METHOD OF SAMPLING AND TESTING
MT 321-17
DETERMINING THEORETICAL MAXIMUM SPECIFIC GRAVITY OF BITUMINOUS PAVING MIXTURES - "RICE GRAVITY"
(Modified AASHTO T 209)

1 Scope

1.1 This test method covers the determination of theoretical maximum specific gravity (commonly referred to as Rice Gravity or Gmm) of un-compacted bituminous paving mixtures.

2 Referenced Documents

AASHTO

M 339 Thermometers Used in the Testing of Construction Materials
R 47 Reducing Samples of Asphalt Mixtures to Testing Size
T 209 Theoretical Maximum Specific Gravity and Density of Hot Mix Asphalt (HMA)

MT Materials Manual

MT 303 Sampling Bituminous Paving Mixtures

3 Terminology

3.1 Residual pressure (as employed by this test method) – the pressure in a vacuum vessel when vacuum is applied.

3.2 Specific gravity (as determined by this test method) – the ratio of a given mass of material at 77°F (25°C) to the mass of an equal volume of water at the same temperature.

3.3 Gmm – Theoretical maximum specific gravity of the mixture or “Rice Gravity”

4 Significance and Use

4.1 The theoretical maximum specific gravities of bituminous paving mixtures are basic properties whose values are influenced by the composition of the mixtures and types and amounts of aggregates and asphalt materials.

4.2 These properties are used to calculate percent air voids in compacted bituminous paving mixtures.

4.3 These properties provide target values for the compaction of bituminous paving mixtures.

4.4 These properties are essential when calculating the amount of asphalt binder absorbed by the internal porosity of the individual aggregate particles in bituminous paving mixtures.

5 Apparatus

Ensure equipment used meets the following requirements:

5.1 *Balance* – Capacity of 16,000 g sensitive to 0.1 g, to allow the maximum specific gravity of the un-compacted mix to be calculated to the nearest thousandth (0.001 g).

5.2 *Container* – 4000 mL volumetric flask. Ensure the flask, with a proper cover (see Note 1), is sufficiently strong to withstand a partial vacuum. Confirm the top surfaces of all containers are smooth and substantially plane.

Note 1 – MDT uses a glass capillary stopper.

5.3 *Vacuum System*

5.3.1 *Vacuum Pump* – Motor driven vacuum pump, capable of maintaining at least 25 mm of Hg of vacuum. The pump is used for removing air from the flask through the vacuum.

5.3.2 *Vacuum Apparatus* - rubber stopper with a hose connection to connect the volumetric flask to vacuum pump.

5.3.3 *Vacuum Measurement Device* – Residual pressure manometer or vacuum gauge connected directly to the vacuum vessel and capable of measuring residual pressure down to 25 mm of Hg or less.

5.4 *Water Bath* – Water bath capable of maintaining constant temperature of 77 ± 1ºF (25 ± 0.6ºC) to fill the 4000 mL flask.

5.5 *Thermometer* – Liquid-in-glass thermometer accurate to 0.5°C (1°F), complying with AASHTO M 339.

6 Sampling

6.1 Obtain field samples in accordance with MT 303. Split field samples in accordance with AASHTO R 47.

6.2 Meet the sample size requirements in Table 1.

Table 1 – Minimum Sample Sizes

Nominal Maximum Aggregate Size	Minimum Sample Size
1" (25 mm)	2500 g (5.50 lb)
3/4" (19 mm)	2000 g (4.40 lb)
1/2" (12.5 mm)	1500 g (3.30 lb)
3/8" (9.5 mm)	1000 g (2.20 lb)
No. 4 (4.75 mm)	500 g (1.10 lb)

7 Standardization of Flasks

7.1 At the beginning of PMS production, the volumetric flask and glass capillary stopper are standardized to accurately determine the mass of water at 77 ± 1ºF (25 ± 0.6ºC) in the flask.

7.1.1 Fill the flask with water. Gently place the stopper in the flask ensuring proper seating. Ensure all air has been removed from the flask. Remove flask from water bath. Carefully towel dry the outside of the flask and stopper area. Weigh the flask with stopper and record the mass. Designate this mass as $\mathbf{E_1}$**,** $\mathbf{E_2}$**, or** $\mathbf{E_3}$.

