



Standard Test Methods for Yarn Crimp and Yarn Take-up in Woven Fabrics¹

This standard is issued under the fixed designation D 3883; 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 determination of the relationship between the length of a piece of fabric and the length of the yarn in the fabric by measurement of the yarn crimp and yarn take-up.

1.2 This test method applies to woven fabrics.

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

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:*

D 123 Terminology Relating to Textiles²

D 1776 Practice for Conditioning and Testing Textiles²

D 2904 Practice for Interlaboratory Testing of a Textile Test Method that Produces Normally Distributed Data²

D 2906 Practice for Statements on Precision and Bias for Textiles²

3. Terminology

3.1 *Definitions:*

3.1.1 *bench marks, n*—marks placed on a specimen to define gage length, that is, the portion of the specimen that will be evaluated in a specific test.

3.1.2 *yarn crimp, n*—in fabric, the undulations or waviness in a yarn due to interactions with other yarns.

3.1.2.1 *Discussion*—Yarn crimp in a fabric is the difference in the measured distance between two points on a yarn as it lies in the fabric, and the same two points when the yarn has been

removed from the fabric and straightened under a specified tension, expressed as a percent based on the in-fabric distance.

3.1.3 *yarn take-up, n*—in fabric, the additional length of yarn used to make a given length of fabric.

3.1.4 Yarn take-up in a fabric is the measured distance between two points on a yarn as it lies in a fabric and the same two points when the yarn has been removed from the fabric and straightened under a specified tension, expressed as a percent based on the straightened out-of-fabric distance.

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

4. Summary of Test Method

4.1 Bench marks are placed on a length of a yarn as it lies in a woven fabric. The distance between the bench marks is measured. The yarn is removed from the fabric, straightened by applying suitable tension, and the distance between the bench marks is remeasured. Yarn crimp is the change in length expressed as a percent and based on the in-fabric distance. Yarn take-up is the change in length expressed as a percent and based on the out-of-fabric distance.

5. Significance and Use

5.1 The relationship of the length of a piece of fabric and the length of yarn in the fabric can be determined accurately only by measuring the length of yarn entering the loom and the length of fabric made from that particular length of yarn. In most cases, however, the determination must of necessity be made on a woven fabric by measuring the length of yarn removed from a measured length of fabric, thus introducing certain variations that will influence the accuracy of the test. Yarn removed from the woven fabric contains undulations or waves that have been introduced by the weaving process. Heat, moisture, and mechanical shrinkage on subsequent finishing operations may accentuate these undulations, and in all probability, increase the force to pull them out and straighten the yarn. In order to accurately measure the length of the yarn after the removal of the crimp, these undulations must be pulled out without elongating the yarn. In some cases, the minimum force necessary to straighten the yarn will cause a certain amount of the elongation to take place, thus increasing the length of the yarn. Also, stresses imposed upon the yarn during the weaving process may have been sufficient to stretch the yarn beyond its elastic limit, again increasing its length. It is recognized that determination made by measuring length of yarn removed from

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² *Annual Book of ASTM Standards*, Vol 7.01.

a measured length of fabric may tend to give crimp values that are somewhat higher than the crimp in the yarn as it lay in the fabric. In the case of fabrics made from yarns that exhibit differential shrinkage, or yarns of widely different count, or yarns woven at different tensions, the crimp of each type of yarn in the fabric must be determined and reported separately.

5.2 This test method can be used for acceptance testing of commercial shipments but comparisons should be made with caution because information on estimates of between-laboratory precision is limited as noted in 13.1.

5.2.1 If there are differences or practical significance between reported test results for two laboratories (or more), comparative tests should be performed to determine if there is a statistical bias between them, using competent statistical assistance. As a minimum, the test samples should be used that are as homogeneous as possible, that are drawn from the material from which the disparate test results were obtained, and that are randomly assigned in equal numbers to each laboratory for testing. Other materials with established test values may be used for this purpose. The test results from the two laboratories should be compared using a statistical test for unpaired data, at a probability level chosen prior to the testing series. If a bias is found, either its cause must be found and corrected, or future test results must be adjusted in consideration of the known bias.

