
Standard Method of Test for

Preparing and Determining the Density of Asphalt Mixture Specimens by Means of the Superpave Gyratory Compactor

AASHTO Designation: T 312-22

Technically Revised: 2022

Editorially Revised: 2022

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



**American Association of State Highway and Transportation Officials
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1. SCOPE

- 1.1. This standard covers the compaction of cylindrical specimens of asphalt mixtures using the Superpave gyratory compactor.
- 1.2. *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 standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*
- 1.3. *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.*
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2. REFERENCED DOCUMENTS

- 2.1. *AASHTO Standards:*
- < M 231, Weighing Devices Used in the Testing of Materials
 - < 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 47, Reducing Samples of Asphalt Mixtures to Testing Size
 - < R 97, Sampling Asphalt Mixtures
 - < T 166, Bulk Specific Gravity (G_{mb}) of Compacted Asphalt Mixtures Using Saturated Surface-Dry Specimens
 - < T 209, Theoretical Maximum Specific Gravity (G_{mm}) and Density of Asphalt Mixtures
 - < T 275, Bulk Specific Gravity (G_{mb}) of Compacted Asphalt Mixtures Using Paraffin-Coated Specimens
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- < T 316, Viscosity Determination of Asphalt Binder Using Rotational Viscometer
- < T 344, Evaluation of Superpave Gyratory Compactor (SGC) Internal Angle of Gyration Using Simulated Loading

2.2. *ASTM Standards:*

- < E1, Standard Specification for ASTM Liquid-in-Glass Thermometers
- < E230/E230M, Standard Specification for Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples
- < E2877, Standard Guide for Digital Contact Thermometers

2.3. *International Electrotechnical Commission Standard:*

- < IEC 60584-1: 2013 Thermocouples - Part 1: EMF Specifications and Tolerances

2.4. *Other Standards:*

- < ANSI/ASME B89.1.6, Measurement of Qualified Plain Internal Diameters for Use as Master Rings and Ring Gages
- < ANSI/ASME B89.4.19, Performance Evaluation of Laser-Based Spherical Coordinate Measurement Systems
- < ASME B46.1, Surface Texture (Surface Roughness, Waviness, and Lay)

3. SIGNIFICANCE AND USE

- 3.1. This standard is used to prepare specimens for determining the mechanical and volumetric properties of asphalt mixtures. The specimens simulate the density, aggregate orientation, and structural characteristics obtained in the actual roadway when proper construction procedure is used in the placement of the paving mix.
- 3.2. This test method may be used to monitor the density of test specimens during their preparation. It may also be used for field control of an asphalt mixture production process.

4. APPARATUS

- 4.1. *Superpave Gyratory Compactor*—An electrohydraulic or electromechanical compactor with a ram and ram heads as described in Section 4.3. The axis of the ram shall be perpendicular to the platen of the compactor. The ram shall apply and maintain a pressure of 600 ± 18 kPa perpendicular to the cylindrical axis of the specimen during compaction (Note 1). The compactor shall tilt the specimen molds at an average internal angle of 20.2 ± 0.35 mrad (1.16 ± 0.02 degrees), determined in accordance with T 344. The compactor shall gyrate the specimen molds at a rate of 30.0 ± 0.5 gyrations per minute throughout compaction.

Note 1—This stress calculates to $10\,600 \pm 310$ N total force for 150-mm specimens.

- 4.1.1. *Specimen Height Measurement and Recording Device*—When specimen density is to be monitored during compaction, a means shall be provided to continuously measure and record the height of the specimen to the nearest 0.1 mm during compaction once per gyration.
- 4.1.2. The system may include a connected printer capable of printing test information, such as specimen height per gyration. In addition to a printer, the system may include a computer and suitable software for data acquisition and reporting.

