Designation: C 1681 – 09

Standard Test Method for Evaluating the Tear Resistance of a Sealant Under Constant Strain[1]

This standard is issued under the fixed designation C 1681; 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 evaluates the impact of an induced tear on a sealant specimen that is dimensioned, cured according to the guidelines in Test Method C 719 and then subjected to a constant strain. It is effective in differentiating between sealants that are used in dynamic joints subject to abrasion, punctures, tears, or combination thereof.

1.2 Since this test method is for the evaluation of tear propagation, an adhesive failure to the substrates provides no usable data regarding tear propagation. This would be considered a failed test and that data would be discarded, or at least separated from the other data from specimens that did not experience an adhesive failure.

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.*

1.4 The committee with jurisdiction over this standard is not aware of any comparable standards published by other organizations.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C 719 Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movement (Hockman Cycle)

3. Terminology

3.1 *Definitions:*

3.1.1 *casting spacers*—rigid spacers made of an anti-adherent material used in the fabrication of joints to maintain the joint dimension during the extrusion, tooling and curing of the sealant material.

3.1.2 *separators*—rigid spacers used to maintain a constant strain on the joint specimens during the testing period while maintaining parallel bond surfaces.

4. Summary of Test Method

4.1 Test specimens are fabricated and cured in accordance with Test Method C 719. At the end of the 21-day cure period, an induced tear is created in the specimens by making a cut with a sharp blade in the midpoint of the joint. The specimens are then extended to a specified strain at both standard conditions and at –26 ± 2°C (–15 ± 3°F). Propagation of the induced tear is measured at 0, 24 and 168 h.

5. Significance and Use

5.1 This test method is intended to determine if a joint that is subjected to a mechanically induced cut will resist tear propagation during normal joint movement. A sealant with a high resistance to tear propagation will typically perform better than a sealant with a low resistance to tear propagation.

6. Apparatus

6.1 A device capable of extending the test specimens to the specified strain.

6.2 *Freezer*, to maintain a constant temperature of –26°C.

6.3 A suitable measuring device such as calipers able to measure the induced tears to 0.01 mm.

6.4 *#17 Knife Blade*, 9 mm (⅜ in.) wide.

7. Reagents and Materials

7.1 *Spatulas*, for use in applying the sealant.

7.2 *Caulking Gun*, for extruding sealant from cartridges when applicable.

7.3 *Glass Substrates*—twelve substrates, with minimum dimensions of 25 by 75 mm (1 by 3 in.) of the same finish are required for each test specimen. Glass is the default substrate, however as mentioned in the scope, this is not an adhesion test, therefore the sealant must exhibit excellent adhesion to the substrate. Other rigid substrates in the above noted dimension are indeed acceptable.

7.4 *Casting Spacers*—Made from polytetrafluoroethylene (PTFE) or a suitable rigid material shall be used with each test specimen to which the test sealant will not bond and will

[1] This test method is under the jurisdiction of ASTM Committee C24 on Building Seals and Sealants and is the direct responsibility of Subcommittee C24.20 on General Test Methods.

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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.

provide the appropriate joint dimensions and configurations. These spacers are machined to provide exact joint dimensions of 12.7 by 12.7 by 50.8 mm (½ by ½ by 2 in.). See Fig. 5 in Test Method C 719.

7.5 *Separators*, to provide a constant strain on the specimen while maintaining parallel bond surfaces.

7.6 *Substrate Cleaning Material*.

7.7 *Primer*, if required on the substrates.

7.8 A suitable measuring device, such as calipers, capable of measuring the induced cut in the sealant and additional changes in the cut to 0.01 mm.

7.9 *Marker*, to identify the exact placement of the induced cut.

