Designation: D7552 – 22

Standard Test Method for Determining the Complex Shear Modulus (G*) of Asphalt Mixtures Using Dynamic Shear Rheometer[1]

This standard is issued under the fixed designation D7552; 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 complex shear modulus of asphalt mixtures using torsion rectangular geometry on a dynamic shear rheometer (DSR). It is applicable to asphalt mixtures having complex shear modulus values greater than 1×10^4 Pa when tested over a range of temperatures from –40 °C to 76 °C at frequencies of 0.01 to 25 Hz and strains of 0.0005 % to 0.1 %. The determination of complex shear modulus is typically determined at 20 °C to 70 °C at 0.01 % strain at ten discrete frequency values covering 0.01 to 10 Hz. From these data, temperature or frequency master curves can be generated as required. This test method is intended for determining the complex shear modulus of asphalt mixtures as required for specification testing or quality control of asphalt mixture production.

1.2 This test method is appropriate for laboratory-prepared and compacted mixtures, field-produced and laboratory-compacted mixtures or field cores, regardless of binder type or grade and regardless of whether RAP is used in the mixture. Due to the geometry of the specimens being tested this test method is not applicable to open-graded or SMA mixtures. It has been found to be appropriate for dense-graded mixtures, whether coarse- or fine-graded, with 19 mm or smaller nominal maximum aggregate size.

1.3 Since a precision estimate for this standard has not been developed, the test method is to be used for research and informational purposes only. Therefore, this standard should not be used for acceptance or rejection of a material for purchasing purposes.

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

1.5 The text of this standard references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

1.6 *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.*

1.7 *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:*[2]

D8 Terminology Relating to Materials for Roads and Pavements

D2041/D2041M Test Method for Theoretical Maximum Specific Gravity and Density of Asphalt Mixtures

D3203 Test Method for Percent Air Voids in Compacted Asphalt Mixtures

D3666 Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials

D6752/D6752M Test Method for Bulk Specific Gravity and Density of Compacted Asphalt Mixtures Using Automatic Vacuum Sealing Method

D6857/D6857M Test Method for Maximum Specific Gravity and Density of Asphalt Mixtures Using Automatic Vacuum Sealing Method

D6925 Test Method for Preparation and Determination of the Relative Density of Asphalt Mix Specimens by Means of the Superpave Gyratory Compactor

D6926 Practice for Preparation of Asphalt Mixture Specimens Using Marshall Apparatus

D7175 Test Method for Determining the Rheological Properties of Asphalt Binder Using a Dynamic Shear Rheometer

[1] This test method is under the jurisdiction of ASTM Committee D04 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.26 on Fundamental/Mechanistic 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.

D7312 Test Method for Determining the Permanent Shear Strain and Complex Shear Modulus of Asphalt Mixtures Using the Superpave Shear Tester (SST) (Withdrawn 2019)[3]

E77 Test Method for Inspection and Verification of Thermometers

E644 Test Methods for Testing Industrial Resistance Thermometers

2.2 *Other Standards:*

DIN Standard 43760 Standard for Calibration of Platinum Resistance Thermometers[4]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *calibration, n*—a process that establishes the relationship (traceability) between the results of a measurement instrument, measurement system, or material measure and the corresponding values assigned to a reference standard.

3.1.1.1 *Discussion*—Calibration is typically performed by the manufacturer or an external commercial calibration service.

3.1.2 *complex shear modulus (G*), n*—a complex number that is defined by the ratio of shear stress to shear strain.

3.1.3 *dummy test specimen, n*—a rectangular prismatic or cylindrical specimen of bituminous mix prepared as discussed in 9.2, into which a small hole is drilled and into which a PRT wire is inserted.

3.1.3.1 *Discussion*—The dummy specimen is mounted in the torsion fixture of the DSR for the purpose of measuring the internal temperature of the asphalt mixture sample for use in determining thermal equilibrium times.

3.1.4 *loading cycle, n*—refers to the application of sinusoidal stress or strain loading for a specified duration.

3.1.5 *portable thermometer, n*—refers to an electronic device that is separate from the dynamic shear rheometer and that consists of a detector (probe containing a thermocouple or resistive element), associated electronic circuitry, and readout system.

3.1.6 *reference thermometer, n*—refers to a NIST-traceable liquid-in-glass or electronic thermometer that is used as a laboratory standard.

3.1.7 *shear stress, n*—the force per unit area that produces the flow.

3.1.8 *temperature correction, n*—difference in temperature between the temperature indicated by the DSR and the test specimen as measured by the portable thermometer inserted between the test plates.

3.1.9 *thermal equilibrium, n*—condition where the temperature of the test specimen mounted between the test plates is constant with time.

3.1.10 *verification, n*—a process that establishes whether the results of a previously calibrated measurement instrument, measurement system, or material measure are stable. Usually performed internally within the operating laboratory.

3.2 For definitions of other terms used in this standard, refer to Terminology D8.

4. Summary of Test Method

4.1 This standard contains the procedure used to measure the complex shear modulus of an asphalt mixture using a DSR in oscillatory mode and using torsional rectangular geometry. The DSR must be temperature-controlled using a forced air system.

4.2 The standard is suitable for use when the complex shear modulus is greater than 1×10^4 Pa at the test temperature. The complex shear modulus is typically determined at 20 °C to 70 °C, although other test temperatures may be used.

4.3 Test specimens, nominally 50 mm in length, 12 mm in width, and 10 mm in thickness may be cut from gyratory or Marshall laboratory specimens or from field cores (see Figs. 1-3). Specimens can be obtained from asphalt mixture samples compacted using other devices as long as it is possible to determine the air voids of the mixture samples. The test specimens are mounted with the 50 mm length forming a vertical dimension in the DSR.

4.4 During testing, one of the fixtures[5] is rotated with respect to the other at a pre-selected percent strain and a range of frequencies at the selected temperatures. The test shall be conducted at 0.01 % strain unless otherwise stated. The percent strain stipulated in this test method has been found to produce acceptable results for the asphalt materials investigated to date.

NOTE 1—Different strain values, within the capabilities of individual equipment, may be selected for testing materials beyond the scope of those tested to date. Regardless of percent strain or test temperatures chosen or test materials investigated, the basic testing process described herein will not change.

4.5 The test specimen is maintained at the test temperature ± 0.1 °C by enclosing the upper and lower fixtures in a thermally controlled environmental test chamber.

5. Significance and Use

5.1 The complex shear modulus of asphalt mixtures is a fundamental property of the material. Test results at critical temperatures ($T_{critical}$) are used for specifications for some mixes. Mixtures with stiffer binders, aged mixes, mixtures with higher amounts of fines (material finer than 75 μ), and mixtures with lower voids all tend to have higher complex shear modulus values than mixtures with less stiff binders, unaged mixes, mixtures with low levels of fines, and higher air voids. In general, mixtures with higher complex shear modulus values at a given service temperature will exhibit lower permanent deformation values than similar mixtures tested at the same temperature that have lower complex shear modulus values.

NOTE 2—The quality of the results produced by this standard are

[3] The last approved version of this historical standard is referenced on www.astm.org.

[4] Available from Beuth Verlag GmbH (DIN--DIN Deutsches Institut fur Normung e.V.), Burggrafenstrasse 6, 10787, Berlin, Germany, http://www.en.din.de.

[5] Depending upon whether a stress or strain controlled rheometer is being used, either the upper or lower fixture will be the one which is rotated. This test method is applicable to both stress and strain controlled rheometers. When a stress controlled rheometer is used, the test is performed in strain controlled mode.