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Standard Specification for Preformed Thermoplastic Vulcanizate Elastomeric Joint Seals for Bridges[1]

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1. Scope

1.1 This specification covers the material requirements for preformed thermoplastic vulcanizate (TPV) elastomeric joint seals for bridges. The seal consists of a multiple-web design composed of a TPV and functions only by compression of the seal between the faces of the joint with the seal folding inward at the top to facilitate compression. The seal is installed with a lubricant adhesive and is designed to seal the joint and reject incompressibles.

NOTE 1—This specification may not be applicable for seals whose height is less than 90 % of its nominal width.

1.2 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are provided for information only.

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 requirements prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 395 Test Methods for Rubber Property—Compression Set[2]

D 412 Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension[2]

D 518 Test Method for Rubber Deterioration—Surface Cracking[2]

D 573 Test Method for Rubber—Deterioration in an Air Oven[2]

D 575 Test Methods for Rubber Properties in Compression[2]

D 1149 Test Method for Rubber Deterioration—Surface Ozone Cracking in a Chamber[2]

D 2240 Test Method for Rubber Property—Durometer Hardness[2]

D 4483 Practice for Determining Precision for Test Method Standards in the Rubber and Carbon Black Industries[2]

D 6338 Classification System for Highly Crosslinked Thermoplastic Vulcanizates (HCTPVs)[3]

3. Marking and Ordering Information

3.1 Each lot of seal shall be marked with characters of not less than 0.25 in. (6.35 mm) in height on the top of the seal at a maximum of 4 ft (1.22 m) intervals showing the lot number, date of manufacture, and the manufacturing seal designation.

3.2 The purchaser shall specify the anticipated required minimum acceptable joint movement, and either the minimum joint opening, or the nominal width of seal.

4. Materials and Manufacture

4.1 The seals shall be preformed, and the material shall be vulcanized elastomeric compound using a thermoplastic vulcanizate as the compound. A thermoplastic vulcanizate is a blend of a crosslinked rubber and a thermoplastic polymer that can be processed on conventional thermoplastic processing machinery and has the properties of a crosslinked elastomer. Highly crosslinked thermoplastic elastomers are classified according to Classification System D 6338. TPV materials are made in the dynamic vulcanization process. One example of a typical TPV is crosslinked ethylene propylene diene rubber blended with polypropylene. The TPV material can also contain processing oils, antioxidants, fillers, or other additives.

5. Physical Requirements

5.1 The materials shall conform to the physical properties prescribed in Table 1.

5.2 In the applicable requirements of Table 1 and the test methods, all deflection shall be based on the nominal width.

6. Dimensions and Working Parameters

6.1 The size, shape and dimensional tolerances shall be as outlined in 6.1.1.

6.1.1 Measurements used for laboratory testing shall be taken to the nearest 0.01 in. (0.3 mm) and reported/recorded to the nearest 0.1 in. (3 mm) as the average of three measurements. The measured width shall be greater than or equal to the nominal width. The seal height shall not be less than 90 % of

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[2] *Annual Book of ASTM Standards*, Vol 09.01.

[3] *Annual Book of ASTM Standards*, Vol 08.03

TABLE 1 Physical Requirements for Preformed Elastomeric Joint Seals

	Requirements	ASTM Test Method
Tensile strength, min, psi (MPa)	730 (4.4)	D 412
Elongation at break, min, %	300	D 412
Hardness, Type A durometer, points	50 to 70	D 2240 (modified)[A]
Oven aging, 168 h at 212°F (100°C)		
Tensile strength, max, % loss	10	
Elongation, max, % loss	10	
Hardness, Type A durometer, points change	0 to 5	
Ozone resistance[B] 20 % strain, 300 pphm in air, 70 h, at 104°F (40°C) (wiped with toluene to remove surface contamination)	no cracks	D 1149[C]
Low-temperature recovery, 72 h at 14°F (-10°C), 50 %:		
Deflection, min, %	80	Section 7[D]
Low-temperature recovery, 22 h at -20°F (-29°C), 50 %:		
Deflection, min, %	70	Section 7[D]
High-temperature recovery, 70 h, at 212°F (100°C), 50 %:		
Deflection, min, %	75	Section 7[D]
Compression-deflection properties:		
LC min in. (mm)	9.3	D 575 Method A (modified)[E]
LC max in. (mm)	9.3	
Movement range, in. (mm)	9.3	

