
Standard Method of Test for

Determining the Permanent Shear Strain and Stiffness of Asphalt Mixtures Using the Superpave Shear Tester (SST)

AASHTO Designation: T 320-22

Technically Revised: 2022

Technical Subcommittee: 2d, Proportioning of Asphalt–Aggregate Mixtures



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1. SCOPE

- 1.1. This standard provides performance-related test procedures for the determination of stiffness and permanent shear strain of asphalt mixtures using the Superpave Shear Tester (SST). Modified and unmodified asphalt mixtures can be tested and analyzed using this standard.
- 1.2. This standard is applicable to specimens prepared in a laboratory or cored from a pavement for postconstruction analysis. It is intended for use with specimens having the following minimum dimensions:

Nominal Maximum Aggregate Size in Asphalt Mixture, mm	Specimen Diameter	Specimen Height
19	150	50
12.5, 9.5, 4.75	150	38

Note 1—Nominal maximum aggregate size is defined in R 35 as the sieve greater than the first sieve to retain more than 10 percent of the total aggregate. Asphalt mixtures with a nominal maximum aggregate size greater than 19 mm can be tested using this procedure, but it is not recommended. The larger aggregate sizes may significantly interfere with the material response, thereby affecting the repeatability of the test.

Note 2—The SST is only capable of testing specimens with a maximum diameter of 150 mm. The specimen height of 50 mm is preferred, but may not be available in roadway cores where layer thickness may only be 38 mm. Specimen heights less than 38 mm usually cannot be tested because of equipment constraints.

Note 3—The diameter-to-height ratio for shear test specimens should be 3:1 or greater. This effectively eliminates the use of 100-mm diameter specimens (because of minimum height requirement for testing discussed in Note 2).

- 1.3. *This practice may involve hazardous materials, operations, and equipment. It does not purport to address all the safety concerns associated with its use. It is the responsibility of the user of this practice to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to its use.*
- 1.4. *The quality of the results produced by this standard are dependent on the competence of the personnel performing the procedure and the capability, calibration, and maintenance of the equipment used. Agencies that meet the criteria of R 18 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with R 18 alone does not completely assure reliable results. Reliable results depend*

on many factors; following the suggestions of R 18 or some similar acceptable guideline provides a means of evaluating and controlling some of those factors.

2. REFERENCED DOCUMENTS

2.1. *AASHTO Standards:*

- < M 339M/M 339, Thermometers Used in the Testing of Construction Materials
- < R 18, Establishing and Implementing a Quality Management System for Construction Materials Testing Laboratories
- < R 30, Laboratory Conditioning of Asphalt Mixtures
- < R 35, Superpave Volumetric Design for Asphalt Mixtures
- < R 66, Sampling Asphalt Materials
- < R 90, Sampling Aggregate Products
- < R 97, Sampling Asphalt Mixtures
- < T 209, Theoretical Maximum Specific Gravity (G_{mm}) and Density of Asphalt Mixtures
- < T 269, Percent Air Voids in Compacted Dense and Open Asphalt Mixtures
- < T 312, Preparing and Determining the Density of Asphalt Mixture Specimens by Means of the Superpave Gyratory Compactor

2.2. *ASTM Standards:*

- < D3549/D3549M, Standard Test Method for Thickness or Height of Compacted Asphalt Mixture Specimens
- < D5361/D5361M, Standard Practice for Sampling Compacted Asphalt Mixtures for Laboratory Testing
- < E1, Standard Specification for ASTM Liquid-in-Glass Thermometers
- < E230/E230M, Standard Specification for Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples
- < E879, Standard Specification for Thermistor Sensors for General Purpose and Laboratory Temperature Measurements
- < E1137/E1137M, Standard Specification for Industrial Platinum Resistance Thermometers

2.3. *International Electrotechnical Commission Standards:*

- < IEC 60584-1: 2013 Thermocouples - Part 1: EMF Specifications and Tolerances
- < IEC 60751: 2008 Industrial Platinum Resistance Thermometers and Platinum Temperature Sensors

3. SIGNIFICANCE AND USE

- 3.1. The test procedures and associated analysis techniques described in this method can be used to determine shear stiffness and permanent shear strain of asphalt mixtures. The shear frequency sweep test at constant height can be used to determine mixture stiffness. The simple shear test at constant height can be used to determine shear deformation from the application of a static shear load. The repeated shear test at constant height can be used with corresponding analysis procedures to estimate the rutting susceptibility of an asphalt mixture.

4. EQUIPMENT AND MATERIALS

4.1. *Shear Test System*—The shear test system shall consist of a loading device, specimen deformation measurement equipment, an environmental chamber, and a control and data acquisition system. It shall accommodate test specimens 150 mm in diameter and 50 mm in height.

4.1.1. *Loading Device*—The loading device shall be capable of simultaneously applying both vertical and horizontal loads to a specimen. It shall also be capable of applying static, ramped (increasing or decreasing), and repetitive loads of various waveforms. As a minimum, the loading device shall be capable of applying horizontal shear load pulses in a haversine waveform with a load duration of 0.1 s with 0.6 s between load pulses. Loading shall be provided by two hydraulic actuators (one each horizontal and vertical) and shall be controlled by closed-loop feedback using either stress or strain control throughout the entire range of frequencies and temperatures. The loading device shall be capable of meeting the minimum requirements specified in Table 1.

