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Standard Method of Test for

# Theoretical Maximum Specific Gravity ( $G_{mm}$ ) and Density of Asphalt Mixtures

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**AASHTO Designation: T 209-23**

Technically Revised: 2023

**Technical Subcommittee: 2c, Asphalt–Aggregate Mixtures**



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## 1. SCOPE

- 1.1. This test method covers the determination of the theoretical maximum specific gravity/gravity mix maximum ( $G_{mm}$ ) and density of uncompact asphalt mixture at 25°C (77°F).
- Note 1**—The precision of the method is best when the procedure is performed on samples that contain aggregates that are completely coated. In order to assure complete coating, it is desirable to perform the method on samples that are close to the optimum asphalt binder content.
- 1.2. The values stated in SI units are to be regarded as the standard.
- 1.3. *This standard may involve hazardous materials, operations, and equipment. 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 and health practices and determine the applicability of regulatory limitations prior to 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.*

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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 Mixture
  - < R 47, Reducing Samples of Asphalt Mixtures to Testing Size
  - < R 61, Establishing Requirements for Equipment Calibrations, Standardizations, and Checks
  - < R 67, Sampling Asphalt Mixtures after Compaction (Obtaining Cores)
  - < R 97, Sampling Asphalt Mixtures
- 2.2. *ASTM Standards:*

- < C670, Standard Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials
- < 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
- < E2877, Standard Guide for Digital Contact 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

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### 3. TERMINOLOGY

3.1. *Definitions:*

- 3.1.1. *density, as determined by this test method*—the mass of a cubic meter of the material at 25°C (77°F) in SI units, or the mass of a cubic foot of the material at 25°C (77°F) in inch-pound units.
- 3.1.2. *residual pressure, as employed by this test method*—the pressure in a vacuum vessel when vacuum is applied.
- 3.1.3. *specific gravity, as determined by this test method*—the ratio of a given mass of material at 25°C (77°F) to the mass of an equal volume of water at the same temperature.

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### 4. SIGNIFICANCE AND USE

- 4.1. The theoretical maximum specific gravity ( $G_{mm}$ ) and density of asphalt mixture are intrinsic properties whose values are influenced by the composition of the mixtures in terms of types and amounts of aggregates and asphalt materials.
- 4.1.1. These properties are used to calculate percent air voids in compacted asphalt mixture.
- 4.1.2. These properties provide target values for the compaction of asphalt mixture.
- 4.1.3. These properties are essential when calculating the amount of asphalt binder absorbed by the internal porosity of the individual aggregate particles in asphalt mixture.

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### 5. APPARATUS

- 5.1. Follow the procedures for performing equipment calibrations, standardizations, and checks that conform to R 18 and R 61.
- 5.2. *Vacuum Container:*
- 5.2.1. The vacuum containers described must be capable of withstanding the full vacuum applied, and each must be equipped with the fittings and other accessories required by the test procedure being

employed. The opening in the container leading to the vacuum pump shall be covered by a piece of 0.075-mm (No. 200) wire mesh to minimize the loss of fine material.

- 5.2.2. The capacity of the vacuum container should be between 2000 and 10 000 mL and depends on the minimum sample size requirements given in Section 6.3. Avoid using a small sample in a large container.
- 5.2.3. *Bowl for Mass Determination in Water Only (Section 11.1)*—Either a metal or plastic bowl with a diameter of approximately 180 to 260 mm (7 to 10 in.) and a bowl height of at least 160 mm (6.3 in.) equipped with a transparent cover fitted with a rubber gasket and a connection for the vacuum line.
- 5.2.4. *Flask for Mass Determination in Air Only (Section 11.2)*—A thick-walled volumetric glass flask with a factory-inscribed line and a rubber stopper with a connection for the vacuum line.
- 5.2.5. *Pycnometer for Mass Determination in Air Only (Section 11.2)*—A glass, metal, or plastic pycnometer with a volume defined by means of a glass capillary stopper, capillary lid, or glass plate.
- 5.3. *Balance*—A balance conforming to the requirements of M 231, Class G 2. The balance shall be standardized at least every 12 months.
- 5.3.1. For the mass determination-in-water method (Section 11.1), the balance shall be equipped with a suitable apparatus and holder to permit determining the mass of the sample while suspended below the balance. The wire suspending the holder shall be the smallest practical size to minimize any possible effects of a variable immersed length.
- 5.4. *Vacuum Pump or Water Aspirator*—Capable of evacuating air from the vacuum container to a residual pressure of 3.4 kPa (25 mmHg).
- 5.4.1. When an oil vacuum pump is used, a suitable trap of one or more filter flasks, or equivalent, shall be installed between the vacuum vessel and vacuum source to reduce the amount of water vapor entering the vacuum pump.
- 5.5. *Vacuum Measurement Device*—Residual pressure manometer<sup>1</sup> or vacuum gauge to be connected directly to the vacuum vessel and capable of measuring residual pressure down to 3.4 kPa (25 mmHg) or less (preferably to zero).

**Note 2**—Residual pressure in the vacuum container, measured in millimeters of mercury, is the difference in the height of mercury in the Torricellian vacuum leg of the manometer and the height of mercury in the other leg of the manometer that is attached to the vacuum container.

The device shall be standardized at least annually and be readable to at least 0.2 kPa (2 mmHg). It shall be connected at the end of the vacuum line using an appropriate tube and either a “T” connector on the top of the vessel or a separate opening (from the vacuum line) in the top of the vessel to attach the hose. To avoid damage, the manometer shall not be situated on top of the vessel.