Designation: D6571 – 22

Standard Test Method for Determination of Compression Resistance and Recovery Properties of Highloft Nonwoven Fabric Using Static Force Loading[1]

This standard is issued under the fixed designation D6571; 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 compression resistance and recovery properties of any type of highloft nonwoven fabric using a simplistic and economical applied static weight loading technique.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.3 The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are provided for information only and are not considered standard.

1.4 This test method offers two options for the measurement of compression resistance and recovery properties. Option 1 contains fewer steps and is, therefore, simpler. Option 2 makes more measurements and provides more details about the behavior of a fabric under these test conditions.

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D123 Terminology Relating to Textiles

D2904 Practice for Interlaboratory Testing of a Textile Test Method that Produces Normally Distributed Data (Withdrawn 2008)[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *applied static force, n—in testing*, the application of a fixed force by action of gravity on a fixed mass.

3.1.2 *batting, n*—a textile filling material consisting of a continuous web of fibers formed by carding, garnetting, air laying, or other means.

3.1.3 *compression force, n*—the perpendicular force applied to surface(s) of a material in compaction.

3.1.4 *compression recovery, n*—the property of a material to regain its original dimensions after release from compaction.

3.1.5 *compression resistance, n*—the property of a material to oppose its change in dimension under compaction.

3.1.6 *dead-weight loading, n—in testing*, a method of loading in which a mass is supported solely by the specimen and has no other mechanical connection to the test machine. Static loading may be considered a synonym of dead-weight loading.

3.1.7 *elastic loss, n*—the permanent loss of specimen's original dimension after the compression or tension force is applied and then subsequently removed.

3.1.8 *highloft nonwoven fabric, n*—a low-density fiber network structure characterized by a high ratio of thickness to mass per unit area.

3.2 For definitions of other textile terms, refer to Terminology D123.

4. Summary of Test Method

4.1 A specimen (one piece of or a stack of pieces) is placed between two plates and the height of the stack measured. A weight of specified mass is placed on the top plate for a specified period of time. The height of the specimen with the mass in place is measured at specified time intervals. The mass is removed and the height of the stack is measured at specified

[1] This test method is under the jurisdiction of ASTM Committee D13 on Textiles and is the direct responsibility of Subcommittee D13.90 on Executive.

Current edition approved March 1, 2022. Published April 2022. Originally approved in 2005. Last previous edition approved in 2001 as D6571- 01$^{\varepsilon 1}$ which was withdrawn October 2008 and reinstated in March 2022. DOI: 10.1520/D6571-22.

[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] The last approved version of this historical standard is referenced on www.astm.org.

time intervals. Compression resistance and recovery properties are calculated using the height measurements.

5. Significance and Use

5.1 The ability of a highloft nonwoven fabric to resist compression and recovery and elastic loss after compression are two basic physical properties that are measured to set specifications for certain end-use applications. This test method provides an inexpensive alternative for highloft producers, their suppliers and customers to determine compression resistance, and recovery properties thus better predicting their performance in the finished product.

5.2 Compression resistance and recovery performance requirements of highloft nonwovens will vary according to the end-use application. Furniture, bedding apparel, and industrial applications do not require the same property values to satisfy their individual consumers. They will require resistance to compression and the ability to recover to some degree.

5.3 Option 1 of this test method is used in the trade for the acceptance testing of commercial shipments. Compression recovery graphs from Option 2 can be helpful in comparing performance of different highloft nonwoven fabrics.

5.3.1 In case of a dispute arising from differences in reported test results when using this test method, the purchaser and the supplier should conduct comparative tests to determine if there is a significant 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 samples that are as homogeneous as possible and that are from a lot of material of the type in question. The test samples should be randomly assigned in equal numbers to each laboratory for testing. The average results from the two laboratories should be compared using an appropriate statistical test for unpaired samples and an acceptance 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 with consideration of the known bias.

NOTE 1—An adequate specification or the agreement between the purchaser and the supplier requires taking into account the variability between rolls and within rolls to provide a meaningful producer's risk, consumer's risk, acceptance quality level, and limiting quality level.

6. Apparatus

6.1 Steel Rule, graduated in at least 1 mm (0.05-in.) increments at least 150 mm (6 in.) long or suitable length to measure specimens' heights for the material of interest.

6.2 Timer, such as a clock, capable of indicating the total time interval of the test method (see 8.2) and graduated in hours and minutes.