7.1.2 Remove the stopper and decant a portion of the water back into the bath. Repeat Section 7.2 two (2) more times.

7.1.3 Record the average of the flask standardization masses (See section 9.1). Designate this average mass as **E**.

7.2 Check standardization daily when testing and re-standardize as needed or when there is a change in tester, equipment, or when adding additional water for the day’s testing. Keep the equipment clean and free from any accumulation that would change the mass if the volume standardization is to remain constant. Do not subject glass vessels to vacuum if they are scratched or damaged.

8 Procedure

8.1 Obtain a sample size in accordance with section 6.2, Table 1.

8.2 Separate the particles of the sample, taking care not to fracture the mineral particles so that the fine aggregate portion is not larger than ¼ inch.

8.3 The sample may be heated at mix design compaction temperature if necessary to facilitate the breakup of the sample.

8.4 Cool the sample to approximately 77ºF (25°C).

8.5 Remove flask from water bath containing enough water at 77 ± 2ºF (25 ± 0.6ºC) to cover the sample by approximately 1 inch, towel dry the outside of the flask, and place on the scale. Record the mass of the flask and water, then tare the scale.

8.6 Add the sample to the tared flask ensuring both the sample and the flask are at 77 ± 2ºF (25 ± 0.6ºC). Weigh to the nearest 0.1g. Designate the mass of the sample as **D**.

8.7 Wet the mouth of the flask and seat the vacuum apparatus on the flask, to ensure a proper seal between the flask and the vacuum apparatus. Turn on the vacuum pump to remove entrapped air by subjecting the contents to a partial vacuum of 27.5 ± 2.5 Hg mm gauge pressure for 15 ± 2 minutes (See Note 2). Agitate the container and contents either continuously by mechanical device or manually by vigorous shaking at intervals of about 2 minutes.

Note 2 – The time the sample is under vacuum does not begin until the proper gauge pressure has been reached.

8.8 Turn off the vacuum pump, slowly open the release valve to allow the pressure to normalize, then remove the vacuum apparatus.

8.9 Fill the flask from the water bath with water at 77 ± 2ºF (25 ± 0.6ºC). Gently place the stopper in the flask ensuring proper seating and taking care not to introduce air into the sample. Place the flask and contents in the water bath and bring the contents to a temperature of 77 ± 2ºF (25 ± 0.6ºC) within 10 ± 1 min after completing the vacuum procedure. Check the temperature of the contents with the thermometer.

8.10 Remove flask from water bath. Carefully towel dry the outside of the flask and stopper area. Determine the mass of the flask filled with contents. Designate the mass of flask with water and sample as **C**.

9 Calculations

9.1 Calculate the average of the flask standardization masses as follows:

$$E = \left(\frac{E_1 + E_2 + E_3}{3}\right)$$

Where:
E = averaged mass of standardized flask, designated as mass of flask
E_1 = 1st flask standardization mass
E_2 = 2nd flask standardization mass
E_3 = 3rd flask standardization mass

9.2 Calculate the mass of the sample (dry mass) and mass of standardized flask:

$$F = D + E$$

Where:
F = mass of the sample (dry mass) and mass of standardized flask
D = mass of the sample (dry mass)
E = mass of flask

9.3 Calculate the volume of the sample as follows:

$$G = F - C$$

Where:
G = Volume of sample
F = mass of sample (dry mass) and flask (equation 9.2)
C = mass of the standardized flask with contents (water and saturated sample after vacuum procedure)

9.4 Calculate the "Rice Gravity" of the sample as follows:

$$R = \frac{D}{G}$$

Where:
R = Gmm = theoretical maximum specific gravity of the mixture, "Rice Gravity"
D = mass of the sample (dry mass)
G = volume of sample (equation 9.3)

10 Report

10.1 Report the theoretical maximum specific gravity of the mixture (Gmm or Rice Gravity) to the nearest thousandth (0.001).