[A] The term "modified" in the table relates to the specimen preparation. The use of the joint seal as the specimen source requires that more plies than specified in either of the modified test procedures be used. Such specimen modification shall be agreed upon between the purchaser and the supplier prior to testing. The hardness test shall be made with the durometer in a durometer stand as recommended in Test Method D 2240.

[B] Sample prepared in accordance with Method A of Test Method D 518.

[C] Cracking, splitting, or sticking of a specimen during a recovery test shall mean that the specimen has failed the test.

[D] The reference section and subsections are those of this specification. The values found in 6.2.2, 6.2.3, and 6.2.4 shall be within the range specified by the purchaser in 3.2.

[E] Speed of testing shall be 0.5 ± 0.05 in. (13 ± 1.3 mm), min at room temperature of 73 ± 4°F (23 ± 2.2°C). The sheets of sandpaper are not used.

the nominal width unless joint recess dimensions or special design considerations dictate the geometry.

6.2 *Compression Deflection Properties*—The contact pressure expressed in pounds-force per square inch (or pascals) when the seal is compressed to any particular width indicates the stress-strain relationship that exists in the seal. This relationship is dependent on both the properties of the elastomer and the cross-sectional configuration of the seal. Therefore, for a predetermined allowable pressure, a definitive relationship will exist and the working limits of the seal may be defined.

6.2.1 The working limits (minimum and maximum degrees of compression) of the seal shall be determined on the basis of the minimum and maximum limits of compressibility (LC min and LC max), and the movement range as specified herein. Seals with nominal width differing from that specified are acceptable, providing the compressed width at LC max is less than the minimum anticipated joint opening, and the movement range requirement is met.

6.2.2 The minimum limit of compressibility (LC min) is defined as the compressed width (expressed in terms of percent of nominal width) corresponding to a contact pressure of 3 psi (20.68 kPa). The LC min shall be determined in accordance with 9.3. For the purpose of calculating movement range, a value at 85 % of nominal width shall be used for LC min when the measured value of LC min exceeds 85 %.

NOTE 2—If the seal generates a pressure of 3 psi at 90 % of nominal width, LC min equals 85 %. However, if the seal generates 3 psi at 70 % of nominal width, the LC min equals 70 %.

6.2.3 The maximum limit of compressibility (LC max) is defined as the compressed width (expressed in terms of percent of nominal width) corresponding to a contact pressure of 35 psi (241.32 kPa). The LC max shall be determined in accordance with 9.3. LC max has been designated at 35 psi (241.32 kPa) in order to mitigate the tendencies toward pressure decay of the seal during use. A reading of 35 psi is considered an absolute maximum pressure which should not be exceeded.

6.2.4 The movement range of the seal is defined as the numerical difference between the LC min and the LC max expressed in inches (mm). For the purpose of calculating the movement range, a value at 85 % shall be used for LC min when the measured value of LC min exceeds 85 %. For purposes of acceptance testing, the calculated movement range of the seal shall not be less than the specified value.

7. Sampling

7.1 A lot shall consist of the quantity for each cross section agreed upon between the purchaser and the supplier.

7.2 Samples shall be taken at random from each shipment of material. If the shipment consists of more than one lot, each lot shall be sampled.

7.3 The minimum lengths of samples for testing purposes shall be as prescribed by the purchaser or as prescribed in Table 2.

8. Specimen Preparation

8.1 All test specimens shall be cut, buffed, or both from the sample of preformed seal. Care should be taken not to overheat the test specimen during buffing. The cut shall be square to within 2° and smooth, with no roughness visible to the naked eye. The use of a tooth blade device or a guillotine-type cutter, or both, is not acceptable. This process will eliminate irregularities.

