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Standard Test Method for Cyclic Movement and Measuring the Minimum and Maximum Joint Widths of Architectural Joint Systems[1]

This standard is issued under the fixed designation E1399/E1399M; 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.

ε1 NOTE—Units information was editorially corrected and keywords were added in September 2013.

1. Scope

1.1 This test method covers testing procedures for architectural joint systems. This test method is intended for the following uses for architectural joint systems:

1.1.1 To verify movement capability information supplied to the user by the producer,

1.1.2 To standardize comparison of movement capability by relating it to specified nominal joint widths,

1.1.3 To determine the cyclic movement capability between specified minimum and maximum joint widths without visual deleterious effects, and

1.1.4 To provide the user with graphic information, drawings or pictures in the test report, depicting them at minimum, maximum, and nominal joint widths during cycling.

1.2 This test method is intended to be used only as part of a specification or acceptance criterion due to the limited movements tested.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.4 *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]

C719 Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movement (Hockman Cycle)

C794 Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants

C962 Standards Guide for Use of Elastomeric Joint Sealants (Withdrawn 1992)[3]

D1079 Terminology Relating to Roofing and Waterproofing

E577 Guide for Dimensional Coordination of Rectilinear Building Parts and Systems (Withdrawn 2011)[3]

E631 Terminology of Building Constructions

IEEE/ASTM SI 10 Standard for Use of the International System of Units (SI): The Modern Metric System

3. Terminology

3.1 *Defintions*—Terms defined in Terminology E631 will prevail for terms not defined in this test method.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *architectural joint system*—any filler or cover, except poured or formed in place sealants, used to span, cover, fill, or seal a joint.

3.2.1.1 *Discussion*—Joint is defined in Guide E577.

3.2.2 *compression seal*—an elastomeric extrusion, having an internal baffle system produced continuously and longitudinally throughout the material having side walls without horizontal edge flaps.

[1] This test method is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.21 on Serviceability.

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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.

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

3.2.3 *cyclic movement*—the periodic change between the widest and narrowest joint widths in an automatically mechanically controlled system.

3.2.4 *elastomeric membrane systems*—an elastomeric extrusion being either a baffled, single, or multi-layered system incorporating horizontal edge flaps normally used with a nosing material.

3.2.5 *fire barriers*—any material or material combination, when fire tested after cycling, designated to resist the passage of flame and hot gases through a movement joint.

3.2.6 *maximum joint width*—the widest linear gap an architectural joint system tolerates and performs its designed function without damaging its functional capabilities.

3.2.7 *metallic systems*—one or more metal components integrated to perform the specific function of sealing or bridging a joint, or both.

3.2.8 *minimum joint width*—the narrowest linear gap an architectural joint system tolerates and performs its designed function without damaging its functional capabilities.

3.2.9 *movement capability*—the value obtained from the difference between the widest and narrowest widths of a joint opening typically expressed in numerical values (mm or in.) or a percentage of the nominal value of the joint width.

3.2.9.1 *Discussion*—Nominal value is defined in IEEE/ASTM SI 10.

3.2.10 *preformed foam and sponges*—a porous elastomeric open or closed cell material capable of being compressed and recovering once the compressive force is removed.

3.2.11 *preformed sealant system*—a device composed of a previously shaped or molded mixture of polymers, fillers, and pigments used to fill and seal joints where moderate movement is expected; unlike caulking, it cures to a resilient solid (see Appendix X1).

3.2.11.1 *Discussion*—Sealant is defined in Terminology D1079.

3.2.12 *strip seal*—a single or multi-layered elastomeric extrusion, not having an internal baffle system produced continuously and longitudinally throughout the material, used in conjunction with a compatible frame(s).

4. Significance and Use

4.1 Types of architectural joint systems included in this test method are the following:

4.1.1 Metallic systems;

4.1.2 Compression seals:

4.1.2.1 With frames, and

4.1.2.2 Without frames,

4.1.3 Strip seals;

4.1.4 Preformed sealant systems (see Appendix X1):

4.1.4.1 With frames, and

4.1.4.2 Without frames,

4.1.5 Preformed foams and sponges:

4.1.5.1 Self-Expanding, and

4.1.5.2 Nonexpanding,

4.1.6 Fire barriers:

4.1.6.1 Used as joint systems, and

4.1.6.2 Used as a part of the joint system, and

4.1.7 Elastomeric membrane systems:

4.1.7.1 With nosing material(s), and

4.1.7.2 Without nosing material(s).

4.2 This test method will assist users, producers, building officials, code authorities, and others in verifying some performance characteristics of representative specimens of architectural joint systems under common test conditions. The following performance characteristics are verifiable:

4.2.1 The maximum joint width,

4.2.2 The minimum joint width, and

4.2.3 The movement capability.

4.3 This test compares similar architectural joint systems by cycling but does not accurately reflect the system's application. Similar refers to the same type of architectural system within the same subsection under 4.1.

