Designation: D 5332 – 92

Standard Test Method for Fiber Length and Length Distribution of Cotton Fibers[1]

This standard is issued under the fixed designation D 5332; 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 can be used to determine the fiber length and length distribution of staple fibers of 100 mm (4 in.) or less, using the Fiber Length Measuring Unit AL-101. It includes determination of the fiber length parameters for loose fibers, carded slivers, drawn slivers, finisher slivers, combed slivers, and roving.

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 and health practices and determine the applicability of regulatory limitations prior to use.* For specific precautionary statements, see 8.1.

2. Referenced Documents

2.1 *ASTM Standards:*

D 123 Terminology Relating to Textiles[2]

D 1440 Test Method for Length and Length Distribution of Cotton Fibers (Array Method)[2]

D 1441 Practice for Sampling Cotton Fibers for Testing[2]

D 1776 Practice for Conditioning Textiles for Testing[2]

3. Terminology

3.1 *Definitions*—For definitions of textile terms used in this test method other than those listed below, refer to Terminology D 123.

3.1.1 *coefficient of length variation, n*—a measure of fiber length distribution.

3.1.1.1 *Discussion*—The standard deviation expressed as a percent of the mean length.

3.1.2 *length distribution, n—of fibers,* a graphic or tabular presentation of the proportion or percent (by number or weight) of fibers having different lengths.

3.1.3 *short-fiber content (SFC), n*—that percent of fibers (by number or weight) in a test specimen that is shorter than 12.5 mm (0.5 in.) in length.

3.1.4 *upper-quartile length (UQL), n*—that length that is exceeded by 25 % of the fibers by either weight or number in a test specimen.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *A-tuft, n*—a single-pass process for aligning hook-free fibers on the Fibroliner FL-101.

3.2.2 *B-tuft, n*—a two-pass process for aligning hooked fibers on the Fibroliner FL-101.

3.2.3 *blending plan, n*—the instructions for mixing fibers during specimen preparation.

3.2.4 *hooks, n—in fiber testing,* curved or bent fiber ends caused by the carding or specimen preparation processes.

3.2.5 *horseshoe, n*—a length of sliver folded in a manner such that the two ends can be fed simultaneously into the needle field of the Fibroliner FL-101.

3.2.6 *one-percent length (L1%N), n—in fiber testing,* the length exceeded by 1 % of the number of fibers in a test specimen.

3.2.7 *ratch-setting by number (L1%N), n*—the basis for setting roll spacing in the drafting zone, namely, the length exceeded by 1 % of the number of fibers in a test specimen.

3.2.8 *test beard, n—in length testing of cotton,* the portion of the test specimen that has been combed and brushed into a "beard" that protrudes from the outside of the comb(s) or clamp(s).

4. Summary of Test Method

4.1 Lay loose fibers parallel to form a laboratory sample for processing on the Fibroliner FL-101. Feed the laboratory sample into the needle field of the FL-101. The FL-101 straightens and aligns the fiber to form a test specimen. Transfer the straightened and aligned test specimen to the Fiber Length Measuring Unit AL-101. Protected between two foils, the drawer moves the test specimen through the condenser (capacitor) slot. The condenser scans the fibers of the test specimen every 0.125 mm (0.005 in.). The fiber-length distributions and all length parameters of the fiber in the test specimen are computed from these data. All data can be read from the built-in display or printed with the printer.

5. Significance and Use

5.1 This test method provides objective measurements for fiber length and length distribution in a sample of short-staple fibers. The results of the fiber distribution are presented on the

[1] This test method is under the jurisdiction of ASTM Committee D-13 on Textiles and is the direct responsibility of Subcommittee D13.11 on Cotton Fibers.

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[2] *Annual Book of ASTM Standards,* Vol 07.01.

display or printed out in numerical values or graphs, or both. Data obtained from this test are useful in fiber length research studies and for investigation of the changes in fiber-length distribution in ginning and mill processing.

5.2 This test method covers sampling procedures from loose fibers through roving. It is therefore possible to measure the fiber-length distribution after every production step and compare the results. This allows finding optimum machine settings and checking production machines regarding changes in fiber-length distribution.

5.3 This test method for testing fiber length and fiber-length distribution of short-staple fibers is not normally used for the acceptance of commercial shipments because this test method is not rapid enough for commercial testing.