8.2 Specimens for determining tensile strength and elongation (Test Methods D 412) shall be prepared using Die C when possible. Die D may be used when the flat sections of a seal are too small for Die C. However, the requirement of Table 1 shall apply regardless of the die used. Buffing should be carefully performed and kept to a minimum.

8.3 Specimens for low-temperature and high-temperature recovery tests and for pressure deflection tests shall consist of 6-in. (150-mm) lengths of the preformed seal.

TABLE 2 Minimum Lengths of Seal Samples

Seal Size, in. (mm)	Length of Sample, in. (m)
Less than 2 (51)	96 (2.44)
2 (51) to less than 3 (76)	72 (1.83)
3 (76) and larger	60 (1.52)

9. Test Methods

9.1 Compliance with the requirements of Table 1 shall be determined by tests conducted in accordance with the methods specified.

9.2 *Recovery Tests*:

9.2.1 Determine the low-temperature and high-temperature recovery test values using specimens prepared in accordance with Section 8. Two specimens shall be used for each test.

9.2.2 Deflect the specimen between parallel plates to 50 % of the nominal width using the compression set clamp assembly described in Method B of Test Methods D 395. Prior to compression, place the specimen in a horizontal position, such that the plane through both edges of the top surface of the joint seal is perpendicular to the compression plate. As the specimen is being compressed, the top surface of the joint seal should fold inward toward the center of the specimen.

9.2.3 Place a clamp assembly containing the compressed specimen in a refrigerated box capable of maintaining a temperature of 14 ± 2°F (-10 ± 1.1°C) for 72 h. Unclamp the assembly and remove the upper compression plate, or carefully remove the specimen from the assembly and transfer it to a wooden surface in the refrigerated box. Allow the specimen to recover for 1 h at 14 ± 2°F (-10 ± 1.1°C). Measure the recovered width in the center of the 6-in. (150-mm) length at the top longitudinal edge of the specimen. Measurements may be made with either a dial caliper or a platform-mounted dial gage graduated in thousandths of an inch (0.025 mm). The platform-mounted gage shall have a ¼-in. (6-mm) diameter pressure foot with a force of 0.18 ± 0.02 lbf (0.80 ± 0.09 N). Measurements with the platform-mounted gage should be taken with the pressure foot centered on the longitudinal edge of the seal. Calculate the recovery as follows:

$$\text{Recovery, \%} = \frac{(\text{recovered width} \times 100)}{(\text{nominal width})} \quad (1)$$

Report the least value of recovery to the nearest 1 %.

NOTE 3—The use of a desiccant, such as calcium chloride, in the refrigerated box should be used to minimize frosting. The desiccant should be changed or reactivated as frequently as necessary to keep it effective.

9.2.4 Place a clamp assembly containing the compressed specimen in a refrigerated box capable of maintaining a temperature of -20 ± 2°F (-29 ± 1.1°C) for 22 h (see Note 3). Unclamp the assembly and remove the upper compression plate, or carefully remove the specimen and transfer it to a wooden surface in the refrigerated box. Allow the specimen to recover for 1 h at -20 ± 2°F (-29 ± 1.1°C). Measure the recovered width and calculate the recovery as in 9.2.3.

9.2.5 Place a clamp assembly containing the compressed specimen in an oven conforming to Test Method D 573. The temperature shall be maintained at 212 ± 2°F (100 ± 1.1°C) for 70 h. Do not preheat the clamp assembly. Unclamp the assembly, carefully remove the specimen, and allow it to recover at 73 ± 4°F (23 ± 2.2°C) on a wooden surface for 1 h. Measure the recovered width and calculate the recovery as in 9.2.3.

9.3 *Compression-Deflection Tests*:

9.3.1 Determine compression-deflection values using specimens prepared in accordance with Section 8. Measure the length of each specimen at the top, center, and bottom using a rule graduated in thirty seconds of an inch (or millimetres). Average the three measurements and record as the length of the specimen to the nearest 1/32 in. (0.8 mm). Measure the height of the contact area on both sides and at both ends (four measurements) with a dial caliper or suitable rule. Average and record to the nearest 1/32 in. (0.8 mm).