- 4.1.3. The loading system, ram, and pressure indicator shall be capable of providing and measuring a constant vertical pressure of 600 ± 60 kPa during the first five gyrations, and 600 ± 18 kPa during the remainder of the compaction period.
- 4.2. *Specimen Molds*—Specimen molds shall have steel walls that are at least 7.5 mm thick and are hardened to at least a Rockwell hardness of C48. The initial inside finish of the molds shall have a root mean square (rms) of $1.60 \mu\text{m}$ or smoother when measured in accordance with ASME B46.1 (see Note 2). New molds shall be manufactured to have an inside diameter of 149.90 to 150.00 mm. The inside diameter of in-service molds shall not exceed 150.2 mm. Molds shall be at least 250 mm in length. The inside diameter and length of the molds shall be measured in accordance with Annex A.
- Note 2**—One source of supply for a surface comparator, which is used to verify the rms value of $1.60 \mu\text{m}$, is GAR Electroforming, Danbury, Connecticut.
- 4.3. *Ram Heads and End Plates*—Ram heads and end plates shall be fabricated from steel with a minimum Rockwell hardness of C48. The ram heads shall stay perpendicular to their axis. The platen side of each end plate shall be flat and parallel to its face. All ram and end plate faces (the sides presented to the specimen) shall be flat to meet the smoothness requirement in Section 4.2 and shall have a diameter of 149.50 to 149.75 mm.
- 4.4. *Thermometers*—Thermometers for measuring temperature of aggregates, binder, and asphalt mixtures shall meet the requirements of M 339M/M 339 with a temperature range of at least 10 to 230°C , and an accuracy of $\pm 2.5^{\circ}\text{C}$ ($\pm 4.5^{\circ}\text{F}$) (see Note 3).
- Note 3**—Thermometer types suitable for use include ASTM E1 mercury thermometers; ASTM E230/E230M thermocouple thermometer, Type J, any Class, or Type K, Class 1 or 2; IEC 60584 thermocouple thermometer, Type J, any Class, or Type K, Class 1 or 2; ASTM E2877 digital metal stem thermometer; or dial gauge metal stem (bi-metal) thermometer.
- 4.5. *Balance*—A balance meeting the requirements of M 231, Class G 5, for determining the mass of aggregates, binder, and asphalt mixtures.
- 4.6. *Oven*—An oven, thermostatically controlled to $\pm 3^{\circ}\text{C}$, for heating aggregates, binder, asphalt mixtures, and equipment as required. The oven shall be capable of maintaining the temperature required for mixture conditioning in accordance with R 30.
- 4.7. *Miscellaneous*—Flat-bottom metal pans for heating aggregates, scoop for batching aggregates, containers (grill-type tins, beakers, containers for heating asphalt), large mixing spoon or small trowel, large spatula, gloves for handling hot equipment, paper disks, mechanical mixer (optional), lubricating materials recommended by the compactor manufacturer.
- 4.8. *Maintenance*—In addition to routine maintenance recommended by the manufacturer, check the Superpave gyratory compactor's mechanical components for wear, and perform repair, as recommended by the manufacturer.

5. HAZARDS

- 5.1. Use standard safety precautions and protective clothing when handling hot materials and preparing test specimens.

6. STANDARDIZATION

- 6.1. Items requiring periodic verification of calibration include the ram pressure, angle of gyration, gyration frequency, LVDT (or other means used to continuously record the specimen height), and

oven temperature. Verification of the mold and platen dimensions and the inside finish of the mold are also required. When the computer and software options are used, periodically verify the data-processing system output using a procedure designed for such purposes. Verification of calibration, system standardization, and quality checks may be performed by the manufacturer, other agencies providing such services, or in-house personnel. Frequency of verification shall follow the manufacturer's recommendations.

- 6.2. The angle of gyration refers to the internal angle (the tilt of the mold with respect to the end plate surface within the gyratory mold). The calibration of the internal angle of gyration shall be verified in accordance with T 344.

7. PREPARATION OF APPARATUS

- 7.1. Immediately prior to the time when the asphalt mixture is ready for placement in the mold, turn on the main power for the compactor for the manufacturer's required warm-up period.
- 7.2. Verify the machine settings are correct for angle, pressure, and number of gyrations.
- 7.3. Lubricate any bearing surfaces as needed per the manufacturer's instructions.
- 7.4. When specimen height is to be monitored, the following additional item of preparation is required. Immediately prior to the time when the asphalt mixture is ready for placement in the mold, turn on the device for measuring and recording the height of the specimen, and verify the readout is in the proper units, mm, and the recording device is ready. Prepare the computer, if used, to record the height data, and enter the header information for the specimen.

8. ASPHALT MIXTURE PREPARATION

- 8.1. *Laboratory Prepared:*
- 8.1.1. Weigh the appropriate aggregate fractions into a separate pan, and combine them to the desired batch weight. The batch weight will vary based on the ultimate disposition of the test specimens. If a target air void level is desired, as would be the case for Superpave mix analysis and performance specimens, batch weights will be adjusted to create a given density in a known volume. If the specimens are to be used for the determination of volumetric properties, the batch weights will be adjusted to result in a compacted specimen having dimensions of 150 mm in diameter and 115 ± 5 mm in height at the desired number of gyrations.
- Note 4**—It may be necessary to produce a trial specimen to achieve this height requirement. Generally, 4500 to 4700 g of aggregate are required to achieve this height for aggregates with combined bulk specific gravities of 2.550 to 2.700, respectively.
- 8.1.2. Place the aggregate and binder container in the oven, and heat them to the required mixing temperature.
- 8.1.2.1. The mixing temperature range is defined as the range of temperatures where the unaged binder has a viscosity of 0.17 ± 0.02 Pa·s when measured in accordance with T 316.
- Note 5**—Modified asphalts may not adhere to the equiviscosity requirements noted, and the manufacturer's recommendations should be used to determine mixing and compaction temperatures.
- 8.1.3. Charge the mixing bowl with the heated aggregate from one pan and dry-mix thoroughly. Form a crater in the dry-blended aggregate, and weigh the required amount of binder into the mix. Immediately initiate mixing.