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Standard Test Method for Adhesion or Cohesive Strength of Flame-Sprayed Coatings[1]

This standard is issued under the fixed designation C 633; 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 determination of the degree of adhesion (bonding strength) of a coating to a substrate, or the cohesive strength of the coating in a tension normal to the surface. The test consists of coating one face of a substrate fixture, bonding this coating to the face of a loading fixture, and subjecting this assembly of coating and fixtures to a tensile load normal to the plane of the coating. It is particularly adapted for testing coatings applied by flame spraying, which is defined to include the combustion flame, plasma flame, arc gun, and detonation processes for spraying wire, rod, or powder.

NOTE 1—Flame-sprayed coating materials include ceramics, such as metal oxides or carbides, and metals. In some cases a coating is formed of several layers of different flame-sprayed materials, such as an oxide layer sprayed onto a sprayed metal-bonding layer. The substrate is generally a metal, but may be a ceramic such as an oxide or graphite.

1.2 Usually this test method is performed at ambient temperature. Higher temperature testing is restricted by the need for a suitable adhesive bonding agent. For certain fundamental investigation it is suggested that very low (cryogenic) temperature be used.

1.3 This test method is limited to testing flame-sprayed coatings that can be applied in thickness greater than 0.015 in. (0.38 mm). The limitation is imposed because an adhesive bonding agent is used in the test. Those bonding agents established so far for this method tend to penetrate flame-sprayed coatings and may invalidate results unless the coatings are thick enough to prevent penetration through the coating. Further development may establish that thin layers of certain types of especially dense coatings may be tested satisfactorily. Alternatively, new adhesive bonding agents that would allow reduction of the minimum thickness limitation may be discovered or developed.

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 limitations prior to use.*

[1] This test method is under the jurisdiction of ASTM Committee B-8 on Metallic and Inorganic Coatingsand is the direct responsibility of Subcommittee B08.12 on Materials for Porcelain Enamel and Ceramic-Metal Systems.

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2. Referenced Documents

2.1 *ASTM Standards:*

E 4 Practices for Force Verification of Testing Machines[2]

3. Significance and Use

3.1 This test method is recommended for quality-control, acceptance testing; or it may help to develop or qualify a flame-spray operator's equipment and procedure or to aid in developing flame-sprayed coatings with improved adhesion and integrity.

3.2 This test method is useful for comparing adhesion or cohesive strengths of coatings of similar types of flame-sprayed materials. The test should not be considered to provide an intrinsic value for direct use in making calculations such as to determine if a coating will withstand specific environmental stresses. Because of residual stresses in flame-sprayed coatings, actual strength is dependent upon the shape of the particular coated part. Also, in actual use a coating is stressed in a much more complicated manner than is practical for a standardized test.

4. Apparatus

4.1 A tension testing machine shall conform to the requirements of Practices E 4. The loads used in determining the adherence or tensile strength shall be within the loading range of the testing machine, as defined in Practices E 4. Permissible variation shall be less than 1.0 %. It shall be possible to apply increasing tensile load at a constant rate of cross-head travel between 0.030 in./min (0.013 mm/s) and 0.050 in./min (0.021 mm/s). The machine shall include a load-indicating device that registers the maximum load applied before rupture occurs.

4.2 Self-aligning devices, for applying the tensile load to the assembly of the coating and fixtures, shall not permit eccentric load or bending moment to the specimen. Self-alignment is often provided by the manufacturer as an integral part of the testing machine. An alternative, satisfactory apparatus is shown in Fig. 1, which also shows a method of connecting the self-aligning apparatus to an assembled test specimen.

5. Material

5.1 *Adhesive Bonding Agent*—A suitable adhesive bonding

[2] *Annual Book of ASTM Standards,* Vol 03.01.