7.10 A device which holds a #17 knife blade 9 mm (⅜ in.) wide to induce the cut into the test specimens. See Fig. 1.

8. Conditioning

8.1 *Multicomponent Sealants*—Prepare six test specimens for each type of substrate that is to be used in the test. After maintaining the unopened sample for at least 24 h at standard conditions, mix thoroughly for 5 min at least 250 g of base compound with the appropriate amount of curing agent. Extrude the sealant 12.7 by 12.7 by 50.8 mm (½ by ½ by 2 in.) between parallel 25.4 by 76.2 mm (1 by 3 in.) faces of similar blocks or plates. Use appropriate casting spacer blocks to form the proper size of the bead. Apply polyethylene adhesive tape or any other suitable inert release agent to the inside surfaces of the spacers to prevent adhesion of the spacers to the sealant after cure. Use adhesive tape, rubber bands, or clamps to hold the test assembly together before and after filling it with the compound. In the case of a pourable-type compound, use masking or any other suitable tape to retain the compound.

8.2 Clean the test substrates using the methods suggested in Test Method C 719. Fabricate the joints using the casting spacers. Mask off the top of the substrate edges, extrude the test sealant into the cavity taking care to fill in the all of the corners, tool the top surface flat, and remove the masking tape.

FIG. 1 #17 Blade

8.3 *Single-Component Sealants*—Prepare six test specimens as described in 8.1 except that no mixing of components is required. Condition the sealed cartridge or bulk container at standard conditions at least 24 h before use.

8.4 Cure specimens made with multicomponent sealants for 14 days at standard conditions. During the second week of the curing period, free the compound from the spacer blocks at the ends and bottom without damaging the sealant bead.

8.5 Cure specimens made with single-component sealants for a total of 21 days at standard conditions. See 8.6.1.

8.6 Separate the casting spacers from the sealant as soon as practical during the curing period without damaging the sealant. Fourteen days is typically necessary.

8.6.1 The producer may request conditions other than those specified in 8.5 for the curing period of single-component sealants provided they meet the following requirements: *(1)* The curing period shall extend for 21 days; and *(2)* The temperature during the curing period shall not exceed 50°C (122°F).

9. Procedure

9.1 Within 8 h after the cure period (14 days for multicomponent or 21 days for single component products), mark the exact location for the induced cut with a permanent marker and then induce a cut, 9 mm (⅜ in.) in length, and 12.7 mm (½ in.) deep with the #17 knife blade. See Fig. 2. Make the cut as parallel as possible to the long direction of the sample, located directly on the midpoint and go perpendicularly through thickness of the sealant.

9.2 Extend all specimens until the separation between the substrates provides the desired/specified extension (in the absence of a specified strain, the sealant shall be strained to its Test Method C 719 movement capability). Apply this strain at a minimum rate of 3 mm per hour (⅛ in. per hour). See Appendix X2.

9.3 When the specimens have reached their specified extension, block the specimens with the appropriate separator and remove from the extension device/machine. Do not remove separators for the duration of test.

9.4 Measure and record the length and width of the induced cut, immediately after the joints have been blocked at the specified strain. This is the 0 hour data.

9.5 Place three specimens in the freezer at –26 ± 2°C.

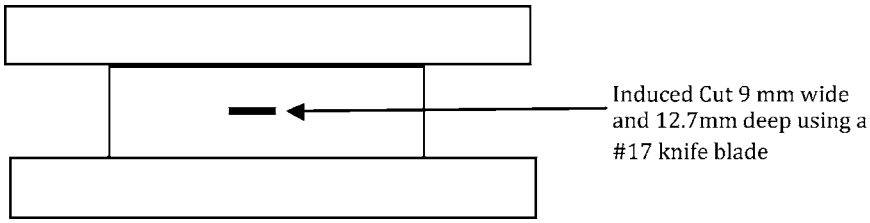
9.6 Place three specimens at room temperature laboratory conditions.

9.7 After 24 and 168 h, measure and record the length and width of the induced cut on the top of the joint and record the observed character of the tearing on the *X* and *Y* axis as noted in Fig. 3 (i.e., clean versus jagged, direction of the tear propagation, propagation of the tear at one or both ends of the induced cut, etc.).