6. Apparatus

6.1 *Fiber Length Measuring Unit AL-101*.
6.2 *Fiber Alignment Machine Fibroliner FL-101*.
6.3 *Printer with Keyboard for Software Dialogue*.
6.4 *Specimen Holder*.
6.5 *Manual Rake*.
6.6 *Steel Bar*.
6.7 *Manual Fiber Gripper*.
6.8 *Tweezers*.
6.9 *Dark-Velvet Board (110 by 210 mm)*.

7. Reagents and Materials

7.1 *Antistatic Liquid (ASL)*[3], used to control the effects of static electricity and treat the measuring foils of the Fiber Length Measuring Unit AL-101.

7.2 *Isopropyl Alcohol*, used to clean the nipper bed and rakes of the fiber alignment machine, Fibroliner FL-101.

8. Hazards

8.1 The isopropyl alcohol used to clean the nipper bed and rakes of the FL-101 is flammable. Use this product with adequate ventilation. Keep it away from heat, sparks, and open flame. Keep the container closed when stored. Do not take internally.

9. Procedure for Taking Samples

9.1 Take lot samples and prepare 100-g laboratory samples as directed in Practice D 1441 or by a plan agreed upon by the parties interested in the results.

10. Manual Preparation of a Test Specimen from Loose Fibers

10.1 This section defines procedures for the preparation of two 90-mg test specimens from the 100-g (4-oz) laboratory sample.

10.2 Spread the 100-g (4-oz) laboratory sample into a thin layer on a work table. Break it into (a minimum of) four parts (clumps), placing these side by side.

10.3 Take five small pinches of loose fibers from each of the four parts of the laboratory sample (a minimum of 20 pinches in total). Place them together to form a composite test specimen having a nominal mass of from 90 to 100 mg. If a specimen mass is too great and must be reduced, pull fibers from the side (not ends) of the specimen.

10.4 Repeat the procedure given in 10.3 to create a second similar 90-mg test specimen.

10.5 Using tweezers, separate any foreign matter from each composite test specimen (trash that can be separated and discarded without breaking fibers or dislodging short fibers).

10.6 Blend each composite test specimen by the following procedure:

10.6.1 Take the specimen in both hands, with one hand at either end, and slip the fibers apart carefully into two tufts, with one in each hand. (Do not break the fibers.)

10.6.2 Reverse one-half and lay parallel to the other to form a single specimen (finger-gripped ends go together).

10.6.3 Rotate the specimen one-quarter turn around the fiber axis.

10.6.4 Blend the composite test specimen three times by repeating the processes described in 10.6.1-10.6.3.

10.7 Draw each test specimen into a hand sliver form. Prepare the hand sliver with a drawing (drafting) action of the fingers, that is, by pulling the specimen from one hand to the other, as follows:

10.7.1 Grasp one end of the sample firmly by the fingers of one hand.

10.7.2 Pull small pinches from the bundle by using the second hand to pinch the longest fibers from the other end of the bundle. Allow the fibers to slip rather than break when pulled.

10.7.3 Lay each sliver parallel on top of the previous one (in the second or pulling hand, which is usually the right hand), and compress gently to form a new sliver.

10.7.4 Draw the fibers completely in one direction (pulled from one hand to the other), reverse the direction of the sliver, and draw completely in that direction. During this step, take the pinches from the opposite end of the bundle as described in 10.7.1-10.7.3. Carefully note the differences between the blending and drawing steps. Drawing helps to remove the excess fiber crimp.

10.8 Manipulate the fibers to form a paralleled bundle. Grasp the bundle at one end in the fingers of the right hand in preparation for drawing the fibers.

NOTE 1—For hand-blended samples, this will be a second-drafting phase.

10.9 Use the dark-velvet board provided with the instrument. Lay the board flat on the work table. Use the short (110-mm) side of the board. Draw or draft the material by pressing the protruding fiber ends, overlapping 5 to 10 mm over the surface of the dark-velvet board, holding the fiber ends against the board with the index or middle finger of the other (left) hand. Pull the fibers from the bundle by slowly pulling away the grasping (right) hand. Apply gentle pressure to the fiber bundle with the fingers of the right hand to straighten the fibers, in a controlled manner, during the drafting motion.