9.3.2 Calculate the contact area of the specimen by multiplying the average length times the average height of the contact area as determined above.

9.3.3 Calculate the forces required to compress the specimen to LC min and LC max by multiplying the contact area times 3 psi (20.68 kPa) and 35 psi (241.32 kPa), respectively.

9.3.4 Place the specimen on its side in such a manner that a plane through both edges of the top surface of the seal shall be perpendicular to the platens. Close the platens until the distance between them is slightly larger than the actual width of the seal. Test in accordance with Method A of Test Methods D 575, except that the speed shall be 0.5 ± 0.05 in. (13 ± 1.3 mm)/min, and the sheets of sandpaper are not used.

9.3.5 Compress the specimen to LC max by observing the force calculated in 9.3.3. Immediately reverse at the same rate to the original distance between the platens. Repeat this cycle two times for a total of three cycles. Record the compressed width of the seal obtained at both the LC min and LC max on the compression portion of the third cycle by measuring the compressed width of the seal at those forces calculated in 9.3.3.

9.3.6 During the course of running the test described in 9.3.4, the tendency of the top surface of the seal to become misaligned shall be observed. Misalignment of more than ¼ in. (6.3 mm) shall be reason for rejection of the seal.

9.3.7 Calculate the movement range of the specimen by subtracting LC max from LC min and express the result in inches.

10. Certification and Acceptance

10.1 The acceptance of the preformed elastomeric seal shall be based upon one of the following procedures, as specified by the purchaser:

10.1.1 A certification of conformance to the specification requirement. This shall consist of a notarized copy of the manufacturer's test report, or a notarized statement by the supplier accompanied by a copy of the results, certifying that the material has been sampled, tested, movement rating established and inspected in accordance with the provisions of the specification. Each certification so furnished shall be signed by an authorized agent of the manufacturer or supplier.

10.1.2 A notarized certification of test results by an independent testing agent or notarized statement that the material has been sampled, movement rating established, tested, and inspected in accordance with the provisions of the specification. Each certification so furnished shall be signed by an authorized agent of the testing agency.

10.1.3 Testing by the purchaser of any or all properties in accordance with the provisions of the specification.

10.1.4 Any alternative method agreed upon between the purchaser and the supplier.

11. Precision and Bias

11.1 The precision and bias statements were prepared in accordance with Practice D 4483.

11.1.1 The precision of these test methods was determined from an interlaboratory study of three samples of seals of three sizes (13⁄16 in., 2 in., 3 in. seals). Each seal was made by three different manufacturers, and ten laboratories tested three samples of each type of seal.

11.2 Table 3 gives the LQC precision data as obtained in the interlaboratory testing program. The values for *S* given are equivalent to "repeatability" for within-laboratory testing and "reproducibility" for among-laboratory testing. The values reported are the pooled values for all of the materials. If two single test results (or determinations) differ by more than the pooled values, they must be considered suspect; that is, to have come from different sample populations. Investigation into the cause of this occurrence may include incorrect following of the test method procedure, faulty apparatus, or the declaration of a significant difference in the two materials, samples, etc. which generated the two test results.

11.3 A "test result" is the single value obtained for a test.

TABLE 3 For Scale Greater Than One Inch

Compression-Recovery Test	Within Laboratories		Among Laboratories	
	S	LSD	S	LSD
22 h at - 20°F	0.57	1.63	3.35	9.48
72 h at 14°F	1.03	2.93	3.70	10.45
70 h at 212°F	0.44	1.24	3.94	11.15
Compression-Deflection Test	**Within Laboratories**		**Among Laboratories**	
	S	LSD	S	LSD
LC min	0.86	2.44	2.23	6.31
LC max	1.06	3.00	1.69	4.78
Movement Range	0.75	2.12	2.03	5.73