Designation: D5/D5M – 13

Standard Test Method for Penetration of Bituminous Materials[1]

This standard is issued under the fixed designation D5/D5M; 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 standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This test method covers determination of the penetration of semi-solid and solid bituminous materials.

1.2 The needles, containers and other conditions described in this test method provide for the determinations of penetrations up to 500.

NOTE 1—For guidance in preparing and testing emulsion residue specimens for this test method, please refer to Section 35 of Test Method D244.

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 nonconformance 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]

D36 Test Method for Softening Point of Bitumen (Ring-and-Ball Apparatus)
D244 Test Methods and Practices for Emulsified Asphalts
E1 Specification for ASTM Liquid-in-Glass Thermometers
E77 Test Method for Inspection and Verification of Thermometers
E1137/E1137M Specification for Industrial Platinum Resistance Thermometers
E2251 Specification for Liquid-in-Glass ASTM Thermometers with Low-Hazard Precision Liquids

2.2 *ANSI Standard:*

B46.1 Surface Texture[3]

2.3 *ISO Standard:*

ISO Standard 468 Surface Roughness—Parameters, Their Values and General Rules for Specifying Requirements[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *penetration, n*—consistency of a bituminous material expressed as the distance in tenths of a millimetre that a standard needle vertically penetrates a sample of the material under known conditions of loading, time, and temperature.

4. Summary of Test Method

4.1 The sample is melted (if starting at ambient temperature) and cooled under controlled conditions. The penetration is measured with a penetrometer by means of which a standard needle is applied to the sample under specific conditions.

5. Significance and Use

5.1 The penetration test is used as a measure of consistency. Higher values of penetration indicate softer consistency.

6. Apparatus

6.1 *Penetration Apparatus*—Any apparatus that permits the needle holder (spindle) to move vertically without measurable friction and is capable of indicating the depth of penetration to the nearest 0.1 mm, will be acceptable. The weight of the spindle shall be 47.5 ± 0.05 g. The total weight of the needle and spindle assembly shall be 50.0 ± 0.05 g. Weights of 50 ± 0.05 g and 100 ± 0.05 g shall also be provided for total loads of 100 and 200 g, as required for some conditions of the test. The surface on which the sample container rests shall be flat and the axis of the plunger shall be at approximately 90° to this surface. The apparatus shall have a leveling indicator. The spindle shall be easily detached for checking its weight.

[1] This test method is under the jurisdiction of ASTM Committee D04 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.44 on Rheological Tests.

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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] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

6.1.1 The leveling indicator shall be verified at least annually with a hand-held level.

6.2 *Penetration Needle:*

6.2.1 The needle (see Fig. 1) shall be made from fully hardened and tempered stainless steel, Grade 440-C or equal, HRC 54 to 60. The standard needle shall be approximately 50 mm [2 in.] in length, the long needle approximately 60 mm [2.4 in.]. The diameter of all needles shall be 1.00 to 1.02 mm [0.0394 to 0.0402 in.]. It shall be symmetrically tapered at one end by grinding to a cone having an angle between 8.7 and 9.7° over the entire cone length. The cone should be coaxial with the straight body of the needle. The total axial variation of the intersection between the conical and straight surfaces shall not be in excess of 0.2 mm [0.008 in.]. The truncated tip of the cone shall be within the diameter limits of 0.14 and 0.16 mm [0.0055 and 0.0063 in.] and square to the needle axis within 2°. The entire edge of the truncated surface at the tip shall be sharp and free of burrs. When the surface texture is measured in accordance with American National Standard B 46.1 or ISO 468 the surface roughness height, Ra, of the tapered cone shall be 0.2 to 0.3 µm [8 to 12 µin.] arithmetic average. The surface roughness height, Ra, of the needle shank shall be 0.025 to 0.125 µm [1 to 5 µin.]. The needle shall be mounted in a non-corroding metal ferrule. The ferrule shall be 3.2 ± 0.05 mm [0.126 ± 0.002 in.] in diameter and 38 ± 1 mm [1.50 ± 0.04 in.] in length. The exposed length of the standard needle shall be within the limits of 40 to 45 mm [1.57 to 1.77 in.], and the exposed length of the long needle shall be 50 to 55 mm [1.97 to 2.17 in.]. The needle shall be rigidly mounted in the ferrule. The run-out (total-indicator reading) of the needle tip and any portion of the needle relative to the ferrule axis shall not exceed 1 mm [0.04 in.]. The weight of the ferrule needle assembly shall be 2.50 ± 0.05 g. (A drill hole at the end of the ferrule or a flat on the side is permissible to control the weight.) Individual identification markings shall be placed on the ferrule of each needle; the same markings shall not be repeated by a manufacturer within a three-year period.

