This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

INTERNATIONAL

Designation: D6648 – 25a

Standard Test Method for Determining the Flexural Creep Stiffness of Asphalt Binder Using the Bending Beam Rheometer (BBR)[1]

This standard is issued under the fixed designation D6648; 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[2] covers the determination of the flexural creep stiffness or compliance and m-value of asphalt binders by means of a bending beam rheometer. It is applicable to material having stiffness values in the range of 20 MPa to 1 GPa and can be used with unaged material or with materials conditioned with procedures such as Test Method D2872 or Practice D6521. The test apparatus is designed for testing within the temperature range from –36 °C to 0 °C.

1.2 Test results are not valid for test specimens that deflect more than 4 mm or less than 0.08 mm when tested in accordance with this test method.

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.4 **Warning—**Mercury has been designated by the United States Environmental Protection Agency (EPA) and many state agencies as a hazardous material that can cause central nervous system, kidney, and liver damage. Mercury, or its vapor, may be hazardous to health and corrosive to materials. Caution should be taken when handling mercury and mercury-containing products. See the applicable product Safety Data Sheet (SDS) for details and EPA's website—http://www.epa.gov/mercury/faq.htm—for additional information. Users should be aware that selling mercury, mercury-containing products, or both, into your state may be prohibited by state law.

1.5 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]

C670 Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials
D8 Terminology Relating to Materials for Roads and Pavements
D140/D140M Practice for Sampling Asphalt Materials
D2872 Test Method for Effect of Heat and Air on a Moving Film of Asphalt Binder (Rolling Thin-Film Oven Test)
D3666 Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
D6373 Specification for Performance-Graded Asphalt Binder
D6521 Practice for Accelerated Aging of Asphalt Binder Using a Pressurized Aging Vessel (PAV)
D7643 Practice for Determining the Continuous Grading Temperatures and Continuous Grades for PG Graded Asphalt Binders
D8055 Guide for Selecting an Appropriate Electronic Thermometer for Replacing Mercury Thermometers in D04 Road and Paving Standards
D8239 Specification for Performance-Graded Asphalt Binder Using the Multiple Stress Creep and Recovery (MSCR) Test
E1 Specification for ASTM Liquid-in-Glass Thermometers
E77 Test Method for Inspection and Verification of Thermometers
E230/E230M Specification for Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples
E644 Test Methods for Testing Industrial Resistance Thermometers
E2877 Guide for Digital Contact Thermometers

[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] This standard is based on SHRP Product 1002.

[3] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at www.astm.org/contact. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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2.2 *AASHTO Standards:*[4]

M 339M/M 339 Standard Specification for Thermometers Used in the Testing of Construction Materials

2.3 *IEC Standards:*[5]

ISO/IEC 17025 General Requirements for the Competence of Testing and Calibration Laboratories

IEC 60584 Thermocouples

3. Terminology

3.1 *Definitions:*

3.1.1 Definitions for many terms common to asphalt binder are found in Terminology D8.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *BBR software, n*—any integrated firmware or external software user interface with the primary function of operating the BBR equipment.

3.2.2 *buttering, n*—a step used immediately before trimming in which a hot trimming tool is momentarily placed in contact with the top surface of the test specimen.

3.2.3 *contact load, P_c, n*—the load required to maintain positive contact between the test specimen, supports, and the loading shaft; 35 ± 10 mN.

3.2.4 *internal thermometer, n*—a thermometer internal to the BBR that cannot be removed.

3.2.5 *m-value, n*—the absolute value of the slope of the logarithm of the stiffness curve versus the logarithm of time (see Eq A1.4, Annex A1).

3.2.6 *null load, n*—the load indicated by the data acquisition system when the loading shaft is in the bath liquid at the null position and not in contact with any beams or test specimens.

3.2.7 *null position, n*—the vertical position of the loading shaft when it is resting on the thick stainless steel beam with a 100 g load on the loading platform.

3.2.7.1 *Discussion*—This closely approximates the vertical position of the loading shaft at the start of a test.

3.2.8 *physical hardening, n*—a time-dependent stiffening of asphalt binder that occurs when the binder is stored at low temperatures.

3.2.8.1 *Discussion*—The increase in stiffness and decrease in the m-value due to physical hardening is reversible when the temperature is raised to ambient temperature. This is typically referred to as physical aging in polymer technology. This is a different mechanism than steric hardening; see 3.2.11.

3.2.9 *reference thermometer, n*—refers to a liquid-in-glass or electronic thermometer that is used as a laboratory reference standard and is calibrated by an agency accredited to ISO/IEC 17025.

3.2.10 *seating load, n*—load of 1 s duration required to seat the beam; 980 ± 50 mN.

3.2.11 *steric hardening, n*—a process where molecular associations occur between asphalt binder molecules during storage at ambient temperature.

3.2.11.1 *Discussion*—Steric hardening decreases the m-value and increases the stiffness. Steric hardening is time and temperature dependent and is asphalt binder specific. This is a different mechanism than physical hardening; see 3.2.8.

3.2.12 *stiffness, S(t), n*—the ratio (see Eq A1.1, Annex A1) obtained by dividing the measured maximum bending stress by the measured maximum bending strain.

3.2.12.1 *Discussion*—Stiffness has been used historically in asphalt technology while the inverse, creep compliance, is commonly used in studies of viscoelasticity.

3.2.13 *test load, P_T, n*—load of 240 s duration required to determine the stiffness of material being tested; 980 ± 50 mN.

3.2.14 *testing zero time, n*—time at which the signal is sent to the solenoid valve to switch from zero load regulator (contact load) to the testing load regulator (test load).

4. Summary of Test Method

4.1 The bending beam rheometer is used to measure the midspan deflection of a simply supported rectangular beam of asphalt binder subjected to a constant force applied to its midspan. The device operates only in the loading mode; due to the design of the device, recovery measurements shall not be considered valid. The effect of the sudden application of the force makes measurements at loading times less than 8 s suspect.

4.2 A rectangular test specimen is placed in the controlled temperature liquid bath and loaded with a constant force for 240.0 s. The force and the midspan deflection of the test specimen are monitored versus time using a computerized data acquisition system.

4.3 The maximum bending stress and strain are calculated from the following parameters: (*1*) dimensions of the test specimen, (*2*) the span length over which the constant force is applied to the test specimen, and (*3*) the midspan deflection. The stiffness for each of these loading times is calculated by dividing the maximum bending stress by the maximum bending strain (Annex A1).

4.4 The m-value at each loading time is calculated as the slope of the log stiffness versus log time (Annex A1).

4.5 The load and deflection at 0.0 and 0.5 s are reported to verify the operating characteristics of the loading system and to make sure that the applied force has dampened to 980 ± 50 mN. They are not used in the calculation of stiffness and m-value and should not be considered to represent material properties.

5. Significance and Use

5.1 The stiffness and m-value describe the low-temperature stress-strain-time response of asphalt binders. The stiffness and m-value are fundamental material properties and may be used to characterize the linear viscoelastic behavior of asphalt binders at low temperatures.

[4] Available from American Association of State Highway and Transportation Officials (AASHTO), 555 12th St., NW, Suite 1000, Washington, DC 20004, http://www.transportation.org.

[5] Available from International Electrotechnical Commission (IEC), 3, rue de Varembé, 1st floor, P.O. Box 131, CH-1211, Geneva 20, Switzerland, https://www.iec.ch.