from small swatches as is possible.

9.3 *Preparation of Specimens*—Prepare a conditioned specimen having an area of at least 130 cm^2 (20 $in.^2$) or a number of smaller die cut specimens taken from different locations in the sample and having a total area of at least 130 cm^2 (20 $in.^2$) Do not take these specimens closer than one tenth of the fabric width to a selvage or cut edge. If insufficient fabric is available to meet these criteria, note that fact in the report.

9.4 *Procedure*:

9.4.1 Determine the area of the specimen(s) used. For die-cut specimens, the area of the die is normally given. For other specimens, multiply the length by the width.

9.4.2 Weigh the specimen(s) to within ±0.1 % of mass (weight) on a balance. Specimens of a fabric may be weighed together.

9.5 *Calculations*:

9.5.1 Dimensions and mass may be determined in SI units and calculated using Eq 15 (8.4.3), Eq 18, or Eq 19, as follows:

Mass per linear metre:

$$g/m = 10^3 GW/L_s W_s \quad (18)$$

Linear metre per kilogram:

$$m/kg = L_s W_s/GW \quad (19)$$

where:

G = mass of specimen, g
W = width of fabric, mm
L_s = length of specimen, mm, and
W_s = width of specimen mm.

9.5.2 Calculate the mass in ounces per square yard, ounces per linear yard, or linear yards per pound to three significant figures using Eq 11 (8.4.1), Eq 19, or Eq 20, as follows:

Mass per linear yard:

$$oz/yd = 1.27 GW/L_s W_s \quad (20)$$

Linear yards per pound:

$$yd/lb = 12.6 L_s W_s/GW \quad (21)$$

where:

G = mass of specimen, g,
W = width of fabric, in.
W_s = width of specimen, in., and
L_s = length of specimen, in.

9.5.3 If preferred convert the U.S. customary units to SI units by using Eq 8, Eq 9, or Eq 10 in 7.4.4.

10. Option D—Narrow Fabrics

10.1 *Significance and Use*:

10.1.1 This procedure is intended for use with narrow fabrics as so designated by the trade. These fabrics are usually 300 mm (12 in.) in width or less, have a selvage on both sides and are woven on multishuttle looms.

10.1.2 Option D is not recommended for acceptance testing of commercial shipments since Option A is regularly used for that purpose.

10.2 *Sampling*:

10.2.1 *Lot Sample*—As a lot sample for acceptance testing, take at random the number of rolls of fabric as directed in an applicable material specification or other agreement between the purchaser and the supplier. Consider the rolls of fabric to be the primary sampling units.

10.2.2 *Laboratory Sample*—From each roll or piece in the lot sample, cut a conditioned laboratory sample 1 m ± 3 mm (36.0 ± 0.10 in.) long perpendicular to the selvages. Take a minimum of three such laboratory samples from different places, distributed as evenly as practicable along the length of the roll or piece. In this procedure a complete laboratory sample is used as a specimen.

10.3 *Procedure*:

10.3.1 Measure the width of the fabric to the nearest 1 mm (0.125 in.) by the tension-free alternative of Option A of Test Methods D 3774.

10.3.2 Weigh each specimen to within ±0.1 % of its weight on a scale or balance.

10.4 *Calculations*:

10.4.1 If all measurements are made in SI units, use Eq 15, Eq 16 or Eq 17 in 8.4.3.

10.4.2 Calculate the average mass as ounces per linear yard or linear yards per pound using Eq 12, Eq 13, or Eq 14 from 8.4.1.

10.4.3 If preferred, convert the U.S. customary units to SI units using Eq 9 or Eq 10 in 7.4.4.

11. Report

11.1 State that the tests were made as directed in Option A (or B or C or D) in Test Methods D 3776. Describe the material or product sampled and the method of sampling used.

11.2 Report the following information:

11.2.1 Option used to measure fabric mass per unit area.

11.2.2 Fabric mass in ounces per square yard, or ounces per linear yard, or in yards per pound, to three significant figures.

11.2.3 Fabric mass in grams per square metre, or grams per linear metre, or metres per kilogram, to three significant figures.

