Standard Method of Test for

Determining the Rheological Properties of Asphalt Binder Using a Dynamic Shear Rheometer (DSR)

AASHTO Designation: T 315-20[1]

Technical Subcommittee: 2b, Liquid Asphalt

Release: Group 3 (July)

AASHTO

American Association of State Highway and Transportation Officials
555 12th Street NW, Suite 1000
Washington, D.C. 20004

Standard Method of Test for

Determining the Rheological Properties of Asphalt Binder Using a Dynamic Shear Rheometer (DSR)

AASHTO Designation: T 315-20[1]

Technical Subcommittee: 2b, Liquid Asphalt

Release: Group 3 (July)

1. SCOPE

1.1. This test method covers the determination of the dynamic shear modulus and phase angle of asphalt binder when tested in dynamic (oscillatory) shear using parallel plate test geometry. It is applicable to asphalt binders having dynamic shear modulus values in the range from 100 Pa to 10 MPa. This range in modulus is typically obtained between 6 and 88°C at an angular frequency of 10 rad/s. This test method is intended for determining the linear viscoelastic properties of asphalt binders as required for specification testing and is not intended as a comprehensive procedure for the full characterization of the viscoelastic properties of asphalt binder.

1.2. This standard is appropriate for unaged material or material aged in accordance with T 240 and R 28.

1.3. Particulate material in the asphalt binder is limited to particles with longest dimensions less than 250 μm.

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

2. REFERENCED DOCUMENTS

2.1. *AASHTO Standards*:

- M 320, Performance-Graded Asphalt Binder
- R 28, Accelerated Aging of Asphalt Binder Using a Pressurized Aging Vessel (PAV)
- R 29, Grading or Verifying the Performance Grade (PG) of an Asphalt Binder
- R 66, Sampling Asphalt Materials
- T 240, Effect of Heat and Air on a Moving Film of Asphalt Binder (Rolling Thin-Film Oven Test)
- T 314, Determining the Fracture Properties of Asphalt Binder in Direct Tension (DT)

2.2. *ASTM Standards*:

- C670, Standard Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials
- D2170/D2170M, Standard Test Method for Kinematic Viscosity of Asphalts (Bitumens)
- D2171/D2171M, Standard Test Method for Viscosity of Asphalts by Vacuum Capillary Viscometer
- E1, Standard Specification for ASTM Liquid-in-Glass Thermometers
- E77, Standard Test Method for Inspection and Verification of Thermometers
- E563, Standard Practice for Preparation and Use of an Ice-Point Bath as a Reference Temperature

2.3. *Deutsche Industrie Norm (DIN) Standard*:

- 43760, Industrial Platinum Resistance Thermometers and Platinum Temperature Sensors

3. TERMINOLOGY

3.1. *Definitions*:

3.1.1. *asphalt binder*—an asphalt-based cement that is produced from petroleum residue either with or without the addition of nonparticulate organic modifiers.

3.2. *Descriptions of Terms Specific to This Standard*:

3.2.1. *annealing*—heating the binder until it is sufficiently fluid to remove the effects of steric hardening.

3.2.2. *calibration*—process of checking the accuracy and precision of a device using NIST-traceable standards and making adjustments to the device where necessary to correct its operation or precision and accuracy.

3.2.3. *complex shear modulus (G*)*—ratio calculated by dividing the absolute value of the peak-to-peak shear stress, τ, by the absolute value of the peak-to-peak shear strain, γ.

3.2.4. *dummy test specimen*—a specimen formed between the dynamic shear rheometer (DSR) test plates from asphalt binder or other polymer to measure the temperature of the asphalt binder held between the plates. The dummy test specimen is used solely to determine temperature corrections.

3.2.5. *linear viscoelastic*—within the context of this specification refers to a region of behavior in which the dynamic shear modulus is independent of shear stress or strain.

3.2.6. *loading cycle*—a unit cycle of time for which the test sample is loaded at a selected frequency and stress or strain level.

3.2.7. *loss shear modulus (G″)*—the complex shear modulus multiplied by the sine of the phase angle expressed in degrees. It represents the component of the complex modulus that is a measure of the energy lost (dissipated during a loading cycle).

3.2.8. *molecular association*—a process where associations occur between asphalt binder molecules during storage at ambient temperature. Often called steric hardening in the asphalt literature, molecular associations can increase the dynamic shear modulus of asphalt binders. The amount of molecular association is asphalt specific and may be significant even after a few hours of storage.

3.2.9. *oscillatory shear*—refers to a type of loading in which a shear stress or shear strain is applied to a test sample in an oscillatory manner such that the shear stress or strain varies in amplitude by about zero in a sinusoidal manner.

3.2.10. *parallel plate geometry*—refers to a testing geometry in which the test sample is sandwiched between two relatively rigid parallel plates and subjected to oscillatory shear.

3.2.11. *phase angle (δ)*—the angle in radians between a sinusoidally applied strain and the resultant sinusoidal stress in a controlled-strain testing mode, or between the applied stress and the resultant strain in a controlled-stress testing mode.

3.2.12. *portable thermometer*—an electronic device that consists of a temperature detector (probe containing a thermocouple or resistive element), required electronic circuitry, and readout system.

3.2.13. *reference thermometer*—a NIST–traceable liquid-in-glass or electronic thermometer that is used as a laboratory standard.

3.2.14. *steric hardening*—see molecular association.

3.2.15. *storage shear modulus (G′)*—the complex shear modulus multiplied by the cosine of the phase angle expressed in degrees. It represents the in-phase component of the complex modulus that is a measure of the energy stored during a loading cycle.

3.2.16. *temperature correction*—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.

3.2.17. *thermal equilibrium*—is reached when the temperature of the test specimen mounted between the test plates is constant with time.

3.2.18. *verification*—process of checking the accuracy of a device or its components against an internal laboratory standard. It is usually performed within the operating laboratory.

4. SUMMARY OF TEST METHOD

4.1. This standard contains the procedure used to measure the complex shear modulus (G^*) and phase angle (δ) of asphalt binders using a dynamic shear rheometer and parallel plate test geometry.

4.2. The standard is suitable for use when the dynamic shear modulus varies between 100 Pa and 10 MPa. This range in modulus is typically obtained between 6 and 88°C at an angular frequency of 10 rad/s, dependent on the grade, test temperature, and conditioning (aging) of the asphalt binder.

4.3. Test specimens 1 mm thick by 25 mm in diameter or 2 mm thick by 8 mm in diameter are formed between parallel metal plates. During testing, one of the parallel plates is oscillated with respect to the other at preselected frequencies and rotational deformation amplitudes (strain control) (or torque amplitudes [stress control]). The required stress or strain amplitude depends on the value of the complex shear modulus of the asphalt binder being tested. The required amplitudes have been selected to ensure that the measurements are within the region of linear behavior.

4.4. The test specimen is maintained at the test temperature to within ±0.1°C by positive heating and cooling of the upper and lower plates or by enclosing the upper and lower plates in a thermally controlled environment or test chamber.