Designation: D5822 – 13

Standard Test Method for Determining Seam Strength in Inflatable Restraint Cushions[1]

This standard is issued under the fixed designation D5822; 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 seam efficiency and the maximum seam strength in inflatable restraint cushions composed of woven fabrics when a force is applied perpendicular to the seam, using a grab test. For evaluating sewing thread, refer to Test Method D204.

1.2 This test method is restricted to seams that are either obtained from an inflatable restraint cushion or prepared off-line, specifically for testing, using fabric blanks, not obtained from a previously sewn cushion assembly. Seams may include but are not limited to sewn, OPW, glued, sealed and sewn, or fused (chemically or thermally). This test method can be used for either lot testing of production cushions, or for research and development purposes.

1.3 This test method is used when the measurement of a resistance to a specified force, a breaking force, a minimum elongation, or a combination thereof are required to determine the seam strength, or seam integrity of a particular fabric for inflatable restraint use.

1.4 Procedures and apparatus other than those stated in this standard may be used by agreement between purchaser and supplier with the specific deviations from the standard acknowledged in the report.

1.5 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other.

1.6 *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]
D123 Terminology Relating to Textiles
D204 Test Methods for Sewing Threads
D1776 Practice for Conditioning and Testing Textiles
D6799 Terminology Relating to Inflatable Restraints

3. Terminology

3.1 For all terminology relating to D13.20, Inflatable restraints, refer to Terminology D6799.

3.1.1 The following terms are relevant to this standard: seam efficiency, seam failure, seam strength.

3.2 For all other terms related to textiles, see Terminology D123.

4. Summary of Test Method

4.1 Specimens either taken from inflatable restraint cushions or made off-line using fabric blanks, specifically for testing, are destructively tested in a tensile testing machine under laboratory conditions to determine seam strength and seam efficiency and nature of the failure mode.

5. Significance and Use

5.1 Seam strength testing is used for design validation and for lot acceptance.

5.2 This test method constitutes the conditions, procedures, and equipment by which either seams taken from inflatable restraint cushions, or seam types that can potentially be used for inflatable restraint cushions are tested for seam strength, seam efficiency, and failure mode. It is intended to be used as a guideline in establishing a written part specification or print. The specification or agreement of purchaser and supplier may deviate from the procedures described herein when (based on experience) considerations of equipment, cushion design, or other factors dictate otherwise.

[1] This test method is under the jurisdiction of ASTM Committee D13 on Textiles and is the direct responsibility of Subcommittee D13.20 on Inflatable Restraints.

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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.

5.3 In cases of dispute arising from differences in reported test results when using this test method for acceptance testing of commercial shipments, the purchaser and the supplier should perform comparative tests to determine if 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 from the same lot of fabric to be evaluated, which utilize a like seam assembly (or standard seam assembly) to achieve seam interaction. The test specimens should then be randomly assigned in equal numbers to each laboratory for testing. If a bias is found, either its cause must be determined and corrected, or the purchaser and supplier must agree to interpret future test results in light of the known bias.

5.4 Test Method D5822 is a reliable test method but procedures which may require special attention are identified in the precision and bias section of this test method.

6. Apparatus

6.1 *Tensile Testing Machine,* of the CRE, CRL or CRT type conforming to Specification D76, with respect to force indication, working range, capacity, and elongation indicator, and designed for operation at a speed of 300 ± 10 mm/min (12 ± 0.5 in./min); or, a variable speed drive, change gears, or interchangeable weights as required to obtain a 20 ± 3-s time-to-break (see 12.4). The constant-rate-of-extension type of tensile testing machine is preferred in this test method.

6.2 *Clamp and Jaw Faces,* adjustable clamps compatible with tensile testing machine, the jaws of which have smooth, flat, metallic gripping surfaces parallel to each other.

6.2.1 Each clamp shall have a front (or top) jaw face measuring 25 ± 1 mm (1.0 ± 0.02 in.) perpendicular to the direction of the application of the force, and not less than 25 nor more than 50 mm (1.0 nor more than 2.0 in.) parallel to the direction of the application of the force. The back, or bottom, jaw face of each clamp shall be at least as large as its mate. Use of a larger face for the second jaw reduces the problem of front and back jaw misalignment.

NOTE 1—Front (or top) faces measuring 25 by 50-mm (1.0 by 2.0-in.) will not necessarily give the same value as 25 by 25-mm (1.0 by 1.0-in.) faces. For many materials, the former are preferable because of the larger gripping area which tends to reduce slippage. While both sizes of gripping surface are permitted, the face sizes used must be the same for all samples in the test and must be recorded in the report.

