



Standard Test Method for Resistance to Yarn Slippage at the Sewn Seam in Upholstery Fabrics (Dynamic Fatigue Method)¹

This standard is issued under the fixed designation D 4033; 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 or visual evaluation of yarn slippage and other types of failures in the three most commonly used upholstery seams—warp sewn to warp (wale to wale), filling sewn to filling (course to course), and warp sewn to filling (wale to course). The stresses at the seam are created by imposing a cyclic, impact, and penetrating load which fatigues the seam construction.

NOTE 1—Within this test method it is assumed, for simplicity, that the sample being tested is of a woven construction. In case the sample is of a knot construction, it is only necessary to substitute “wale” for “warp” and “course” for “filling” in the instructions.

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

1.3 *This standard does not purport to address all of the safety problems, 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 Textiles for Testing²
- D 3453 Specification for Flexible Cellular Materials—Urethane for Furniture and Automotive Cushioning Bedding, and Similar Applications³
- D 3574 Test Methods for Flexible Cellular Materials—Slab, Bonded, and Molded Urethane Foams³
- D 3597 Specification for Woven Upholstery Fabrics—Plain, Tufted, or Flocked⁴

¹ This test method is under the jurisdiction of ASTM Committee D-13 on Textiles and is the direct responsibility of Subcommittee D13.59 on Fabric Test Methods, General.

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

³ *Annual Book of ASTM Standards*, Vol 09.02.

⁴ *Annual Book of ASTM Standards*, Vol 07.02.

2.2 Federal Standard:

Fed. Std. No. 751a Stitches, Seams, and Stitching⁵

3. Terminology

3.1 Definitions:

3.1.1 *fatiguing load, n*—in testing sewn seams, the force that is repeatedly applied to a test specimen.

3.1.2 *filling-to-filling seam, n*—a sewn seam in which the yarns in the filling direction on both sides of the sewn seam are perpendicular to the seam.

3.1.3 *flagging, n*—in sewn seams, a mode of failure evidenced by slippage of one or more yarns entirely out of the original seam.

3.1.4 *reinforced seam, n*—in sewn fabrics, a seam that includes an additional layer of material on the face or back side of the seam allowance.

3.1.4.1 *Discussion*—The added material is used to strengthen the seam and delay failure of the seam beyond the minimum acceptable limits and so enable the specimen to pass a specified cyclic impact test.

3.1.5 *resistance to yarn slippage, n*—at the seam, the force required to displace one or more yarns in a fabric from the original position, causing differences in alignment, spacing, or both.

3.1.6 *seam allowance, n*—in sewn fabric, the distance from the edge of a fabric to the parallel stitch line furthest from that edge.

3.1.7 *sewn seam, n*—in sewn fabrics, a juncture at which two or more planar structures such as textile fabrics, are joined by sewing, usually near the edge.

3.1.8 *thread break, n*—in sewn seams, a mode of failure evidenced by rupture of the sewing thread.

3.1.8.1 *Discussion*—A sewing thread break is not construed as a failure unless the test is being performed as a sewing thread analysis.

3.1.9 *warp-to-filling seam, n*—a sewn seam in which the warp yarns are perpendicular to the sewn seam on one side of the seam and parallel to the seam on the opposite side of that seam.

3.1.10 *warp-to-warp seam, n*—a sewn seam in which the yarns in the warp direction on both sides of the seam are

⁵ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, Pa. 19111-5094, Attn: NPODS.

perpendicular to the seam.

3.1.11 *yarn break, n—in sewn seams*, a mode of failure evidence by yarns rupturing at the seam or at any other area in the test specimen (Syn. **yarn burst** and **yarn tear**).

3.1.12 *yarn slippage, n—at the seam in sewn fabrics*, the displacement of one or more yarns from the original position, causing differences in alignment, spacing, or both.

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 A specimen with the type of seam to be tested is mounted in the specimen mounting box containing a piece of resilient polyurethane foam composite that forms a simulated seat cushion with appropriate crown height. A fatiguing load is applied through a freely moving, rubber-faced wheel which is automatically dropped onto the specimen from a constant height. The circumference of the wheel impacts the mounted specimen 25 mm (1 in.) from the center line of the seam and parallel to the seam. Continuous impact cycling is begun and continued at a constant rate until failure is measured or observed, or until 7000 drops (cycles) have been completed. Passing the test is construed to be the completion of 7000 cycles without any of the failures described. Each material sampled is tested with each of the three types of seams defined in Section 3.

5. Significance and Use

5.1 Test Method D 4033 for measuring the resistance to yarn slippage at the seam in upholstery fabrics is recommended for acceptance testing of commercial shipments of upholstery fabrics since the method does accurately simulate, under controlled conditions, the loads, forces, and subsequent stresses imposed on seat cushions and other upholstery seams during their use in the field. In cases of disagreement arising from differences in values reported by the purchaser and the seller when using this test method for acceptance testing, the statistical bias, if any, between the laboratory of the purchaser and the laboratory of the supplier should be determined with each comparison being based on testing specimens randomly drawn from one sample of material of the type being evaluated.