6.3 *Plates:*

6.3.1 *Base or Bottom Plate,* 230 mm by 230 mm by 6.35 mm (9-in. by 9-in. by 1⁄4-in.) plywood plate covered with aluminum foil, or a piece of aluminum sheet.

6.3.2 *Cover or Top Plate,* 230 mm by 230 mm by 6.35 mm (9-in. by 9-in. by 1⁄4-in.) plywood plate covered with aluminum foil weighing 187 ± 2 g (0.41 ± 0.005 lb).

6.4 Weight, pieces of metal, liquid-filled containers, or other appropriate substitute of a specific mass to equal 7.26 kg (16 lb) used to compress highloft battings.

7. Sampling and Test Specimens

7.1 *Lot Sample*—As a lot sample for acceptance testing, take at random the number of rolls directed in an application material specification or other agreement between the purchaser and the supplier. Consider the rolls, or pieces, of nonwoven material to be the primary sampling unit. In absence of such an agreement, take the number of rolls specified in Table 1.

7.2 *Laboratory Sample*—For the laboratory sample, take a swatch extending the width of the fabric and approximately 1 m (1 yd) along the machine direction from each roll, or piece, in the lot sample. If the thickness of the sample is such that this length is not adequate to supply enough fabric for the testing, use a swatch that is twice this length. For rolls of fabric, take a sample that will exclude the outer wrap of the roll or the inner wrap around the core

7.3 *Test Specimens*—Specimens should be taken randomly from areas of the laboratory sample that are free of folds and wrinkles and any distortions that make these specimens abnormal from the rest of the test material. Unless otherwise specified, take specimens randomly no nearer to the edges of the sample than one tenth of the width of the sample. Test one specimen from each sampling unit, or test three specimens representing the right, the center, and the left of each sampling unit, if the width exceeds 1 m.

7.3.1 A specimen consists of sufficient 200 by 200 mm (8 by 8-in.) pieces of highloft nonwoven fabric which, when stacked, measures at least 100 mm (4 in.) in height, or one piece of finished product that measures at least 100 mm in height.

NOTE 2—For highloft nonwoven fabrics, typically, four to six pieces are stacked to make a specimen.

7.3.2 Cutting Test Specimens—If making one test per unit, cut the pieces for each specimen at random across and along each laboratory sampling unit, preferably along the diagonal. If testing right, center, and left areas, cut the pieces needed for each specimen from the appropriate section of each laboratory sampling unit.

8. Conditioning

8.1 No preconditioning is needed.

8.2 Control the temperature for conditioning and testing between 20 °C and 24 °C (68 °F and 75 °F). No control of relative humidity is required.

TABLE 1 Number of Rolls, or Pieces, of Nonwoven Material in the Lot Sample

Number of Rolls, Pieces in Lot Inclusive	Number of Rolls or Pieces in Lot Samples
1 to 3	all
4 to 24	4
25 to 50	5
over 50	10 % to a maximum of 10 rolls or pieces

9. Procedure

9.1 *Height Measurements:*

9.1.1 For each height determination, make four measurements of distance from the top of the base plate to the bottom of the cover plate, with a measurement at the midpoint of each side of the cover plate. Make the four measurements in rapid succession and read to the nearest mm (0.05 in.)

9.2 *Option 1: Acceptance Testing:*

9.2.1 Place a specimen (one piece or stack of pieces as needed) on the base plate and add the cover plate. Measure the specimen height. Record the values, average the values in calculations in all sections, as the initial height, *A*. Once the cover plate is put on the specimen, do not remove the cover plate until the test is completed.

9.2.2 Immediately after measuring the initial height, place the mass (6.4) centrally and uniformly and start the timer. After the mass has been on the specimen for 10 min measure the specimen height. Record the average of the four measurements as the 10-min compressed height, *C*.

9.2.3 Remove the mass, allow the specimen to relax for 10 min, and then measure the specimen height. Record the as 10-min relaxed height *E* (elapsed time 20 min).

9.2.4 Replace the mass on the specimen. After a 24-h test period, remove the mass and allow the specimen to relax for 1 h. Measure the specimen height. Record as 1-h recovery height.

9.3 *Option 2: Long-Term Recovery and Graphical Analysis:*

9.3.1 Place a specimen (one piece or stack of pieces) on the base plate and add the cover plate. Measure the specimen height. Record the average of the four measurements as the initial height, *A*. Once the cover plate is put on the specimen, do not remove the cover plate until the test method is completed.

9.3.2 Immediately after measuring the initial height, place the mass (6.4) centrally and uniformly on the cover plate and start the timer. Immediately measure the height of the weighted specimen and record the average of the four measurements as the initial compressed height, *B*.