6.2.2 Needles used in testing materials for conformance to specifications shall be shown to have met the requirements of 6.2.1 when tested by a qualified agency.

6.3 *Sample Container*—A metal or glass cylindrical, flat-bottom container of essentially the following dimensions shall be used:

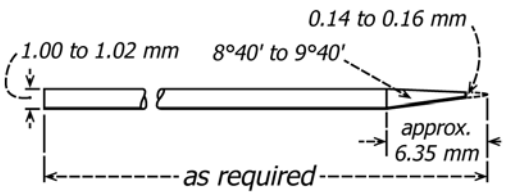

FIG. 1 Needle for Penetration Test

For penetrations below 40:	
Diameter, mm	33–50
Internal depth, mm	8-16
For penetrations below 200:	
Diameter, mm	55
Internal depth, mm	35
For penetrations between 200 and 350:	
Diameter, mm	55–75
Internal depth, mm	45–70
For penetrations 350 to 500	
Diameter, mm	55
Internal depth, mm	70

NOTE 2—For referee testing, the container for testing materials with penetrations below 40 shall be 55 × 35 mm.

6.4 *Water Bath*—A bath capable of maintaining a temperature of 25 ± 0.1°C [77 ± 0.2°F] or any other temperature of test within 0.1°C [0.2°F]. The bath shall have a perforated shelf supported in a position not less than 50 mm from the bottom and not less than 100 mm below the liquid level in the bath. If penetration tests are to be made in the bath itself, an additional shelf strong enough to support the penetrometer shall be provided. Brine may be used in the bath for determinations at low temperatures.

NOTE 3—The use of distilled water is recommended for the bath. Take care to avoid contamination of the bath water by surface active agents, release agents, or other chemicals; as their presence may affect the penetration values obtained.

6.5 *Transfer Dish*—When used, the transfer dish shall have a capacity of at least 350 mL and of sufficient depth of water to cover the large sample container. It shall be provided with some means for obtaining a firm bearing and preventing rocking of the container. A three-legged stand with three-point contact for the sample container is a convenient way of ensuring this.

6.6 *Timing Device*—For hand-operated-penetrometers any convenient timing device such as an electric timer, a stop watch, or other spring activated device may be used provided it is graduated in 0.1 s or less and is accurate to within ±0.1 s for a 60-s interval. An audible seconds counter adjusted to provide 1 beat each 0.5 s may also be used. The time for a 11-count interval shall be 5 ± 0.1 s. Any automatic timing device attached to a penetrometer shall be accurately calibrated to provide the desired test interval within ±0.1 s.

6.7 *Thermometers*—Calibrated liquid–in–glass thermometers of suitable range with subdivisions and maximum scale error of 0.1°C [0.2°F] or any other thermometric device of equal accuracy, precision and sensitivity shall be used. Thermometers shall conform to the requirements of Specification E1 or Specification E2251. Other thermometric devices shall conform to the requirements of Specification E1137/E1137M.

6.7.1 Suitable thermometers commonly used are:

ASTM Number	Range
17C or 17F	19 to 27°C [66 to 80°F]
63C or 63F	–8 to + 32°C [18 to 89°F]
64C or 64F	25 to 55°C [77 to 131°F]

6.7.2 The thermometer used for the water bath shall periodically be calibrated in accordance with Test Method E77. An