10.10 Repeat this action, transferring all fibers to the dark-velvet board in small increments. The drawn fibers should be distributed evenly across the short side (110 mm) of the board,

[3] Instruments and accessories meeting these requirements may be obtained from Peyer Corporation, P.O. Box 6446, Spartanburg, SC 29304.

forming a 100-mm wide“ beard.”

10.11 Starting at one side of the board, roll the row of fibers with both hands to form a bundle.

10.12 Grasp this tuft in the right hand by the end that was on the dark-velvet board. The end that was the uneven end of the “beard” now faces the dark-velvet board. Use the short (110-mm) side of the board for the second pass. Repeat the steps given in 10.9 and 10.10 to draft in the second direction, forming a 100-mm beard.

11. Manual Preparation of a Test Specimen from Roving

11.1 Sample blending and opening procedures as described in Section 10 are not necessary because these fibers are already blended and parallel. They should be prepared in the following manner:

11.1.1 Use one hand to position the roving so that the fibers cover a distance 5 or 10 mm perpendicular to their length on the dark-velvet board. Hold the fibers firmly on the board with the index or middle finger, and pull out with a motion of the other hand (between 10 and 20 times).

12. Machine Preparation of a Test Specimen from Loose Fibers and Roving

12.1 Transfer the test specimen, laid on the dark-velvet board according to 10.12 and 11.1.2, directly into the needle field of the FL-101, with the uneven fiber ends facing the grippers. Use the manual rake to push the fibers into the needle field until the first needle points show above the fibers. Use the crank to advance the needles in the direction of the gripper until the first fibers of the test specimen are approximately 3 mm before the last needle bar. Use the selector switch to select several cycles so that all of the fibers in the needle field are caught by the gripper and are transferred to the specimen holder. The test specimen in the specimen holder is called A-tuft (see 3.2.1).

12.2 Remove the test specimen (A-tuft) from the specimen holder with a manual-fiber gripper. Place it in the empty needle field of the FL-101 with the uneven fiber ends facing the gripper. Use the manual rake to push the fibers into the needle field until the first needle points show above the fibers. To reduce the drafting time, turn the crank clockwise to displace the needle field, to the left until the first fibers are approximately 3 mm before the last needle bar. Use the selector switch to select several cycles so that all of the fibers in the needle field are caught by the gripper. Between 30 and 40 cycles are usually sufficient. The number of cycles necessary depends on the maximum fiber length. Ensure that no fibers remain in the needle field. A test specimen transferred in this manner to the specimen holder is called B-tuft (see 3.2.2). Transfer it directly to the Fiber Length Measuring Unit AL-101, with the uneven fiber ends facing the instrument sensor condenser.

13. Preparation of a Test Specimen for Sliver from Processing Steps Before Combing

13.1 This section applies to the preparation of a test specimen from sliver samples that are taken from processing steps that take place before combing.

13.2 Transfer the lot sample (10) directly into the needle field of the FL-101 in horseshoe form, with both ends of the sliver together (see 3.2.5). Use the manual rake to push the fibers into the needle field until the first needle points show above the fibers. Use the crank to advance the needles in the direction of the gripper until the first fibers are approximately 3 mm before the last needle bar. Cycle until sample protruding is an even beard. At least 20 cycles must be conducted on this lot sample to prepare the actual test specimen. Remove the fibers in the specimen holder. These fibers are not used for the length measurement. The FL-101 is ready to process the test specimen. The selection of the necessary number of drafting cycles for a test specimen to be prepared must be based on experience (between 8 and 15). The test specimen in the specimen holder is called A-tuft.

13.3 Remove the test specimen (A-tuft) from the specimen holder with a manual-fiber gripper. Place it in the empty needle field of the FL-101, with the uneven fiber ends facing the gripper. Use the manual rake to push the fibers into the needle field until the first needle points show above the fibers. To reduce the drafting time, turn the crank clockwise to displace the needle field to the left until the first fibers are approximately 3 mm before the last needle bar. Use the selector switch to select several cycles so that all the fibers in the needle field are caught by the gripper and transferred to the specimen holder. Between 30 and 40 cycles are usually sufficient. The number of cycles necessary depends on the maximum fiber length. Ensure that no fibers remain in the needle field. A test specimen transferred in this way to the specimen holder is called B-tuft. Transfer it directly to the Fiber Length Measuring Unit AL-101, with the uneven fiber ends facing the instrument sensor condenser.