9.3.3 After the mass has been on the specimen for 10 min, measure the specimen height. Record the average of the four measurements as the 10-min (1st) compressed height, *C*.

9.3.4 Remove the mass from the cover plate and immediately measure the height of the specimen. Record this as the first relaxed height, *D*.

9.3.5 Allow the specimen to relax for 10 min and then measure the specimen height. Record this as the 2nd relaxed height, *E*.

9.3.6 Replace the mass on the cover plate and measure the height of the specimen. Record this as the 2nd compressed Height, *F*.

9.3.7 After a 24-h test period, measure the height of the weighted specimen. Record this as the 3rd compressed height, *G*.

9.3.8 Remove the mass from the cover plate and measure the height of the specimen. Record this as the 3rd relaxed height, *H*.

9.3.9 Allow the specimen to relax for 1 h. Measure the specimen height. Record this as the 4th relaxed height, *J*.

NOTE 3—Most samples reach their maximum recovery within an hour after removal of the mass.

9.3.10 Allow the specimen to continue to relax for an additional 7 h and measure the specimen height. Record this as the final relaxed height, *K*.

10. Calculation or Interpretation of Results

10.1 *Option 1:*

10.1.1 Calculate the compression resistance, compression recovery, and elastic loss properties to the nearest 0.1 % using Eq 1-3:

$$L = 100\ C/A \tag{1}$$

$$M = 100\ (A - E)/A \tag{2}$$

$$N = 100\ J/E \tag{3}$$

where:

L = compression resistance, %,
C = 10-min weighted height, mm (in.),
A = initial height, mm (in.),
M = elastic loss, %,
E = 2nd relaxed height, mm (in.),
N = short-term compression recovery, %, and
J = 1-h recovery height, mm (in.).

NOTE 4—The loss in height of a highloft nonwoven fabric between Measurements *A* and *E* is attributed to a loss in elasticity. Under most conditions, this loss is permanent.

10.2 *Option 2:*

10.2.1 Calculate compression properties as directed in 10.1.1.

10.2.2 Calculate long-term compression recovery using Eq 4 as follows:

$$O = 100\ K/E \tag{4}$$

where:

O = long-term compression recovery, %, and
K = final relaxed height, mm (in.).

10.3 Calculate the average of each compression property for each laboratory sampling unit (if left, right, and middle areas were tested separately) and for the lot.

10.4 If requested, make a graph of the compression recovery performance. See Fig. 1 for an example graph.

11. Report

11.1 State that the specimens were tested in accordance with Test Method D 6571. Describe the material(s) or product(s) and the method of sampling used.

11.2 Report the following information for each sampling unit and the lot as applicable to the material specification or other agreement:

11.2.1 The number of specimens in each lot and the number of pieces in a stack if more than one is needed.

11.2.2 The compression resistance.

11.2.3 The elastic loss.

11.2.4 The compression recovery.

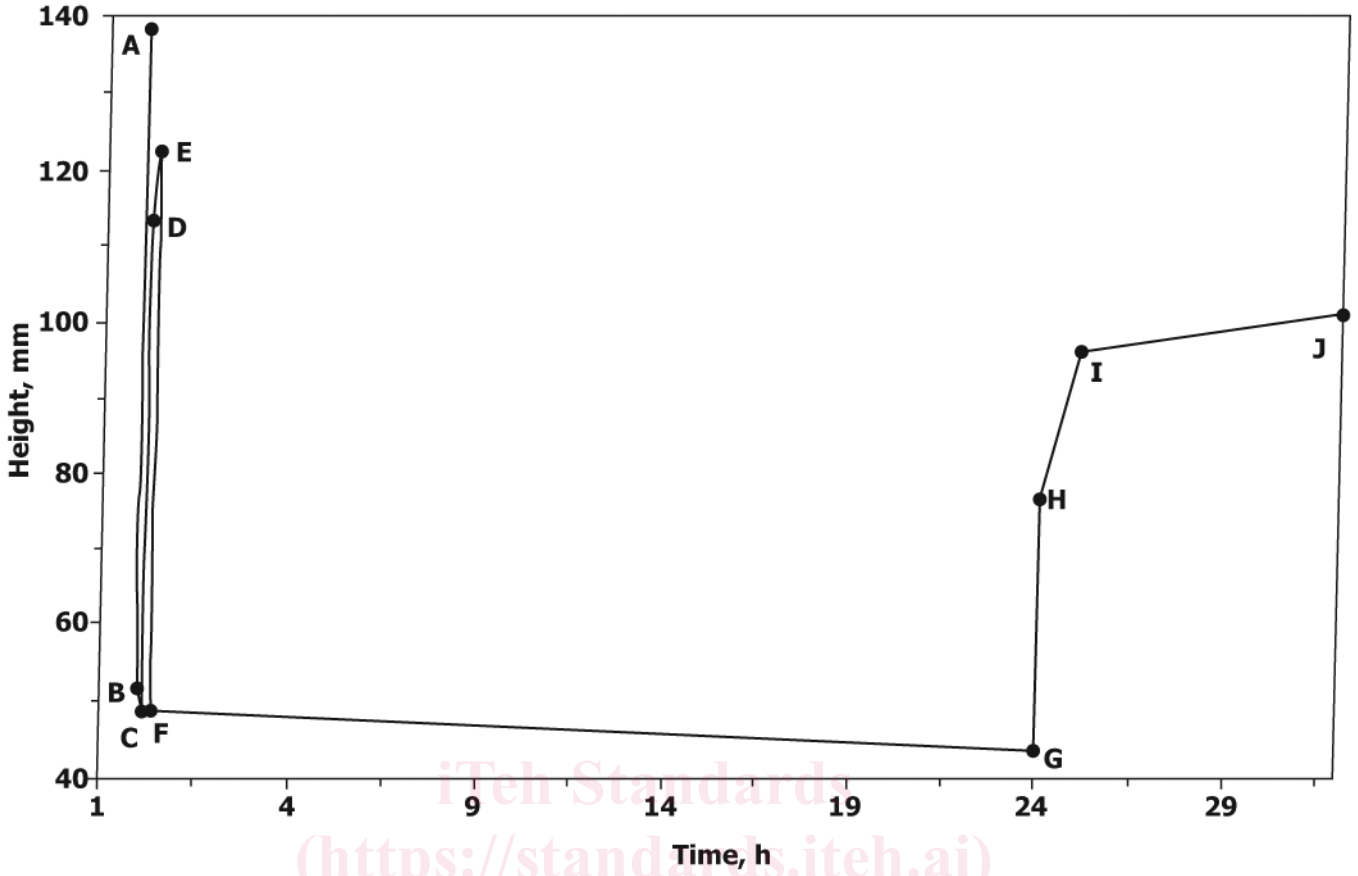

FIG. 1 Typical Example of Compression Recovery Performance at Room Temperature

11.2.5 The use of either Option 1 or Option 2. If Option 2 was used, the long-term compression recovery.

11.2.6 Copies of any compression recovery performance graphs prepared.

12. Precision and Bias[4]

12.1 *Summary*—Preliminary interlaboratory test data have shown that the variance in compression recovery of highloft nonwoven fabrics by this test method is dependent upon the nominal thickness and possibly the manufacturing method of the material under evaluation; therefore, no general statement can be made concerning least critical differences. The following data were generated during the interlaboratory test and are presented for reference. In comparing two averages for four observations, the difference between averages should not exceed the following values in 95 out of 100 cases when all observations are taken by the same well-trained operator using the same piece of equipment and specimens are randomly drawn from the same sample having a nominal thickness as indicated in Table 2. Larger differences are likely to occur under all other circumstances.

12.2 *Interlaboratory Test Data*—A preliminary test run in 1992 in which randomly drawn samples of three materials were tested in each of six laboratories. Data from one of the materials and data from one of the laboratories was found to be erratic and the sampling of the material questionable and the laboratory procedure unreliable. Two operators in each laboratory tested three specimens of each material. The materials used in the evaluation were manufactured by different processes. Analysis of the data was conducted using Practice D2904 and the Adjunct TEX-PAC. Data from the TEX-PAC suggested reporting the components and least critical difference for each material. The components of variance, expressed as standard deviation, for materials evaluated are listed in Table 3. Further testing is in progress to elucidate the ruggedness of this test method.

TABLE 2 Difference Between Averages

Nominal Thickness, (in.) Manufacturing Method	Percentage Points Difference in Production Process (A or B)
% compression resistance	
2 in./Method A	1.61
3 in./Method B	3.20
% elastic loss	
2 in./Method A	1.36
3 in./Method B	2.27
% compression recovery	
2 in./Method A	4.13
3 in./Method B	2.39
% long-term compression recovery	
2 in./Method A	2.49
3 in./Method B	1.46

[4] Supporting data was originally filed as Research Report RR:D13-1106.