5.2 Determination can be made as to whether a fabric will perform satisfactorily in end use.

5.3 Determination can be made as to whether a reinforced seam (as defined in 3.1.4) is necessary in order that the fabric being tested may perform satisfactorily in end use (refer to Specification D 3597, Table 1).

5.4 Fabrics that do not meet the requirements agreed upon between the purchaser and the supplier should be classified as delicate or light duty (refer to Table 1) and the purchaser and furniture manufacturer so notified.

6. Apparatus

6.1 *Fatiguing Unit*—The apparatus used to simulate the forces and stresses imposed on upholstery seams during use (see Fig. 1).

6.1.1 The fatiguing unit is designed with a preset dropping height of approximately 150 mm (6 in.) and a dropping mass of approximately 3.75 kg (8.25 lb) to develop the appropriate

forces and stresses for this test method.

6.2 *Core Foam* (see Specification D 3453)—The foam onto which two sheets of convolute foam are glued to create the polyurethane foam composite. The core foam shall conform to the following requirements:

Dimensions	230 by 280 by 100 mm (9 by 11 by 4 in.)
Density	28.8 kg/m ³ (1.8 lb/ft ³)
25 % indentation-force-deflection (IFD)	3.5 to 4.1 kPa (26 to 30 lb/50 in. ²)
Modulus	2.0 min
Tensile strength	82.7 kPa (12 psi) min
Elongation	150 % min
Tear strength	10.3 kPa (1.5 psi) min
90 % compression set	6 % max
Flex fatigue	30 % max

6.3 *Convolute Foam* (Specification D 3453)—The type of foam as shown in Fig. 2 which is glued onto the core foam to create the polyurethane foam composite and conforms to the following requirements:

Dimensions	230 by 280 by 40 mm (9 by 11 by 1.5 in.)
Density	17.6 kg/m ³ (1.1 lb/ft ³)
25 % IFD	2.4 to 3.3 kPa (18 to 24 lb/50 in. ²)
90 % compression set	10 % max
Flex fatigue	30 % max

6.4 *Compression Plate*—A plate used to compress the test specimen and polyurethane foam composite in order to properly clamp the test specimen to the specimen mounting box (see Fig. 3).

6.5 *Specimen Mounting Box*—A box designed to contain the polyurethane foam composite and equipped with the proper clamping devices for fastening the test specimens (see Fig. 4).⁶

6.6 *Polyurethane Foam Composite*—The filling for the specimen mounting box consisting of two sheets of convolute foam and one sheet of core foam glued together using a neoprene-based adhesive (see Fig. 5).⁷

6.7 *Sewing Needle*—Size 22 light ball point needle.⁸

6.8 *Sewing Thread*—100 % nylon bonded monocord thread. The needle thread shall have a minimum breaking strength of 35 N (8 lbf) and the bobbin thread shall have a minimum breaking strength of 23 N (5 lbf).⁹

7. Sampling

7.1 *Lot Sample*—For acceptance testing, take at random the number of rolls of fabric 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.

7.2 *Laboratory Sample*—Take a full width swatch 2 m (2 yd) long from the end of each roll of fabric in the lot sample, after first discarding a minimum of 1 m (1 yd) from the outside of the roll.

7.3 *Test Specimens*—From each swatch, cut enough pieces to construct three warp-to-warp, three filling-to-filling, and three warp-to-filling specimens that are representative of any

⁶ Available from Furniture Testing Equipment, RD #1 Box 83, Muncy, PA 17756.

⁷ Available from Textile Innovators Corp., PO Box 115, Dallastown, PA 17313.

⁸ Singer 135 × 17 Size 22 or Schmetz NM 140 has been found to be satisfactory.

⁹ Belding Corticelli Thread identified as NYMO-ES-HR size 8 needle thread and NYMO-EX ready wound size 5 bobbin thread have been found to be satisfactory. They can be obtained from Belding Corticelli Thread Co., 1430 Broadway, New York N. Y. 10018.