6.2.2 At least one clamp should be supported by a free swivel or universal joint to allow the clamp to rotate in the plane of the fabric.

6.3 For inflatable restraints, all test equipment used in accordance with this test method shall be certified for calibration annually by an independent agency or equipment manufacturer whose results are traceable to the National Institute of Science and Technology (NIST) or other national standards laboratory. The test parameters of the equipment shall be tested within the operating ranges covered in the cushion specification or equivalent document.

7. Sampling

7.1 Seam strength testing is a destructive test and therefore necessitates sampling procedures if used in conjunction with lot acceptance.

7.2 For acceptance testing, the lot size is the quantity of cushions produced in one day.

7.3 *Lot Sample*—For acceptance testing, take at random the number of cushions directed in an applicable cushion specification or other agreement between purchaser and supplier. Consider the cushions to be the primary sampling units.

7.4 *Test Specimens*—Select portions of sampled cushions containing seam assemblies as directed in an applicable cushion specification or as agreed upon by purchaser and supplier. If seam efficiency testing is to be done, select a portion of unseamed fabric adjacent to the sampled area, from which the seamed specimen was taken. Wherever possible, such specimens should contain the same yarns as the seam assemblies that are to be placed in the clamps oriented parallel to the traverse direction of test.

NOTE 2—Specimens are usually specified to be taken from a cushion at a location on the cushion seam(s) where the greatest stresses are anticipated. In seams involving woven fabric, this is usually where the warp or filling yarns are parallel to the seam. Cushion design may indicate other stress points of concern.

NOTE 3—Use caution in selecting specimens from areas of the cushion where the seams exhibit sharp radius turns. During seam strength testing, these areas will exhibit uneven point loading at the edges of the test specimen.

NOTE 4—Unless otherwise specified for driver-side cushions, select specimens taken from the perimeter seam at the 0 rad (0°), 0.79 rad (45°), and 1.57 rad (90°) positions, relative to the warp direction of the fabric in the front panel.

7.4.1 Cut each specimen 100 ± 1 mm (4 ± 0.05 in.) wide by at least 150 mm (6 in.) long (Note 5) with the long dimension parallel to the direction of testing and force application. For seamed specimens, the seam shall be centrally located perpendicular to the application of force.

NOTE 5—The length of the specimen depends on the type of clamps being used. The specimen should be long enough to extend through the clamps and project at least 10 mm (0.5 in.) at each end. The specimen length may be calculated using Eq 1 or Eq 2:

$$\text{Specimen length, mm} = C + 2W \quad (1)$$

$$\text{Specimen length, in.} = K + 2W \quad (2)$$

where:

C = 95 mm (constant based on a gage length of 75 plus 20 mm for projections beyond the clamp),
K = 4 in. (constant based on a gage length of 3 plus 1 in. for projections beyond the clamps), and
W = jaw face width in direction of force, mm (in.).

7.4.2 To aid in aligning the specimens in the clamps of the tensile testing machine, draw vertical lines parallel to the long direction (and along a yarn of woven fabric) located 37 ± 1 mm (1.5 ± 0.02 in.) in from the edge of both sides of the specimen. The parallel lines serve as a guide to ensure that the same yarns in the direction of test are gripped in both clamps.

8. Conditioning

8.1 Conditioning of specimens for seam strength testing shall be at the standard atmosphere for testing textiles for at least 4 h prior to test, in accordance with Practice D1776.

9. Procedure

9.1 Select and condition specimens in accordance with Sections 7 and 8 of this test method.

9.2 For seam assembly testing, place the specimen containing the seam assembly in the clamps with the seam towards the rear of the machine (as shown in Fig. 1) using the vertical alignment guides, and center the seam line in the clamp faces, perpendicular to the direction of test. For seam efficiency, place the unseamed fabric specimen in the clamps using the vertical alignment guides in the clamp faces, parallel to the direction of test.

9.3 Ensure that the tension on the specimen is uniform across the clamp width.

9.4 Draw a mark across the specimen at the front inner edge of each jaw to check for specimen slippage. When slippage occurs, the mark will move away from the jaw edge and such movement can be observed.

9.5 Operate the tensile tester until partial rupture or severe yarn slippage of the specimen is observed. Record whether the mode of failure is yarn slippage or rupture, and its location.