4.4 This test method does not provide information on:

4.4.1 Durability of the architectural joint system under actual service conditions, including the effects of cycled temperature on the joint system,

4.4.2 Loading capability of the system and the effects of a load on the functional parameters established by this test method,

4.4.3 Rotational, vertical, and horizontal shear capabilities of the specimen,

4.4.4 Any other attributes of the specimen, such as fire resistance, wear resistance, chemical resistance, air infiltration, watertightness, and so forth, and

4.4.5 Testing or compatibility of substrates.

4.5 This test method is only to be used as one element in the selection of an architectural joint system for a particular application. It is not intended as an independent pass/fail acceptance procedure. In conjunction with this test method, other test methods are to be used to evaluate the importance of other service conditions such as durability, structural loading, and compatibility.

5. Apparatus

5.1 *Testing Machine,* capable of attaining specified maximum and minimum joint widths.

5.2 *Measuring Device,* capable of an accuracy of 0.25 ± 0.013 mm [0.010 ± 0.005 in.].

5.3 *Cyclic Device,* capable of continual repetitious movement between two specified dimensions, equipped with an automatic counter which records movement of the joint during the test.

5.4 *Mounting Plates,* or other apparatus suitable to install the specimen and undergo the test procedures.

6. Safety Hazards

6.1 **Warning—**Take proper precautions to protect the observers in the event of any failure. If extreme pressures develop during this test, considerable energy and hazard are involved. In cases of failure, the hazard to personnel is less if a protective shield is used and protective eye wear worn. Do not permit personnel between the shield and equipment during the test procedure.

7. Sampling

7.1 A lot of material consists of the quantity for each cross section agreed upon by the user and the producer. Sample each lot.

7.2 Obtain samples by one of the following methods:
7.2.1 Samples provided by the producer, or
7.2.2 Samples taken at random from each shipment.

7.3 A sample constitutes a minimum length as required to perform the tests, but not less than 914.4 mm [36.00 in.].

7.4 Producer specifies the following in mm [in.]:
7.4.1 Nominal joint width,
7.4.2 Minimum joint width,
7.4.3 Maximum joint width, and
7.4.4 Movement capability.

8. Test Specimens

8.1 Cut the sample into nine specimens with a minimum length as required to perform the tests, but not less than 101.6 mm [4.00 in.].
8.1.1 Condition the specimens according to the producer's instructions. If applicable, the producer will designate attachment procedures, and:
8.1.1.1 Substrate material(s), or
8.1.1.2 Frame material(s).

8.2 Maintain laboratory at a temperature of 23 ± 2°C [73 ± 3°F].

9. Procedure

9.1 *Verifying Minimum and Maximum Joint Widths*
9.1.1 According to the producer's instructions, attach one specimen to the mounting plates forming a parallel joint.
9.1.2 Set the distance between the mounting plates equal to the nominal joint width.
9.1.3 Secure the specimen in the testing machine, according to the producer's instructions, while maintaining parallelism and the specified nominal joint width.
9.1.4 Maintaining parallelism, verify both the minimum joint width and the maximum joint width.
9.1.4.1 Verify the minimum joint width by closing the specimen in the testing machine until the producer specified minimum joint width is attained, or a failure (see Appendix X2) is noted in the architectural joint system. Repeat 9.1.1 – 9.1.4 for two other specimens. Fire barriers are not required to have multiple samples tested if this test method is used to fatigue the test specimen before fire testing it.
9.1.4.2 Verify the maximum joint width by expanding the specimen in the testing machine until the producer specified minimum joint is attained, or a failure is noted in the architectural joint system. Repeat 9.1.1 – 9.1.4 for two other specimens. Fire barriers are not required to have multiple samples tested if this test method is used to fatigue the test specimen before fire testing it.
9.1.5 Specimen failure is indicated by the inability to meet the minimum or maximum joint width criteria that is specified in 7.4 or the appearance of a condition that in the judgement of the laboratory will affect the performance of the test specimen (see Appendix X2.2).
9.1.6 Record the specified dimension in 9.1 being verified and all data to the nearest 0.10 mm [0.004 in.] at which the test was terminated.
9.1.7 Describe failed specimens in detail using photographs, if necessary, to clarify the descriptions.
9.1.8 Note failed specimen measurements with an asterisk.

