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Standard Test Method for ELONGATION OF ATTACHED ORGANIC COATINGS WITH CYLINDRICAL MANDREL APPARATUS¹

This standard is issued under the fixed designation D 1737; 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.

This test method has been approved for use by agencies of the Department of Defense to replace Method 6222 of Federal Test Method Standard No. 141A and for listing in the DoD Index of Specifications and Standards.

1. Scope

1.1 This test method covers the determination by the cylindrical test apparatus of the elongation of attached organic coatings when applied to flat sheet metal of uniform surface texture.

1.2 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of whoever uses this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Applicable Documents

2.1 ASTM Standards:

D 823 Methods of Producing Films of Uniform Thickness of Paint, Varnish, Lacquer, and Related Products on Test Panels²

D 1005 Test Method for Measurement of Dry-Film Thickness of Organic Coatings Using Micrometer²

D 1186 Methods for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to a Ferrous Base²

3. Summary of Method

3.1 The materials under test are applied at uniform thickness to flat sheet metal panels. After the coatings are dried or baked, the panels are bent over cylindrical mandrels of various diameters. The elongation is determined from the largest diameter mandrel that produces visible cracking in the coating.

4. Significance and Use

4.1 Coatings attached to substrates are elongated when the substrates are bent during the manufacture of articles or when the articles are abused in service. This test method has been useful in rating attached coatings for their ability to resist cracking when elongated. It has been useful in evaluating the flexibility of coatings on flexible substrates.

5. Apparatus³

5.1 *Automatic Application Equipment*, as described in Methods D 823.

5.2 *Film Thickness Measuring Apparatus*, as described in Test Method D 1005 or in Methods D 1186.

5.3 *Elongation Test Equipment*, consisting of six cylindrical steel rods having diameters of 1 in. (25 mm), 3/4 in. (19 mm), 1/2 in. (12.7 mm), 3/8 in. (9.5 mm), 1/4 in. (6.4 mm), and 1/8 in. (3.2 mm), and a means for firmly supporting them during a test.

6. Preparation of Specimens

6.1 Apply the materials to be tested to cold rolled steel (Note 1) conforming to the chemical

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² *Annual Book of ASTM Standards*, Vol 06.01.

³ Suitable apparatus may be obtained from laboratory instrument supply houses.



requirements of SAE steel No. 1010, dead soft, finish A, 1/32 in. (0.8 mm) in thickness (22 gage). The surface preparation of the metal shall be agreed upon by the purchaser and the seller. Prior to the application of the finish the edges of the panel shall be rounded slightly to remove burrs in order to eliminate anomalous edge effects. Apply uniform coatings of the materials in accordance with Methods D 823 and air dry or bake under conditions of humidity and temperature mutually agreeable to the purchaser and seller.

NOTE 1—Other suitable base materials for the test specimen may be employed. This method is designed for testing materials on 1/32-in. (0.8 mm) cold rolled steel. The method for determining the percent of elongation of coatings applied to base materials other than the steel or thickness specified in Section 5 is described in the Appendix.

7. Conditioning and Number of Tests

7.1 Condition the test panels for at least 24 h at $73.5 \pm 3.5^\circ\text{F}$ ($23 \pm 2^\circ\text{C}$) and $50 \pm 5\%$ relative humidity, and test in the same environment or immediately on removal therefrom unless otherwise specified by the purchaser and the seller. Test at least two replicate specimens at each diameter of interest.

8. Procedure

8.1 Place the test panel over a mandrel with the uncoated side in contact and with at least 2 in. (50 mm) overhang on either side. Using a steady pressure of the fingers, bend the panel approximately 180° around the mandrel in 1.5 s. Remove and examine immediately for cracking visible to the unaided eye. If cracking has not occurred, repeat the procedure using successively smaller diameter mandrels on previously untested location (area) of a specimen until failure occurs or until the smallest diameter mandrel has been used.

NOTE 2—This procedure can be applied as a “pass/

fail” test by determining whether cracking is produced by a specified mandrel size.

9. Calculations

9.1 Determine the elongation range of the material from Table 1 in which the elongation of a 1 mil (25 μm) thick coating on 1/32-in. (0.8 mm) cold rolled steel is given for each mandrel diameter.

9.2 If the coating thickness exceeds 1 mil (25 μm), correct the determined elongation for film thickness using the factors for each mandrel diameter given in Table 2. Calculate the total elongation of the coating as follows:

$$E = e_1 + tc_1$$

where:

E = total elongation,

e_1 = elongation from Table 1,

t = thickness, mils, and

c_1 = correction factor from Table 2.

10. Report

10.1 Report the following information:

10.1.1 Mean and range of coating elongation values obtained for each specimen,

10.1.2 Mean and range of coating film thickness for each specimen,

10.1.3 Specimen preparation procedures used,

10.1.4 Test conditions, and

10.1.5 Mean and range of elongation and film thickness for the replicate specimens.

11. Precision

11.1 Results are not available to determine the precision of this test method. Plans are being made to obtain such results. The method has been in use for many years and is considered acceptable for evaluating the crack resistance of attached coatings.

TABLE 1 Elongation

Mandrel Diameter, in. (mm)	Elongation, %
1 (25)	3.3
3/4 (19)	4.4
1/2 (12.7)	6.75
3/8 (9.5)	9.0
1/4 (6.4)	14.0
1/8 (3.2)	28.0

TABLE 2 Correction for Film Thickness

Mandrel Diameter, in. (mm)	Correction Factor
1 (25)	0.21
3/4 (19)	0.26
1/2 (12.7)	0.38
3/8 (9.5)	0.50
1/4 (6.4)	0.71
1/8 (3.2)	1.40