9.6 Record the maximum seam strength or maximum fabric strength of the test specimen depending upon the type of specimen tested.

9.7 Inspect the mark previously drawn on each specimen across the jaw to check for seam slippage. No noticeable seam slippage should occur during the test.

9.8 Discard test data if the measured breaking force values are significantly below specified value or below the average value of the other specimens.

NOTE 6—The causes of such outlying data include, but are not limited to, *(1)* specimen slippage in jaws, *(2)* specimen rupture at the edge of or within the jaws, and *(3)* faulty operation of the tensile tester. The criteria for deciding to discard outlying test data and the method of reporting such rejection of test data should be established by purchaser and supplier. In the absence of any such agreement, these specimens and results shall be retained.

NOTE 7—When a specimen is observed to slip in the jaws, or if more than 25 % of the specimens break at a point within 5 mm (0.020 in.) of the edge of the jaw, then *(1)* the jaws may be padded, *(2)* the fabric may be coated under the jaw face area, or *(3)* the surface of the jaw face may be modified. If any of these modifications are used, state so in the report.

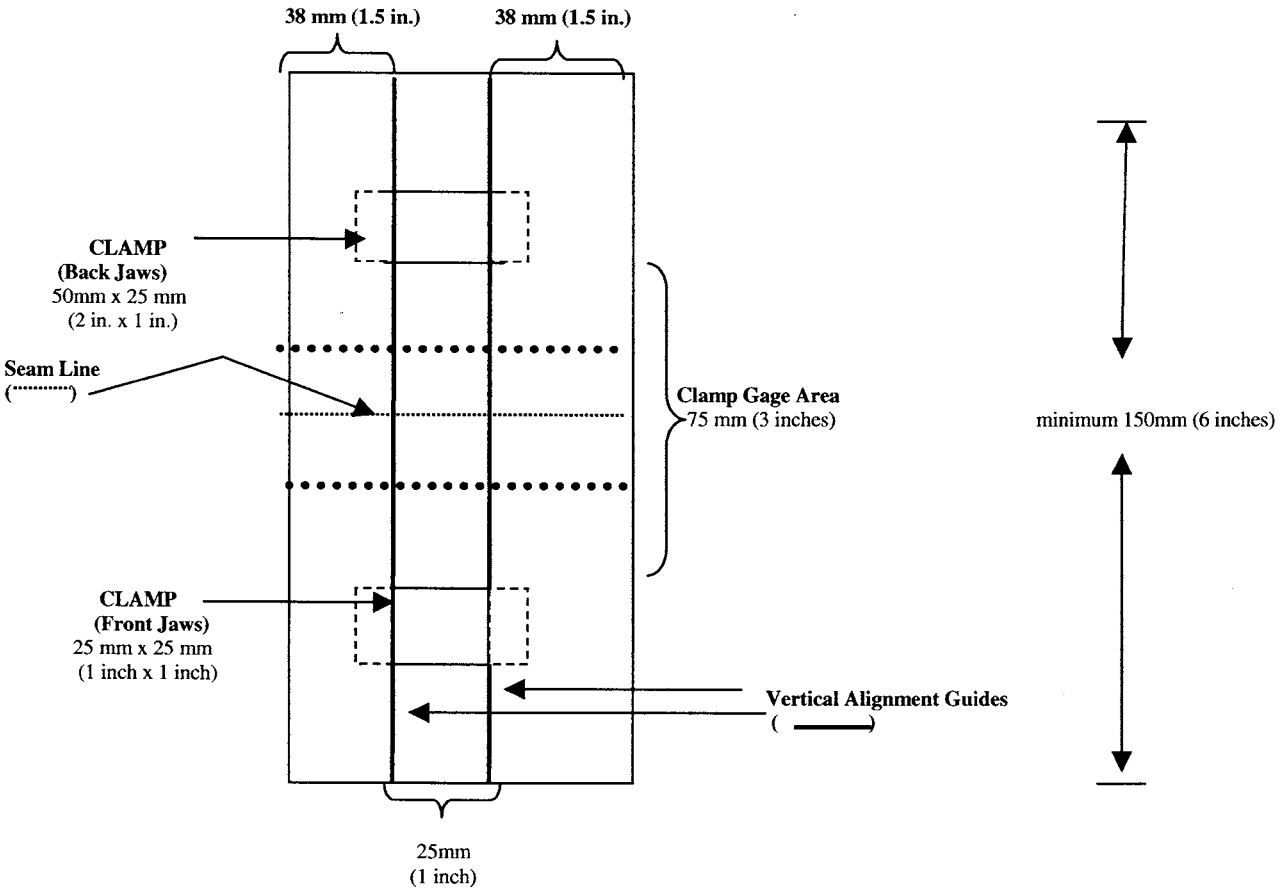

FIG. 1 Specimen Placement in Clamps
(Clamp Gage Area and Vertical Alignment Guides)