9.2 *Verifying Cyclic Movement:*
9.2.1 Standard machine speeds are 1 r/m, 10 r/m, and 30 r/min.
9.2.2 The maximum time duration of the specimen at rest during cyclic movement is 4 s.
9.2.3 Follow procedures in 9.1.1 and 9.1.2.
9.2.4 According to the producer's instructions, while maintaining parallelism and the nominal joint width, secure the specimen in the cyclic device.
9.2.5 Maintaining parallelism, cycle the specimen until the number of cycles required for the specified class in Table 1 (see Appendix X3) are recorded on the counter or until a failure is noted. Repeat 9.2.3 – 9.2.6 for two other specimens. Fire barriers are not required to have multiple samples tested if this test method is used to fatigue the test specimen before fire testing it.
9.2.6 Specimen failure is indicated by the inability to cycle between the designated joint widths or the appearance of a condition that in the judgment of the laboratory will affect the performance of the test specimen (see Appendix X2.2).
9.2.7 Record the number of cycles at which the test was terminated.
9.2.8 Describe failed specimens in detail using photographs, if necessary, to clarify the description.

10. Calculation

10.1 Ascertain the minimum joint width by using 10.1.1 or 10.1.2, as applicable.
10.1.1 If the test specimens meet the criteria in 7.4.2, express that value.
10.1.2 If any test specimen does not meet the criteria in 7.4.2, average the recorded measurements in 9.1.6 and express that value.

10.2 Ascertain the maximum joint width by using 10.2.1 or 10.2.2, as applicable.

TABLE 1 Cycling Requirements

Class	Movement	Minimum Number of Cycles	Cycling Rates (cpm)
I	Thermal	500	less than or equal to 1
II	Wind Sway	500	greater than or equal to 10
III	Seismic	100	greater than or equal to 30
IV	Combined	100 400	greater than or equal to 30 followed by greater than or equal to 10

10.2.1 If the test specimens meet the criteria in 7.4.3, express that value.

10.2.2 If any test specimen does not meet the criteria in 7.4.3, average the recorded measurements in 9.2.6 and express that value.

10.3 Ascertain the movement capability by using 10.3.1 or 10.3.2, as applicable.

10.3.1 If the test specimens meet the criteria in 7.4.4, express that value.

10.3.2 If any test specimen does not meet the criteria in 7.4.4, calculate the movement capability, using the equation:

$$W_{max} - W_{min} = M$$

where:

W_{min} = minimum joint width (10.1),
W_{max} = maximum joint width (10.2), and
M = movement capability

Express the resulting value.

10.4 The following nomenclature expresses the movement capability:

$$M, W_{min}, W_{max}$$

for example, information:

$$M = 50.8 \text{ mm} [2.00 \text{ in.}]$$
$$W_{min} = 38.1 \text{ mm} [1.50 \text{ in.}]$$
$$W_{max} = 88.9 \text{ mm} [3.50 \text{ in.}]$$

or, for example, expressions:

$$50.8 \text{ mm}, 38.1 \text{ mm}, 88.9 \text{ mm}$$
$$[2.00 \text{ in.}, 1.50 \text{ in.}, 3.50 \text{ in.}]$$

10.5 Contraction movements will always be expressed as negative numbers and expansion movements as positive numbers because they express direction and magnitude of movement.

10.5.1 Calculate numerical contraction movement as follows:

$$W_{min} - W_{nom} = C$$

where:

W_{nom} = nominal joint width (7.4.1), and
C = allowable contraction related to nominal joint width.

10.5.2 Calculate numerical expansion movement as follows:

$$W_{max} - W_{nom} = E$$

where E = allowable expansion related to nominal joint width.

10.6 The following nomenclature expresses numerical contraction and expansion movements:

$$W_{nom}, C, E$$

for example, information:

$$W_{nom} = 50.8 \text{ mm} [2.00 \text{ in.}]$$
$$C = -12.7 \text{ mm} [-0.50 \text{ in.}]$$
$$E = 38.1 \text{ mm} [1.50 \text{ in.}]$$

or, for example, expressions:

$$50.8 \text{ mm}, -12.7 \text{ mm}, 38.1 \text{ mm}$$
$$[2.00 \text{ in.}, -0.50 \text{ in.}, 1.50 \text{ in.}]$$

10.7 Calculate the contraction and expansion percentages.

10.7.1 The contraction percentage formula is as follows:

$$(C/W_{nom}) \times 100\,\% = C_p$$

where C_p = contraction percentage related to nominal joint width.

10.7.2 The expansion percentage formula is as follows:

$$(E/W_{nom}) \times 100\,\% = E_p$$

where E_p = expansion percentage related to nominal joint width.