11.2.4 Fabric width if mass is reported as mass per linear metre (yard) or metres per kilogram (yards per pound).

11.2.5 State whether the fabric weight includes or does not include selvages, and

11.2.6 Atmospheric conditions under which the tests were conducted and whether the specimens were conditioned as directed in Practice D 1776.

12. Precision and Bias

12.1 *Summary*—In comparing two averages of four observations when using Option B of Test Methods D 3776, the difference should not exceed the following amounts in 95 out of 100 cases when all of the observations were taken by the same well-trained operator using the same piece of equipment and specimens randomly drawn from the same sample of material:

Seersucker	0.125 oz/yd^2
Gingham	0.080 oz/yd^2
Corduroy	0.330 oz/yd^2
Denim	0.105 oz/yd^2

Larger differences are likely under all other circumstances. The procedure in Option B of Test Methods D 3776 has no known bias and is used as a referee method.

12.2 *Interlaboratory Test Data*—An interlaboratory test was run in 1981 in which randomly drawn specimens of four materials were tested in each of four laboratories using Option B of Test Methods D 3776. Two operators in each laboratory each tested two specimens of each material for mass per unit area. The first fabric was a 65 % polyester and 35 % cotton seersucker type basket weave. The second fabric was a 65 % polyester and 35 % cotton gingham check. The third fabric was an 88 % cotton and 12 % polyester corduroy. The fourth fabric was a 100 % cotton denim. The components of variance for fabric mass per unit area expressed as standard deviations were calculated to be as follows:

	Average Mass per Unit Area	Single-Operator Component	Within-Laboratory Component	Between-Laboratory Component
Seersucker	6.11 oz/yd^2	0.091	0.000	0.023
Gingham	2.90 oz/yd^2	0.029	0.000	0.031
Corduroy	10.42 oz/yd^2	0.119	0.073	0.082
Denim	7.45 oz/yd^2	0.038	0.000	0.066

NOTE 1—The square roots of the components are being reported to express the variability in the appropriate unit of measure rather than as the square of those units of measure.

12.3 *Precision*—For the components of variance reported in 12.2, two averages of observed values should be considered significantly different at the 95 % probability level if the difference equals or exceeds the critical differences in Table 1.

NOTE 2—The tabulated values of the critical differences should be considered to be a general statement, particularly with respect to between-laboratory precision. Before a meaningful statement can be made about two specific laboratories, the amount of statistical bias, if any, between them must be established with each comparison being based on recent data obtained on specimens taken from a lot of material of the type being evaluated so as to be as nearly homogeneous as possible and then randomly assigned in equal numbers to each of the laboratories.

12.4 *Bias*—Option B in Test Method D 3776 for measuring mass per unit area (weight) of full width samples has no known bias and is accepted as a referee procedure. The accuracy of the other procedures in Test Method D 3776 has not been established. Weights of unconditioned fabric will be affected by the past history of the product.

13. Keywords

13.1 fabric; mass per unit area; weight

TABLE 1 Critical Differences for the Conditions Noted, 95 % Probability Level, Option B, Mass per Unit Area[A]

Fabric	Number of Observations in Each Average	Single-Operator Precision	Within-Laboratory Precision	Between-Laboratory Precision
Seersucker (6.11 oz/yd^2)	1	0.249	0.249	0.257
	4	0.125	0.125	0.140
	8	0.088	0.088	0.109
	16	0.062	0.062	0.089
Gingham (2.90 oz/yd^2)	1	0.080	0.080	0.118
	4	0.040	0.040	0.095
	8	0.028	0.028	0.090
	16	0.020	0.020	0.088
Corduroy (10.42 oz/yd^2)	1	0.330	0.387	0.449
	4	0.165	0.261	0.346
	8	0.117	0.234	0.326
	16	0.082	0.218	0.315
Denim (7.45 oz/yd^2)	1	0.105	0.105	0.211
	4	0.053	0.053	0.190
	8	0.037	0.037	0.187
	16	0.026	0.026	0.185

[A] The critical differences were calculated using $t = 1.960$ which is based on infinite degrees of freedom.