NOTE 8—It is difficult to determine the precise reason for certain specimens to break near the edge of the jaws. If such a break is caused by damage to the specimen by the jaws, then the results should be discarded. If, however, the break is due merely to randomly distributed weak places, it is a legitimate test result. In some cases, it may also be caused by a concentration of stress in the area adjacent to the jaws because the jaws prevent the specimen from contracting in width as the force is applied. In such cases, a break near the edge of the jaw is inevitable and should be accepted as a characteristic of the particular test method. This is often the case when testing fabrics using the grab procedure.

10. Calculations

10.1 Calculate the maximum seam strength of individual specimens using Eq 3:

$$S_s = kS_b/W \quad (3)$$

where:

S_s = maximum seam strength, N (lbf),
k = a constant equal to 1000 for SI units and 1 for inch-pound units,
S_b = recorded seam assembly breaking force, N (lbf), and
W = width of specimen in jaws, mm (in.).

10.2 Determine percent seam efficiency using Eq 4:

$$E = 100\,S_s/F \quad (4)$$

where:

E = seam efficiency, %,
S_s = recorded seam strength, N (lbf), and
F = fabric breaking force, N (lbf).

11. Report

11.1 State that the tests were conducted in accordance with Test Method D5822 for determining the maximum seam strength in inflatable restraints cushions.

11.1.1 If deviation from Test Method D5822 occurred, any reference to this test method shall state: "Testing was performed in accordance with ASTM D5822, with the following changes:"

11.2 The purchaser and supplier shall determine the exact form of the test report. Unless otherwise specified, the report shall provide the following information:

11.2.1 Cushion designation(s), or in the case of seams produced off-line from fabric blanks, the properties and descriptions of the tested seam(s).

11.2.2 Lot identification,

11.2.3 Date of report,

11.2.4 Name of person certifying report,

11.2.5 Relevant specification,

11.2.6 Type of testing machine used,

11.2.7 Maximum force obtainable in the range used for testing,

11.2.8 Pretension if used,

11.2.9 Size of jaw faces used,

11.2.10 Type of padding used in the jaws, modification of specimen gripped in the jaws, or modification of jaw faces, if any,

11.2.11 Cushion location of the specimens used in the seam strength test,

11.2.12 Number of specimens used in each test,

11.2.13 Type of test specimen,

11.2.14 The average breaking force for specimens giving acceptable breaks,

11.2.15 Results of the seam strength tests for each location in the cushion, if applicable,

11.2.16 Mode of failure, i.e., whether the observed seam failure is due to the failure of the thread, fabric, or adhesive. Additionally, in the case of sealed and sewn seams, whether the sealer failed adhesively or cohesively.

11.2.17 Tests performed and data obtained,

11.2.18 Laboratory conditions if other than standard, and

11.2.19 Deviations from standard procedures and apparatus.

12. Precision and Bias

12.1 Two laboratories conducted an interlaboratory test in 2002 using randomly drawn seamed and unseamed specimens (see Appendix X1). The standard fabric used was 630 denier Nylon 66, plain weave, uncoated, count 41 by 41.

12.2 As indicated in Appendix X1, the test procedure in Test Method D5822 is reliable at the 95 % confidence level.

12.3 Variability in results using this test method can be attributed, but not restricted to, the following: *(1)* fabric slippage in clamps; *(2)* yarns not parallel to direction of test; *(3)* vertical alignment guides not drawn parallel to yarns; *(4)* jaw face misalignment; *(5)* the axis of the seam assembly not perpendicular to direction of force when testing. See Notes 6-8 of this test method for further discussion on controlling such variability.

12.4 Comparison of results from tensile testing machines operating on different principles of traverse is not recommended. When different types of machines are used for comparison testing, constant-time-to-break at 20 ± 3 s is the established way of producing data. Even then the data may differ significantly.

