TEST METHOD **WA 733.2 – 2022**

BULK DENSITY AND VOID CONTENT OF ASPHALT – VACUUM SEALING METHOD

1 SCOPE

This method describes the procedure for the determination of the bulk density, air voids, voids in mineral aggregate (VMA) and voids filled with bitumen (VFB) of asphalt using the vacuum sealing method for laboratory prepared test specimens or core specimens. The method is applicable to all types of asphalt in particular absorptive, open graded and stone mastic mixes.

2 SAFETY

This method does not attempt to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this method to establish appropriate occupational health and safety practices that meet statutory regulations.

3 REFERENCED METHODS

Australian Standard 2891

AS 2891.2.2 - Sample preparation – compaction of asphalt test specimens using a gyratory compactor

Main Roads Western Australia

WA 701.1	Sampling and Storage of Asphalt
WA 705.1	Preparation of Asphalt for Testing
WA 730.1	Bitumen content and particle size distribution of asphalt and stabilised soil:centrifuge method
WA 731.1	Stability and flow of asphalt - Marshall method
WA 732.2	Maximum density of asphalt – Rice method

Other

Manufacturer's operating manual for vacuum sealing apparatus.

4 DEFINITIONS

Constant mass is achieved when successive weighings of a test specimen after additional evacuation in the vacuum desiccator for intervals of not less than four hours differ by not more than 0.1% of the mass of the test specimen at the previous weighing.

5 APPARATUS

(a) **Balance** readable to at least 0.01 g with a Limit of Performance (F) of not more than 0.05 g and capable of below balance mass determination.

(b) A **cushioned suspension device** such as a mesh covered frame shaped to hold the specimen and be suspended from the balance for mass determinations whilst the specimen is immersed in the water bath.

(c) Temperature controlled **water bath** with an overflow device for maintaining a constant water level at a temperature of 25 ± 1.0°C. The dimensions of the water bath should be such that the sealed bag and specimen does not come within 50 mm of the sides or bottom of the bath or the surface of the water (Note).

NOTE: A plastic bath with dimensions of 610 x 460 x 460 mm has been found suitable.

(d) **Thermometer** readable to 0.1°C and with a Limit of Performance (F) of not more than 0.3°C.

(e) **Vacuum chamber**, with a pump capable of evacuating a sealed enclosed chamber to a minimum pressure of 100.6 kPa. The chamber shall be able to accommodate core specimens up to 150 mm in diameter with a maximum height of 70 mm.

NOTE: A method of checking if the machine attains the minimum pressure throughout the evacuation cycle is to place an appropriate gauge within the vacuum chamber and initiate the vacuum process.

(f) **Plastic bag** made of low density polyethylene that will not adhere to bitumen, is puncture resistant, capable of withstanding temperatures of up to 70°C, is impermeable to water and contains no air channels for evacuation of air from the bag. The density of the plastic shall be known. The bag shall comply with the following dimensions:

- The open side is to be 230 to 265 mm in width
- The long side is to be 330 to 390 mm in length
- The plastic film is to be 0.120 mm to 0.160 mm in thickness for each side of a bag.

NOTE: Bags from the following suppliers have been found to be suitable, Instrotek, Churchill & Coombes and Sandvik.

(g) A **cushioned specimen sliding plate** that is used within the vacuum chamber to reduce friction on the plastic bag during evacuation.

(h) **Knife** or **scissors** to cut the plastic bag.

6 PROCEDURE

6.1 SAMPLE PREPARATION

Unless stated otherwise the term "specimen" refers to either a laboratory prepared test specimen or a core specimen.

(a) Obtain a core specimen in accordance with WA 701.1 or a laboratory prepared test specimen in accordance with WA 731.1 or AS 2891.2.2.

(b) Prepare a core specimen in accordance with WA 705.1. Inspect the core specimen and using an abrasive media remove any sharp edges or points.

(c) Allow the temperature of the laboratory prepared specimen to cool to below 50°C (Note) before sealing it in a plastic bag.

NOTE: It is important that the test specimen not have a temperature greater than 50°C as this may reduce the thickness of the plastic and/or cause distortion of the test specimen when it is subjected to a vacuum. It has been found that with fan assisted cooling it takes at least 40 minutes to reduce the temperature of the specimen to below 50°C.

6.2 Determination of Density

(a) Select an appropriate sized plastic bag and inspect the plastic bag for holes or irregularities.

(b) Determine and record the mass (m_2) of the plastic bag to the nearest 0.01 g and place the plastic bag into the vacuum chamber on top of the cushioned specimen sliding plate.

(c) Carefully open the plastic bag and place the specimen in the plastic bag on top of the cushioned specimen sliding plate, being careful to handle the plastic bag and specimen in such a manner that will prevent puncture. Avoid dropping or impacting the plastic bag and if available follow the manufacturer's recommendations for handling the specimens and the plastic bags. Place the specimen towards the back of the plastic bag leaving a gap of approximately 25 mm between the specimen and the back of the plastic bag.

(d) Allow the open end of the plastic bag to overhang the sealing bar by approximately 25 mm and check that the plastic bag is free of wrinkles.