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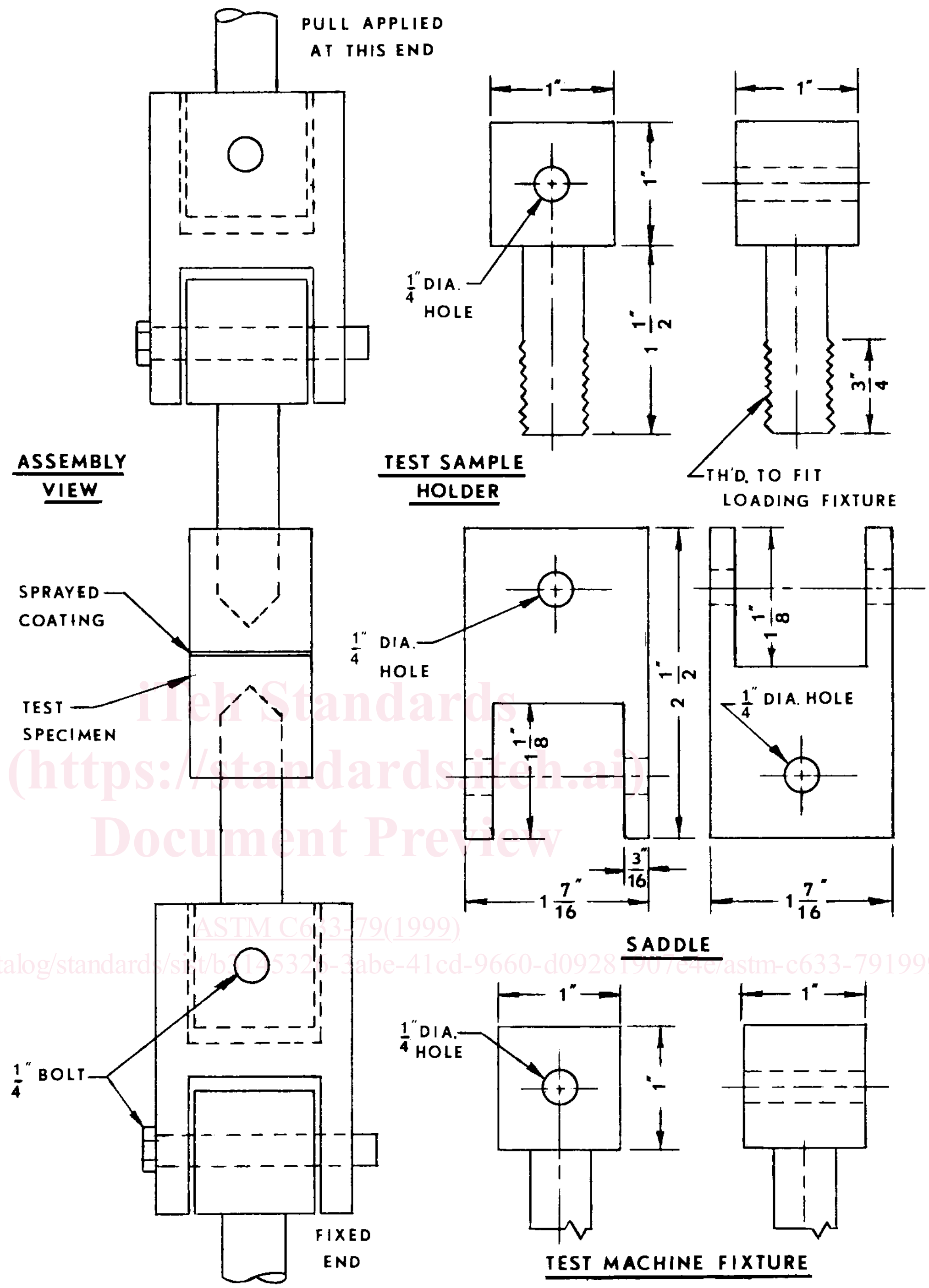

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Metric Equivalents

in.	3⁄16	1⁄4	3⁄4	1	1 1⁄8	1 7⁄16	1 1⁄2	2 1⁄2
(*mm*)	(4.8)	(6.4)	(19)	(25.4)	(29)	(37)	(38)	(64)

FIG. 1 Self-Aligning Device

agent shall be agreed between the purchaser and manufacturer of the coating and shall meet the following requirements.[3]

5.1.1 The bonding agent shall be capable of bonding the coating to the loading fixture with a tensile strength that is at least as great as the minimum required adhesion and cohesive strength of the coating.

5.1.2 The bonding agent shall be sufficiently viscous not to penetrate through a 0.015-in. (0.38-mm) thickness of the coating. Certain commercial resins that cure or harden at room temperature by means of a curing agent have been proven satisfactory. If any other bonding agent is to be used, it shall

[3] A list of satisfactory bonding agents is provided in the annex which follows this standard.