

**METHOD OF SAMPLING AND TESTING**  
**MT 321-14**  
**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) of un-compacted bituminous paving mixtures.

**2 Referenced Documents****AASHTO**

T 209 Theoretical Maximum Specific Gravity and Density of Hot Mix Asphalt (HMA)

**MT Materials Manual**

MT 303 Sampling Bituminous Paving Mixtures

MT 309 Splitting Samples of Plant Mix Surfacing to Testing Size

MT 325 Determining Moisture Content of Bituminous Mixtures or Aggregate Using Microwave Ovens

**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 25° C (77° F) to the mass of an equal volume of water at the same temperature.

**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 four significant figures (3 decimal places).
- 5.2 *Container* - 4000 mL volumetric flask. Ensure the flask, with a proper cover, is sufficiently strong to withstand a partial vacuum. Ensure the flask includes a rubber stopper and a hose connection. Confirm the top surfaces of all containers are smooth and substantially plane.
- 5.3 *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.

- 5.4 *Water Bath* - Water bath capable of maintaining constant temperature of  $25 \pm 0.6^\circ \text{C}$  ( $77 \pm 1^\circ \text{F}$ ), to fill the 4000 mL flask.
- 5.5 *Thermometer* – Liquid-in-glass thermometer accurate to  $0.5^\circ \text{C}$  ( $1^\circ \text{F}$ ).

**6 Sampling**

- 6.1 Obtain field samples in accordance with [MT 303](#). Split field samples in accordance with [MT 309](#).
- 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)                     | 2500g (5.50 lb.)    |
| 3/4" (19 mm)                   | 2000g (4.40 lb.)    |
| 1/2" (12.5 mm)                 | 1500g (3.30 lb.)    |
| 3/8" (9.5 mm)                  | 1000g (2.20 lb.)    |
| No. 4 (4.75 mm)                | 500g (1.10 lb.)     |

**7 Standardization of Flasks**

- 7.1 Volumetric flask and glass capillary stopper are standardized to accurately determine the mass of water, at  $25 \pm 0.5^\circ \text{C}$  ( $77 \pm 0.9^\circ \text{F}$ ), in the flask.
- 7.2 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 *E*.
- 7.3 Remove the stopper and decant a portion of the water back into the bath.
- 7.4 Repeat section 7.2 two (2) more times at the beginning of PMS production and periodically thereafter.
- 7.5 Record the average of the flask standardization masses. Designate this average mass as *E*. (See section 9.1)

*Note 1 – Check standardization daily and re-standardize as needed or when there is a change in tester. 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. The fine aggregate portion is all the material passing the ¼ inch (6 mm) sieve.
- 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  $77^\circ \text{F}$ .

- 8.5 Remove flask (containing enough water at 77° F to cover the sample by approximately 1 inch). Towel dry the outside of the flask, place on scale, and tare the scale.
- 8.6 Add the test sample to the flask (about 2000 ml) at  $25 \pm 0.6^{\circ}\text{C}$  ( $77 \pm 2^{\circ}\text{F}$ ). 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 in the flask, to ensure a proper seal between the flask vacuum apparatus. Turn on the vacuum pump to remove entrapped air by subjecting the contents to a partial vacuum of  $27.5 \pm 2.5$  Hg mm gauge pressure for  $15 \pm 2$  minutes. (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, and remove the vacuum apparatus.
- 8.9 Fill the flask with water ( $77 \pm 2^{\circ}\text{F}$ ). Gently place the stopper in the flask ensuring proper seating and taking care not to introduce air into the sample. Bring contents to a temperature of  $77 \pm 2^{\circ}\text{F}$  in the constant temperature bath within  $10 \pm 1$  min after completing the vacuum procedure.
- 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 = average mass of standardized flask*

*E<sub>1</sub> = 1<sup>st</sup> flask standardization mass*

*E<sub>2</sub> = 2<sup>nd</sup> flask standardization mass*

*E<sub>3</sub> = 3<sup>rd</sup> 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)*

- 9.3 Calculate the volume of the sample as follows:

$$G = F - C$$

*Where:*

*G = Volume of sample*

*C = mass of the standardized flask with contents (water and saturated sample)*

- 9.4 Calculate the “Rice Gravity” of the sample as follows:

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

*Where:*

$R = G_{mm}$  = theoretical maximum specific gravity of the mixture, “Rice Gravity”

## 10 Report

- 10.1 Report the theoretical maximum specific gravity of the mixture, “Rice Gravity”, nearest thousandth, 0.001.