6. Apparatus

6.1 *Suitable Device*³, for straightening the yarn through application of horizontal or vertical tension, having two yarn support surfaces or two clamps, the distance between which may be altered in order to apply the needed tension.

6.2 *Suitable Marking Device*, for marking bench marks on the yarn specimen.

7. Sampling and Test Specimens

7.1 *Primary Sampling Unit*—Consider rolls of fabric or fabric components of fabricated systems to be the primary sampling unit, as applicable.

7.2 *Laboratory Sampling Unit*—As a laboratory sampling unit take from rolls two pieces of fabric, full width, each 375 mm (15 in.) in length along the selvage (machine direction) after removing a first 1-mm (1-yd) length. For fabric components of fabricated systems use the entire system.

7.3 *Test Specimens*—From each laboratory sampling unit, as required for each the warpwise and fillingwise directions, take ten test specimens, each 300 mm (14 in.) long as direction in Section 9. Consider the long direction as the direction of test.

7.3.1 For fabric widths 125-mm (5-in.) or more, take no specimen closer than 25-mm (1-in.) from the selvage edge.

7.3.2 For fabric widths less than 125-mm (5-in.), use the entire width for specimens.

7.3.3 Ensure specimens are free of folds, creases, or wrinkles. Avoid getting oil, water, grease, etc., on the specimens when handling.

³ Commercially available devices that have been found acceptable are a twist tester with tension device, a tensile testing machine, and a crimp tester of the direct reading type.

7.3.4 If the fabric has a pattern, ensure that the specimens are a representative sampling of the pattern.

8. Conditioning

8.1 Condition the specimens by bringing them to approximate moisture equilibrium in the standard atmosphere for conditioning textiles as directed in Practice D 1776.

9. Preparation of Test Apparatus and Calibration

9.1 Set-up procedures for machines from different manufacturers may vary. Prepare and verify calibration of the testing device as directed in the manufacturer's instructions.

10. Procedure

10.1 Test the specimens in the standard atmosphere for testing textiles, as described in Practice D 1776.

10.2 Handle the test specimens carefully to avoid altering the natural state of the material.

10.3 Test ten specimens from the warpwise direction or ten specimens from the fillingwise direction, or both, as required in a material specification or contract order.

10.4 Using the marking device, make two lines (bench marks) 250 mm (10 in.) apart, perpendicular to the yarn being tested and extending 25 mm (1 in.) into the fabric, and record the distance between bench marks as distance (F) (in-fabric distance).

10.4.1 If a direct reading device is used, follow the manufacturer's recommendations for establishing the specimen length.

10.5 Prepare an edge by making a cut at least 350 mm (14 in.) long, parallel, and in the direction of the yarn to be measured, and such that it crosses near the ends of both lines of the bench mark.

10.6 Ravel several yarns from the cut edge, such that they contain the bench marks.

10.7 One at a time, when ready to use, ravel ten yarn specimens from the prepared edge of the fabric. Ensure that the bench marks appear on each yarn. Take care not to disturb the twist or strain the yarn. Maintain identity of the fabric direction being evaluated, that is, warpwise or fillingwise.

10.8 Fasten one of the yarn specimens in the clamps of a tensioning device or, if applicable, in the proper position of the yarn supports of a direct reading crimp tester with the bench marks coincident with the nips of the respective clamps that are set for the initial in-fabric length.

10.8.1 Clamp type devices may consist of a twist counter fitted with graduated sliding clamp, or a tension testing machine or which the movement or action can be stopped instantly at any point, such as the constant-rate-of-elongation (CRE-Type) or other similar instrument. For a direct reading crimp tester, the yarn is placed under the hook of the movable shaft with the bench marks on the yarn aligned with the upper fixed yarn supports.

10.9 Apply a force to the yarn just sufficient to remove undulations due to weaving, without imparting stretch as determined by using one of the following three options.