14. Preparation of the Test Specimen from Combed Sliver

14.1 This section applies to the preparation of test specimens from comber slivers and post combing drawing processes.

14.2 Transfer the lot sample directly into the needle field of the FL-101 in horseshoe form, with both ends of the sliver together. Use the manual rake to push the fibers into the needle field until the first needle points show above the fibers. Use the crank to advance the needles in the direction of the gripper until the first fibers are approximately 3 mm before the last needle bar. Cycle until the sample protruding is an even beard. To prepare the actual test specimen, at least 20 cycles must be conducted on this lot sample. Remove the fibers in the specimen holder. These fibers are not used for the length measurement. The FL-101 is ready to process the test specimen. Selection of the necessary number of drafting cycles for a test specimen to be prepared must be based on experience (between 8 and 15). The test specimen in the specimen holder is called an A-tuft. Transfer it directly to the Fiber Length Measuring Unit AL-101, with the uneven fiber ends facing the instrument sensor condenser.

15. Preparation of Apparatus

15.1 Switch the Fiber Length Measuring Unit AL-101 on at least 10 min before use.

15.2 Check the functions of the AL-101 once per day, with the measuring gage, as described in the user’s manual. The

measuring gage is a precision cut template. Call the manufacturer for calibration adjustments.

16. Conditioning

16.1 Test the specimens in the standard atmosphere for testing textiles after bringing them to moisture equilibrium as directed in Practice D 1776. Preconditioning is not necessary.

17. Procedure

17.1 Clean the AL-101 as described in the user's manual. Select the short range and Material Sensitivity 2 for test specimens of short-staple fibers 100 mm (4 in.) or less.

17.2 Before transferring a test specimen, reset the AL-101 with the instrument reset button to clear all memory and to load the new test specimen data.

17.3 Then transfer the test specimen with the specimen holder to the bottom foil of the AL-101. Push the test specimen out of the specimen holder by using the manual rake. Place the steel bar on the base of the test specimen to prevent the specimen from moving when the specimen holder and rake are removed. Remove the specimen holder and rake.

17.4 While pressing gently on the steel bar with one hand, remove any loose fibers in front of the test specimen by using a lint free, soft cloth.

17.5 Lower the foil-covered top portion of the drawer of the AL-101 onto the test specimen while removing the steel bar. The steel bar should be removed by rolling it off the end of the fibers. This protects the test specimen between the two layers of foil. Press the start button to begin the measuring process.

17.6 The drawer with the test specimen enters the measuring field of the AL-101. Measurements are taken while the test specimen travels through the measuring field.

18. Calculations of Results

18.1 After the measuring process is started, the microprocessor automatically executes the measuring process and calculation and computation of fiber-length distribution.

19. Report

19.1 State that the specimens were tested as described in this test method.

19.2 Describe the material or product sampled, the method of sampling used, and the number of specimens tested for each sample.

19.3 *Report the following information*:

19.3.1 Mean-fiber length (ML),

19.3.2 Upper-quartile length (L25%),

19.3.3 Coefficient of variation for length (CV),

19.3.4 Short-fiber content (SFC) (percent shorter than 12.5 mm (0.5 in.), and

19.3.5 One percent length (L1%N).

20. Precision and Bias

20.1 *Interlaboratory Test Data*—An interlaboratory test was conducted in 1984. Two operators in each of the eight laboratories performed fiber-length tests with this test method. Both operators tested specimens from eight different cottons. Each test specimen was coded with a number, and the result was decoded after the completed tests. Table 1 lists the components of variance expressed as standard deviations (calculations based on weight measurements).

20.2 *Bias*—The procedures given in this test method for measuring fiber length and fiber-length distributions have no known bias because the value of the properties can be defined only in terms of a test method.

21. Keywords

21.1 cotton; length; textile fibers

TABLE 1 Variance Components

Test Item	Within Laboratory	Between Laboratories
Mean-fiber length (ML), in. (mm)	0.0193 (0.490)	0.0208 (0.528)
Upper-quartile length (L25%), in. (mm)	0.0224 (0.569)	0.0244 (0.620)
Coefficient of length variation, CV (%)	2.06	2.2071
Short-fiber content (SFC), %	2.20	2.4166