Table 1—Minimum Test System Requirements

Measurement and Control Parameters	Range	Resolution	Accuracy
Load, N	0 to 31,000	2	5
Axial LVDT, mm	0 to 5	0.0025	0.005
Shear LVDT, mm	0 to 0.05	0.001	0.002
Temperature, °C	0 to 80	0.25	0.5

4.1.2. *Environmental Chamber*—The environmental chamber shall be capable of maintaining the temperature of the test specimen as specified in Table 1 during the testing sequence.

4.1.3. *Data Acquisition and Control System*—The data acquisition and control system shall automatically control user-selected measurement parameters, within the accuracy specified in Table 1, during the testing sequence. The system shall record load cycles, applied horizontal and vertical loads, specimen deformation in two directions (vertical and horizontal), environmental conditions, and the required frequency of data sampling. At the conclusion of the test, the data acquisition and control system shall provide all applicable test data.

4.2. *Conditioning Chamber*—The conditioning chamber shall be capable of maintaining the specimen conditioning temperatures as specified in Table 1. Thermometers for measuring the temperature within the chamber shall meet the requirements of M 339M/M 339 with a temperature range of at least -5 to 85°C , and an accuracy of $\pm 0.13^{\circ}\text{C}$ (see Note 4).

Note 4—Thermometer types suitable for use include ASTM E879 thermistor thermometer, Special order; ASTM E1137/E1137M Pt-100 RTD platinum resistance thermometer, Special order; or IEC 60751: 2008 Pt-100 RTD platinum resistance thermometer, Special order.

4.3. *Platen-Specimen Assembly Device (optional)*—The platen-specimen assembly device is used to facilitate bonding the specimen to the loading platens with adhesive. The device shall maintain the platens in a parallel position (relative to each other) during the gluing operation. The platens must remain parallel so that stresses do not develop in the specimen when the platen-specimen assembly is clamped in the test system. The device shall be capable of testing specimens with a maximum diameter of 150 mm and maximum height of 50 mm.

4.4. *Aluminum Loading Platens*—Top and bottom aluminum loading platens at least 6.35 mm greater in diameter than the diameter of the specimen to be tested and at least 20 mm thick. The bearing face of each platen shall be plane to 0.025 mm.

4.5. *Adhesive*—Quickset adhesive with a minimum hardened stiffness modulus of 2000 MPa for bonding the platens to the specimen ends.

Note 5—Devcon™ 5-Minute Plastic Steel Epoxy Cement is one possible material that is satisfactory for tests conducted at 20°C or higher.

- 4.6. *Solvent*—Acetone, kerosene, or other equivalent solvent for cleaning the platens after testing.

Note 6—Most of the epoxy and samples can be removed by heating and scraping the platens. The solvent is used only for a final cleaning.

- 4.7. *Oven*—Thermostatically controlled, properly standardized, and capable of maintaining any desired temperature setting from room temperature to 176°C within $\pm 5^\circ\text{C}$. More than one oven may be used, provided each is used within its proper operating temperature range. The thermometer for measuring the temperature within the oven shall meet the requirements of M 339M/M 339 with a temperature range of at least 25 to 185°C, and an accuracy of $\pm 1.25^\circ\text{C}$ (see Note 7).

Note 7—Thermometer types suitable for use include ASTM E1 mercury thermometers; ASTM E230/E230M thermocouple thermometer, Type J, K, or T, Special Class; or IEC 60584 thermocouple thermometer, Type T, Class 1.

5. STANDARDIZATION

- 5.1. The testing system shall be standardized prior to initial use and at least once every 12 months thereafter.
- 5.1.1. Verify the capability of the environmental control chamber to maintain the required temperature within the accuracy specified in Table 1.
- 5.1.2. Verify the calibration of all measurement components [such as load cells and linear variable differential transducers (LVDTs)] of the testing system.
- 5.1.3. If any of the verifications yield data that do not comply with the accuracy requirements specified in Table 1, correct the problem prior to proceeding with testing. Appropriate action may involve correction of menu entries, maintenance of system components, calibration of system components (using an independent calibration service, manufacturer service, or in-house resources), or replacement of system components.

6. SAMPLING AND SPECIMEN PREPARATION

- 6.1. Five test specimens are preferred, and a minimum of three specimens are required, for performing the repeated shear test at constant height. Three test specimens are preferred for performing the shear frequency sweep test at constant height and the simple shear test at constant height.
- 6.2. *Laboratory-Mixed, Laboratory-Compacted (MLLC) Specimens*—Sample asphalt binder and aggregates in accordance with R 66 and R 90, respectively. Use the appropriate proportions of asphalt binder and aggregates according to the final asphalt mix design.
- 6.2.1. Prepare aggregate batches of the appropriate size to produce a compacted specimen that will be 150 mm in diameter and 75 mm in height. Heat the aggregate batches to the appropriate mixing temperature.
- Note 8**—The Appendix contains information on the calculation of the appropriate aggregate batch weight to achieve the correct specimen dimension at the proper percentage of air voids.
- 6.2.2. Heat the asphalt binder to the appropriate mixing temperature. Mix the correct proportions of asphalt binder and combined aggregates to match the asphalt mix design.