(e) Close the lid to commence the removal of air from the chamber and plastic bag. The plastic bag shall be automatically sealed once evacuation has been completed.

(f) Carefully remove the specimen and plastic bag from the evacuation chamber and inspect the plastic bag for punctures or any folds that have the potential to entrap air.

(g) The specimen and plastic bag shall be weighed in the water bath within 5 minutes of the completion of the sealing process.

NOTE: With time the firm bond between the plastic and the specimen weakens.

(h) Suspend the weighing device under the balance and tare to zero. Place the specimen and plastic bag into the water bath in a manner that will not entrap air into folds or creases of the plastic bag and completely submerge the specimen and plastic bag. Remove pockets of air trapped in seams and folds.

(i) After the balance reading stabilises record the mass (m_3) of the specimen and plastic bag to the nearest 0.01 g.

NOTE: The water bath should be at 25 ± 1.0°C with no disturbance from currents generated from temperature controllers or stirrers.

(j) Carefully remove the specimen and plastic bag from the water bath and wipe excess water from the surface of the plastic bag. Using a suitable knife or scissors cut the plastic bag and carefully remove the specimen from the plastic bag.

(k) Determine and record the mass (m_4) of the specimen to the nearest 0.01 g. If the difference between the weighings is more than 0.1% of the original mass of the specimen then dry the specimen to constant mass in accordance with WA 705.1 and repeat Procedure 6.2(a) to Procedure 6.2(k).

7 CALCULATONS

(a) Check that the specimen remained dry during immersion in the water bath using the formula:

$$\%\ Difference = \frac{m_1 - m_4}{m_1} \times 100$$

(must be ≤0.1%)

Where:

m_1 = Dry mass of specimen before evacuation in grams

m_4 = Mass of specimen after evacuation in grams

ρ_{max} = maximum density of the asphalt determined by WA 732.2 in t/m^3

ρ_{bulk} = bulk of density of specimen in t/m^3

(b) Calculate the volume of the specimen in the plastic bag using the formula:

$$V_{TS} = \frac{(m_1 + m_2) - m_3}{\rho_w}$$

Where:

V_{TS} = Volume of specimen in plastic bag in cm^3

m_1 + m_2= Mass of specimen and plastic bag in air in grams

m_3 = Mass of specimen and plastic bag immersed in water in grams

ρ_w = Density of water at 25°C in g/cm^3 (sufficiently correct to use 0.997)

(c) Calculate the volume of the plastic bag using the formula:

$$V_{bag} = \frac{m_2}{\rho_{bag}}$$

Where:

V_{bag} = Volume of plastic bag in cm^3

m_2 = Mass of plastic bag in grams

ρ_{bag} = Density of the plastic bag at 25°C

(d) Calculate the bulk density of the specimen using the formula:

$$\rho_{bulk} = \frac{m_1}{V_{TS} - V_{bag}}$$

Where:

ρ_{bulk} = Bulk density of specimen in t/m^3

m_1 = Mass of specimen in grams

V_{TS} = Volume of specimen and plastic bag in cm^3

V_{bag} = Volume of plastic bag in cm^3

(e) Calculate the percentage air voids using the formula:

$$\%AIR\ VOIDS = \frac{\rho_{max} - \rho_{bulk}}{\rho_{max}} \times 100$$

Where:

(f) Calculate the VMA using the formula:

$$VMA = \%\ AIR\ VOIDS + \%\ BITUMEN\ BY\ VOLUME$$

$$VMA = \%\ AIR\ VOIDS + \frac{\rho_{bulk} \times BIT\%}{\rho_{BIT}}$$

Where:

VMA = percentage voids in mineral aggregate

ρ_{bulk} = bulk density of specimen in t/m^3

$BIT\%$ = percentage bitumen as determined by WA 730.1.

ρ_{BIT} = density of bitumen at 25ºC in t/m^3

(g) Calculate the VFB using the formula:

$$VFB = \frac{\%\ Bitumen\ By\ Volume}{VMA} \times 100$$

$$VFB = \frac{\rho_{bulk} \times BIT\%}{\rho_{BIT} \times VMA}$$

Where:

VFB = percentage voids filled with bitumen

ρ_{bulk} = bulk density of the specimen in t/m^3

$BIT\%$ = percentage bitumen as determined by WA 730.1

ρ_{BIT} = density of bitumen in 25ºC in t/m^3

VMA = percentage voids in mineral aggregate.

8 REPORTING

Where reporting results for laboratory prepared test specimens report the average of all test specimens prepared.

(a) Report for core specimens and laboratory prepared test specimens the bulk density to the nearest 0.001 t/m^3 and the percentage air voids to the nearest 0.1%.

(b) Report for laboratory prepared test specimens the percentage voids in mineral aggregate (VMA) and the percentage voids filled with bitumen (VFB) to the nearest 0.1%.

9 ISSUING AUTHORITY

Document Owner:
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10 REVISION STATUS RECORD

Page No.	Section	Revision Description / Reference
3	9	Update Issuing Authority