10. Calculation or Interpretation of Results

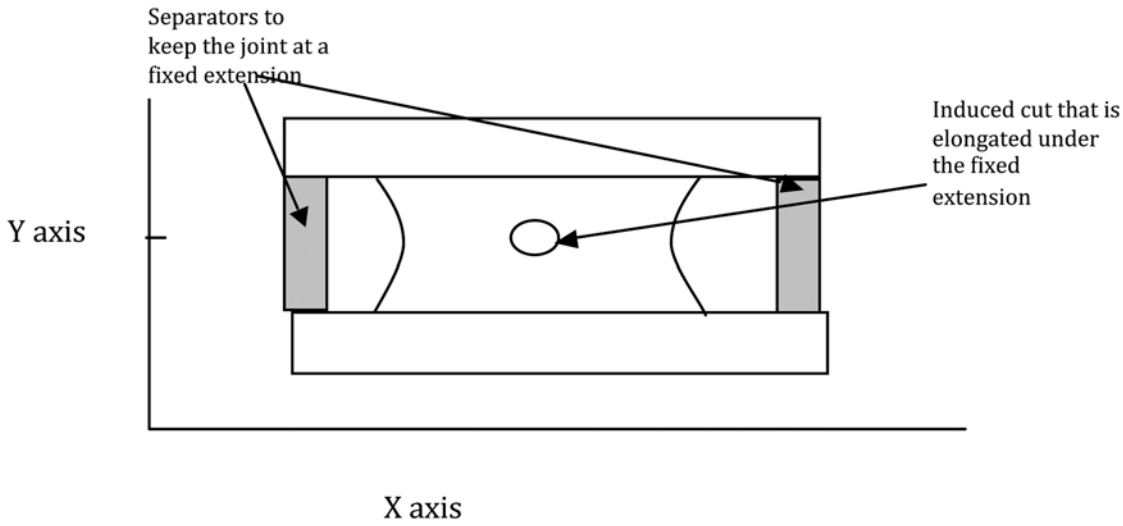
10.1 Report the change in length and width of the induced cut on the top of the joint in the sealant for each specimen along the *X* and *Y* axis noted below to the nearest 0.1 mm.

10.2 Report the average change in dimension for length and width for the room temperature and –26°C conditions at 24 and 168 h.



Top view of joint showing induced cut centered at the midpoint of the joint.

FIG. 2 Top View of Joint Showing the Placement of the Induced Cut



Top view of joint showing induced cut centered at the midpoint of the joint.

NOTE—Measurements of the length of the cut (*X* axis) and width of cut (*Y* axis) are taken and reported at 0, 24, and 168 h.

FIG. 3 Top View of a Joint that is Held Under a Fixed Extension

10.2.1 (ΔL1 + ΔL2 + ΔL3)/3 = Average change in Length.

10.2.1.1 L24 h – L0h = ΔL24 h= Change in Length at 24 h.

10.2.1.2 L168 h – L0h = ΔL168 h = Change in Length at 168 h.

10.2.2 (ΔW1 + ΔW2 + ΔW3)/3 = Average change in Width.

10.2.2.1 W24 h – W0h = ΔW24 h = Change in Width at 24 h.

10.2.2.2 W168 h – W0h = ΔW168 h = Change in Width at 168 h.

10.3 See Table 1 for a suggested table for taking data.

11. Report

11.1 Report the following information:

TABLE 1 Suggested Table for Taking Data

	Length 0 h	Width 0 h	Length 24 h	Width 24 h	Length 168 h	Width 168 h
Specimen 1 RT						
Specimen 2 RT						
Specimen 3 RT						
Average Change RT after 24 and 168 h	NA	NA				
Specimen 1 –26°C						
Specimen 2 –26°C						
Specimen 3 –26°C						
Average Change –26°C after 24 and 168 h	NA	NA				

11.1.1 Sealant used, color, manufacturers' lot, type (single component or multicomponent) and rated movement capability per Test Method C 719 as designated by the manufacturer,

11.1.2 Actual dimensions of the joint and configuration,

11.1.3 Cleaning method for each substrate,

11.1.4 Description of the test substrate(s),

11.1.5 Primer used on specific substrates,

11.1.6 Curing method and duration,

11.1.7 Time of removal of casting spacers,

11.1.8 Movement induced on the sealant during the test in % of original joint width,

11.1.9 Method used to elongate the specimens to the desired strain and an estimated strain rate,

11.1.10 Length and width of induced cut in each specimen after 0, 24, and 168 h for the room temperature and cold temperatures and observations reported,

11.1.11 Average change in length and width of the induced cut after 24 and 168 h at both the room temperature and –26°C conditioning, and

11.1.12 Any other observations worthy of reporting.

12. Precision and Bias

12.1 A preliminary study was conducted with 7 laboratories and 3 different sealants. Problems encountered in measurement resulted in revisions to the standard. Only single sets of tests

were run so repeatability also was not able to be determined. A summary of the program is included in the Appendix.