NOTE 1—The three options can give different results. For maximum precision between laboratories, it is recommended that the laboratories use the same equipment and the same option.

10.9.1 *Option A, By Hand*—Straighten the yarn by hand against a scale graduated in 1 mm ($\frac{1}{16}$ in.), observe and record the distance between bench marks to the nearest 1 mm ($\frac{1}{16}$ in.) as (Y) (straightened yarn distance).

NOTE 2—This is the least accurate option because the tension required to remove crimp is unknown.

10.9.2 *Option B, by Tension Device or Crimp Tester*—Using one of the tensioning devices or crimp tester, apply a tension force based upon the known yarn size. If the tension force is not sufficient to remove all the crimp, gradually increase the tension force until the crimp just removed. Use the determined force on all the yarns in the set and proportional force on any other samples in the series or test.

10.9.2.1 Estimate the required tension force using Eq 1:

$$\text{Tensile force, g} = \text{yarn number in tex} \times 0.25 \quad (1)$$

10.9.3 *Option C, Tensile Testing Machine*—Using a constant-rate-of-extension (CRE-type) of testing machine, determine the force to remove undulations by analysis of a force-extension as described in 10.9.3.1.

10.9.3.1 Establish Point A as the point where the force-extension curve begins, that is, zero force and zero extension. Extrapolate the straight-line portion of the force-extension curve through the extension axis, Line CE. The portion of the curve AD represents the removal of the crimp and initial stretch of the yarn. Establish Point D where the force-extension curve separates from the line CE. Establish Point B by constructing a line from Point C, parallel to the force axis to curve AD. Establish Point L by constructing a line from Point B through the force axis, parallel to the extension axis. The force corresponding to Point L is the required tensile force to remove the crimp without stretching (see Fig. 1).

10.10 Determine and record the length of the yarn to the nearest 2.5 mm (0.1 in.) after removal of the crimp as follows:

10.10.1 For clamp-type devices, measure the distance between the bench marks on the straightened yarn and record as distance (Y) (straightened yarn distance).

10.10.2 For constant-rate-of-extension machines, determine and record the straightened distance (Y) between bench marks directly from the extension axis of the force-extension curve illustrated on Fig. 1 by line LB, projected to the extension axis, allowing for any chart magnification ratio.

10.10.2.1 For some tensile testers, straightened yarn distance (Y) and the percent yarn crimp or yarn take-up can be computer-processed automatically.

10.10.3 For direct-reading crimp testers, read the yarn crimp or yarn take-up directly from the dial or scale.

11. Calculation

11.1 Calculate the average distance between the two bench marks on the straightened yarn for all measured specimens to the nearest 2.5 mm (0.1 in.), for each warpwise direction and fillingwise direction, as applicable.

11.2 Calculate the average yarn crimp or average yarn take-up to the nearest 0.1 % using Eq 2 or Eq 3, for each warpwise direction and fillingwise direction, as applicable:

$$C = 100(Y-F)/F \quad (2)$$

$$T = 100(Y-F)/Y \quad (3)$$

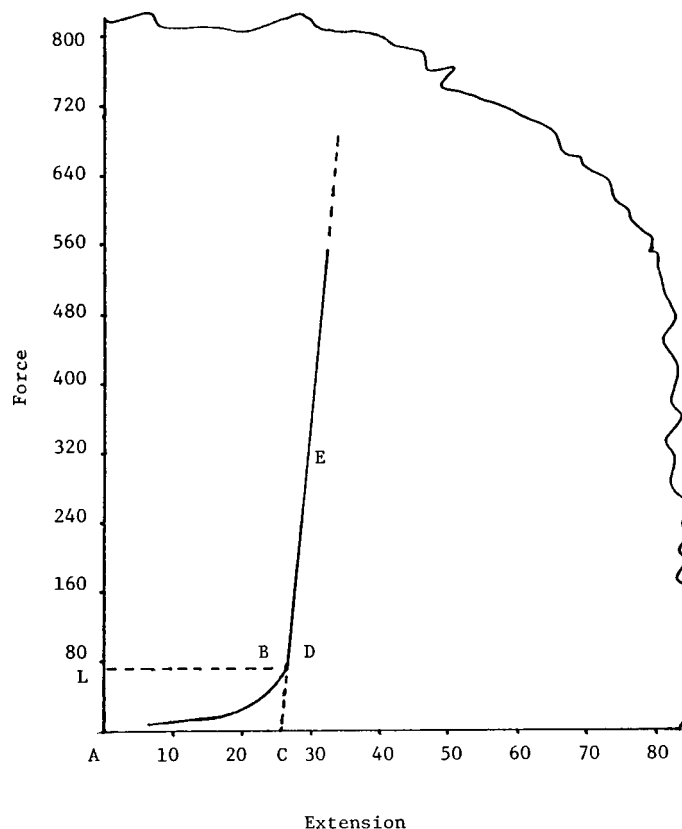


FIG. 1 Example Chart For Determining of Tensile Force Using Option C

where:

C = yarn crimp, %,

T = yarn take-up, %,

F = average of distances between bench marks on yarn in fabric, mm (in.) (from 10.4), and

Y = average of distances between bench marks on yarn after removal from fabric and straightened under tension, mm (in.) (from 10.10).

11.2.1 When data are computer-processed automatically, calculations generally are contained in the associated software. It is recommended that computer processed data be verified against known property values and its software described in the report.

11.2.2 For direct-reading crimp testers, the yarn crimp or yarn take-up is read directly from the dial or scale.

12. Report

12.1 The report shall contain the following information:

12.1.1 Report that the yarn crimp and yarn take-up was determined as directed in Test Method D 3883. Describe the material or product sampled and the method of sampling used.

12.1.2 Report the following information for the warpwise and fillingwise directions for the laboratory sampling unit and for the lot as applicable to a material specification or contract order.

12.1.2.1 Average yarn crimp and average yarn take-up;

12.1.2.2 Test option, manufacturer, and model of test instrument;

12.1.2.3 Force used to remove crimp;

12.1.2.4 When calculated, the standard deviation or the coefficient of variation.

12.1.2.5 For computer-processed data, identify the program (software) used.

13. Precision and Bias

13.1 *Interlaboratory Test Data*⁴—An interlaboratory test was run in 1972 in which randomly-drawn samples of three materials were tested in each of three laboratories. One operator in each laboratory each tested ten specimens from each of two samples of each material using this test method. The precision statement is based upon a testing plan described in Practices D 2904 and D 2906. The components of variance for yarn crimp and yarn take-up expressed as percent of the average were calculated to be:

Single-operator component 4.7 %

Between-laboratory component 5.8 %

13.2 Precision:

13.2.1 Based on the limited study, if a well-trained operator with the same apparatus tests ten yarns from each of the two samples from the same piece of fabric for yarn crimp or yarn take-up, the two results obtained should not differ by more than 10 % of their average.

13.2.2 Based on the limited study, if two well-trained operators in different laboratories using the same type of apparatus tests ten yarns from each of the two samples from the same piece of fabric for yarn crimp or yarn take-up, the two results obtained should not differ by more than 20 % of their grand average.

13.2.3 Because yarn crimp and yarn take-up are calculated from the same two measurements, the precision of these two properties is considered equivalent.

NOTE 3—The tabulated values of single-operator and between-laboratory precision 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 to the type being evaluated so as to be nearly homogeneous as possible and then randomly assigned in equal numbers to each of the laboratories.

NOTE 4—Since the interlaboratory test for yarn crimp and yarn take-up included only three laboratories, estimates of between laboratory precision may be either underestimated or overestimated to a considerable extent and should be used with special caution.

13.3 *Bias*—The procedure of this test method produces a test value that can be defined only in terms of a test method. There is no independent, referee method by which bias may be determined. This test method has no known bias.

14. Keywords

14.1 woven fabric; yarn crimp; yarn take-up

⁴ A research report is available from ASTM Headquarters. Request RR: D-13-1062.

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