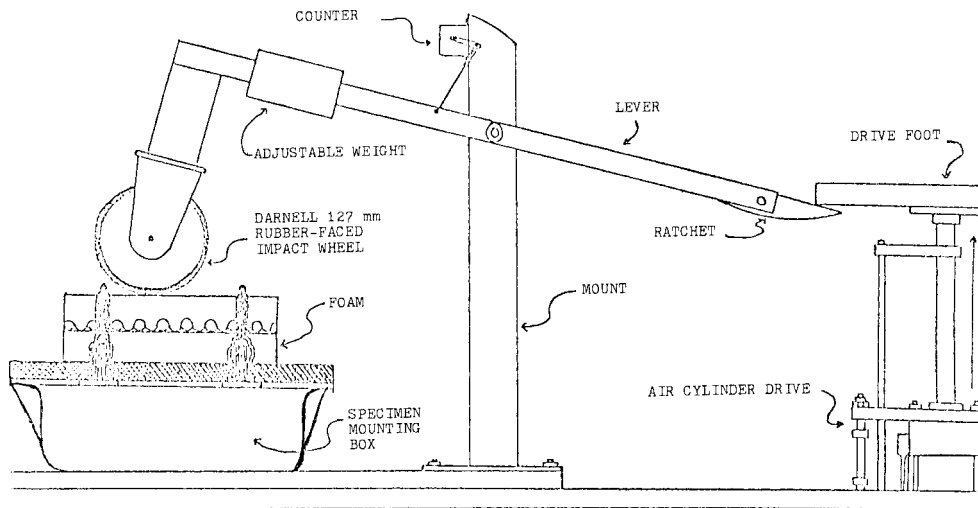


FIG. 1 Single Unit—Complete Apparatus

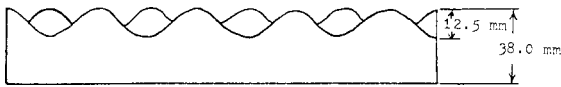


FIG. 2 Convolute Foam

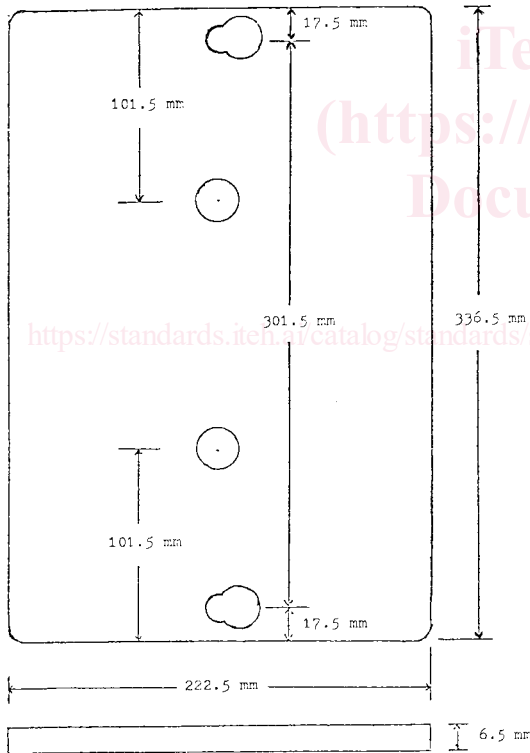


FIG. 3 Compression Plate

selvage, lay out and cut two pieces 190 by 255 mm (7.5 by 10 in.). The warpwise yarns should be parallel to the 190-mm edge of the pieces (see Fig. 8).

7.3.2 *Filling-to-Filling Specimens*—After selecting a beginning edge filling yarn, lay out and cut two pieces 190 by 255 mm (7.5 by 10 in.). The warp yarns should be parallel to the 190-mm (7.5-in.) edge of the pieces (see Fig. 9).

7.3.3 *Warp-to-Filling Specimens*—Cut one piece as directed in 7.3.1 and cut another piece as in 7.3.2 (see Fig. 10).

8. Preparation of Samples

8.1 Samples should be cut at least 1.8 m (2 yd) back from the beginning or the end of the roll.

8.2 Cut three warp-to-warp, three filling-to-filling, and three warp-to-filling samples that are representative of any yarn, construction, or pattern variations of the specific fabric being tested.

9. Preparation of Test Specimens

9.1 *Seams Made for Test*—Sew all seams to be tested by this method with a Type 301 seam as described in Fed. Std. No. 751A.

9.1.1 All seams shall be sewn with a seam allowance of 13 to 16 mm (0.5 to 0.6 in.).

9.1.2 All seams shall be sewn with a stitch count (density) of 7 ± 1 stitches per 25 mm (1 in.). Discard any seams that do not meet this specification.

9.1.3 Adjust the tensions of the sewing threads to properly form the prescribed stitch type.

9.2 *Warp-to-Warp Seam*—Place one of the fabric pieces cut as directed in 7.3.1 on a flat surface with the face of the fabric up. Place the other piece, face down, on top of the first piece with the warp yarns of each piece running in the same direction. Align the edges, and sew a seam perpendicular to the warp yarns across the entire 255-mm (10-in.) dimension. Backtack the seam for 25 ± 8 mm (1.0 ± 0.3 in.) on each end.

9.3 *Warp-to-Filling Seam*—Place one of the fabric pieces cut as directed in 7.3.3 on a flat surface with the face of the fabric up. Place the other piece, face down, on top of the first piece. Align the edges, and sew a seam across the entire

yarn, construction, or pattern variations of the specific fabric being tested.

NOTE 2—If there is disagreement or if the purchaser or supplier does not agree that the standard sampling is representative of a specific fabric, the number and location of the test specimens from each sample roll shall be as agreed upon by the purchaser and the supplier.

7.3.1 *Warp-to-Warp Specimens*—After selecting a beginning edge warpwise yarn at least 100 mm (4 in.) from either