12.2 An interlaboratory program will be conducted after the test method is approved and in practice.

13. Keywords

13.1 constant strain testing; fixed extension; movement induced tear; sealant

APPENDIXES

(Nonmandatory Information)

X1. PILOT STUDY

X1.1 A pilot study was conducted on the performance of the initial draft of the proposed standard. Seven laboratories participated by testing three different materials. Three samples of each material were to be prepared by each laboratory and stored at two different temperatures during the test procedure.

X1.2 The draft standard did not define the type and resolution of measurement devices. Some laboratories measured to the nearest mm while others provided readings to either 0.1 or 0.01 mm. These later data sets showed variation in all sample sets while those measured to the nearest mm (or half mm) showed virtually no differences in the samples tested to make up the test results.

X1.3 Since the standard has been revised to require greater resolution in taking all observations, Table X1.1 only shows results from the laboratories that conducted more detailed tests. All readings are in millimeters and are the average of three samples.

X1.4 The silicone and the urethane materials tested had a claimed movement capability rating of 25 %. The modified polyether had a claimed movement rating of +100–50 %. This is reflected in the initial width of cut noted in Table X1.1.

TABLE X1.1 Results from Four Laboratories

NOTE—All measurements are in mm.

Material	Lab	Initial Length of Cut	Change in Length 1 Day	Change in Length 7 Day	Initial Width of Cut	Change in Width 1 Day	Change in Width 7 Day
Silicone RT	A	7.03	13.20	27.18	3.73	0.18	0.36
	B	10.95	4.27	13.00	3.55	–0.35	–0.86
	C	9.63	6.50	18.27	2.90		–0.10
	D	8.47	1.28	5.27	2.96	0.19	0.08
Urethane RT	A	7.62	0.76	0.58	3.66	0.33	0.08
	B	10.45	0.45	–0.37	3.93	–0.09	–0.23
	C	8.30	–0.33	0.07	2.87		0.17
	D	8.68	0.02	0.51	2.90	0.36	0.23
Modified Polyether RT	A	7.90	0.99	2.12	10.84	3.02	2.16
	B	11.27	0.38	0.08	13.34	–0.09	–0.07
	C	10.67	–0.37	–0.27	13.47		0.17
	D	9.98	0.86	0.76	12.17	0.47	0.20
Silicone –29°C	A	6.63	5.97	6.67	3.50	1.68	1.13
	B	9.94	0.49	8.23	4.18	–0.01	–0.54
	C	9.07	–0.77	–0.33	3.47		0.20
	D	8.68	0.48	0.77	3.14	0.14	–0.06
Urethane –29°C	A	8.08	1.67	1.40	3.92	0.46	0.40
	B	10.44	–0.23	–0.17	3.53	0.37	0.10
	C	8.17	–0.03	0.07	3.40		–0.37
	D	8.62	0.18	1.18	3.05	0.06	–0.18
Modified Polyether –29°C	A	8.21	1.18	1.64	11.69	0.83	1.52
	B	10.77	0.07	1.17	12.84	–0.75	–0.37
	C	10.40	–0.70	–0.33	13.57		–0.30
	D	9.85	1.02	1.02	12.24	0.53	0.49

X2. EXTENSION PARAMETERS

X2.1 The extension that should be used to evaluate sealants with this test method depends on the reason/purpose for performing the test. A few examples are:

X2.1.1 If the test is being performed to compare tear propagation performance between different sealants, all the sealants should be extended to the same separation.

X2.1.2 If the test is being performed to evaluate a sealant for use in a specific application, an analysis of the application should be performed to determine the appropriate extension parameter to use.