10.8 The following nomenclature expresses contraction and expansion percentage:

$$W_{nom}, C_p, E_p$$

for example, information:

$$W_{nom} = 50.8 \text{ mm} [2.00 \text{ in.}]$$
$$C_p = -25\,\%$$
$$E_p = 75\,\%$$

or, for example, expressions:

$$50.8 \text{ mm}, -25\,\%, 75\,\%$$
$$[2.00 \text{ in.}, -25\,\%, 75\,\%]$$

10.9 Ascertain the cyclic movement by using the following applicable subsection:

10.9.1 If the test specimens complete the required cycles in Table 1, express that value.

10.9.2 If any test specimen does not complete the required cycles in Table 1, average the recorded measurements in 9.2.7 and express that value.

11. Report

11.1 Report the following information:

11.1.1 Test date and report number;

11.1.2 Testing agency, address, and phone number;

11.1.3 Specimen identification:

11.1.3.1 Specimen type (4.1),

11.1.3.2 Nominal joint width (7.4.1),

11.1.3.3 Specimen producer's name and address, and

11.1.3.4 Other pertinent data,

11.1.4 Detailed cross sectional specimen drawings, or, if acceptable to the user; photographs of:

11.1.4.1 Nominal joint width (7.4.1),

11.1.4.2 Minimum joint width (10.1), and

11.1.4.3 Maximum joint width (10.2),

11.1.5 Detailed plan view, including component identification and material composition;

11.1.6 Producer's instructions in 8.1.1, 9.1.1, 9.1.3, and 9.2.4;

11.1.7 Method of determining the minimum joint width, specifying 10.1.1 or 10.1.2;

11.1.8 Method of determining the maximum joint width, specifying 10.2.1 or 10.2.2;

11.1.9 Method of determining the movement capability, specifying 10.3.1 or 10.3.2;

11.1.10 Numerical contraction and expansion values, as expressed in 10.6;

11.1.11 Contraction and expansion percentage values as expressed in 10.8;

11.1.12 Method of determining the number of cycles, specified in 10.9.1 or 10.9.2 and, if applicable, all information under 9.2.8;

11.1.13 The Class that the test specimen complied with in Table 1;

11.1.14 Whether the test specimen passed or failed; and

11.1.15 The cyclic device tolerances.

12. Precision and Bias

12.1 *Precision*—It is not practicable to specify the precision of the procedure in this test method for measuring the minimum and maximum joint widths because the procedure allows numerous types of mounting plates to be used which will create deviations.

12.2 *Bias*—No information is presented on the bias of the procedure in this test method for measuring the minimum and maximum joint widths because no material having an acceptable reference is available.

13. Keywords

13.1 architectural joint systems; joint systems; joint widths

APPENDIXES

(Nonmandatory Information)

X1. TYPES OF EXCLUSIONS

X1.1 This test method is not intended to evaluate or test any type of poured or formed in place sealants described in Guide C962. Suitable test methods for these types of sealants are referenced in Test Method C719 and Test Method C794.

X2. TYPES OF FAILURES

X2.1 *Failure*—the inability of the architectural joint system to perform its designated task or an apparent deleterious sign caused by testing.

X2.2 In addition to the definition in X2.1 and failure criteria in Section 9, the following is a partial list of other possible failure conditions:

X2.2.1 Visual metal fatigue,

X2.2.2 Disengagement of components,

X2.2.3 Broken component,

X2.2.4 Permanent deformation of specimen or component,

X2.2.5 Loose components after test,

X2.2.6 Deep scratches in specimen,

X2.2.7 Scaling or cracking of the specimen or component,

X2.2.8 Tearing (cohesive failure) of the specimen or component,

X2.2.9 Loss of specimen or component bonding (adhesive failure),

X2.2.10 Dislocation of the specimen or component during testing, and

X2.2.11 Loss of specimen or component recovery during testing.

X3. CYCLIC RATIONALE

X3.1 The original logic was presented in establishing 5000 full cycles as the test criteria. The presumption was made that a typical architectural joint system life expectancy is fifty years and that a maximum of fifty full cycles, minimum to maximum joint openings, occur during a year due to environmental forces. This would establish 2500 full cycles to be an adequate test. However, a multitude of partial cycles occur daily. Long term stress on an architectural joint system should be considered in testing; to reflect this information a factor of 100 % was added.

X3.2 Table 1 has replaced 5000 cycles as the minimum number of cycles. This change was made to: reflect the number of cycles issue that was thoroughly debated before a major model code organization; reasonably reflect the intent of the code and sound engineering; and, differentiate between types of applications.