13. Keywords

13.1 airbag; cushion; inflatable restraint; seam efficiency; seam failure; seam strength

APPENDIX

(Nonmandatory Information)

X1. Interlaboratory Tests

Gage R&R

ILC 2.5 ILC D5822/D1683
Lab “1” Fill Oct. 31/02

Historic Std. Dev. = N/A

Tolerance = 1600 Gage R&R

Distinct Categories = 18

Source	VarComp	Standard Deviation	% Contribution	% Process	5.15 (SD)	% of Tolerance
Reproducibility	494.2687	22.23215	0.05 %	N/A	114.4956	7.16 %
Operator	46.65186	6.830217	0.00 %	N/A	35.17562	2.20 %
Replicate	447.6168	21.15696	0.04 %	N/A	108.9583	6.81 %
Repeatability	5768.978	75.95379	0.54 %	N/A	391.162	24.45 %
Test Portion	5768.978	75.95379	0.54 %	N/A	391.162	24.45 %
Total Gage R&R	6263.247	79.14068	0.59 %	N/A	407.5745	25.47 %
Sample	1055070	1027.166	99.41 %	N/A	5289.906	330.62 %
Total Study	1061334	1030.211	100.00 %	N/A	5305.584	331.60 %

ILC D5822/D1683

Lab “2” Fill Oct. 31/02

Historic Std. Dev. = N/A

Tolerance = 1600 Gage R&R

Distinct Categories = 6

Source	VarComp	Standard Deviation	% Contribution	% Process	5.15 (SD)	% of Tolerance
Reproducibility	4730.233	68.77669	0.64 %	N/A	354.2	22.14 %
Operator	-1972.99	0	0.00 %	N/A	0	0.00 %
Sample Operator	4730.233	68.77669	0.64 %	N/A	354.2	22.14 %
Replicate	-999.056	0	0.00 %	N/A	0	0.00 %
Repeatability	26870.43	163.922	3.64 %	N/A	844.1984	52.76 %
Test Portion	26870.43	163.922	3.64 %	N/A	844.1984	52.76 %
Total Gage R&R	31600.66	177.7657	4.28 %	N/A	915.4936	57.22 %
Sample	706267.6	840.3973	95.72 %	N/A	4328.046	270.50 %
Total Study	737868.3	858.9926	100.00 %	N/A	4423.812	276.49 %

Gage R&R ILC 2.5

ILC Measurement Warp Industrial D1683
Lab “1” Warp Oct. 31, 2002
Historic Std. Dev. = N/A
Tolerance = 200 Gage R&R
Distinct Categories = 20

Source	VarComp	Standard Deviation	% Contribution	% Process	5.15 (SD)	% of Tolerance
Reproducibility	1276.574	35.72917	0.11 %	N/A	184.0053	92.00 %
Operator	-565.384	0	0.00 %	N/A	0	0.00 %
Replicate	1276.574	35.72917	0.11 %	N/A	184.0053	92.00 %
Repeatability	4004.655	63.28234	0.34 %	N/A	325.9041	162.95 %
Test Portion	4004.655	63.28234	0.34 %	N/A	325.9041	162.95 %
Total Gage R&R	5281.229	72.67206	0.45 %	N/A	374.2611	187.13 %
Sample	1171191	1082.216	99.55 %	N/A	5573.411	2786.71 %
Total Study	1176472	1084.653	100.00 %	N/A	5585.963	2792.98 %

ILC Measurement Warp Industrial D1683
Lab “2” Warp Oct. 31, 2002
Historic Std. Dev. = N/A
Tolerance = 200 Gage R&R
Distinct Categories = 7

Source	VarComp	Standard Deviation	% Contribution	% Process	5.15 (SD)	% of Tolerance
Reproducibility	12070.77	109.8671	1.94 %	N/A	565.8154	282.91 %
Operator	1268.193	35.6117	0.20 %	N/A	183.4002	91.70 %
Sample Operator	4468.577	66.84742	0.72 %	N/A	344.2642	172.13 %
Replicate	6334.002	79.58644	1.02 %	N/A	409.8702	204.94 %
Repeatability	11641.68	107.8966	1.87 %	N/A	555.6677	277.83 %
Test Portion	11641.68	107.8966	1.87 %	N/A	555.6677	277.83 %
Total Gage R&R	23712.45	153.9885	3.81 %	N/A	793.0407	396.52 %
Sample	599311.8	774.1523	96.19 %	N/A	3986.885	1993.44 %
Total Study	623024.3	789.3189	100.00 %	N/A	4064.992	2032.50 %