Transport Roads & Maritime Services

NSW GOVERNMENT

Test method T606

Bulk density of compacted dense graded bituminous mixtures

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Revision Summary

Ed/Rev Number	Clause Number	Description of Revision	Authorisation	Date
		Reformatted and Revision Summary Added. Note added 3(e). Safety Notes Added	D.Dash	Jan 2000
Ed 2/ Rev 0	All	Reformatted RMS template	J. Friedrich	November 2012

Note that Roads and Maritime Services is hereafter referred to as 'RMS'.

The most recent revision to Test method T606 (other than minor editorial changes) are indicated by a vertical line in the margin as shown here.

Test method T606

Bulk density of compacted dense graded bituminous mixtures

1. Scope

This test method sets out the procedure for determining the bulk density of compacted specimens of dense and open graded bituminous mixtures. A method is also set out in the appendix for computing the voids relationships of bituminous mixtures.

2. Safety Notes

Heat resisting gloves or tongs should be used when handling hot bituminous materials. Loosen or puncture lids before heating containers. Solvents such as toluene should be used within a fume cupboard. Safety data sheet should be consulted before handling any materials.

3. Definition

The bulk density is defined as the mass per unit volume of the compacted material, the volume being the gross volume including both permeable and impermeable voids.

4. Apparatus

(a) A balance of 3.5 kg capacity, accurate and readable to 0.1 g.

(b) A wire basket, shaped to hold a 100 mm or 150 mm diameter by 50 mm or 75 mm high compacted specimen.

(c) A water container with overflow device for immersing the wire basket while maintaining a constant water level.

(d) Suspension apparatus for mounting the balance over the water container and suspending the wire basket from the centre of the scale pan or other appropriate part of the balance.

(e) A paraffin wax bath suitably heated to keep the paraffin wax at a temperature slightly above its melting point. A water jacketed bath placed on a hotplate has been found suitable. Heat resisting gloves should be used when working with hot paraffin wax.

(f) A constant temperature water bath thermostatically controlled to maintain a temperature of $25 \pm 1^{\circ}C$.

(g) External micrometers, complying with A.S. B75, graduated to read to 0.01 mm, and covering the following ranges:

150	-	175 mm
100	-	125 mm
75	-	100 mm
50	-	75 mm

The micrometers to be fitted with ratchet-operated thimbles, and the anvils and spindles are to be fitted with flat hardened steel discs of diameter 13 mm and thickness at least 1.5 mm.

Each micrometer is to be complete with an insulated hardened and lapped radial ended setting rod.

5. Test Sample

The test specimen of bituminous mixture may be either moulded in the laboratory according to Test Method T601 or T602, or cut or cored from a pavement.

6. Procedure

6.1 Dense Graded Mixtures

(a) Dry the specimen to constant mass if necessary, by standing in a current of air at a temperature between 18°C and 25°C and obtain the mass to the nearest 0.1 g. Designate this mass as "A".

(b) Coat the specimen by dipping in the molten paraffin wax of known density "F" g/mL at 25°C, rotating the specimen as necessary to ensure complete coating with a sufficiently thick layer of paraffin wax to seal surface voids. Brush the surface of the cooled paraffin wax with added hot paraffin from a brush in order to fill any pin-point holes.

(c) Cool the coated specimen for half an hour in air at a temperature of 18°C to 25°C and obtain the mass in air, to the nearest 0.1g. Designate this mass as "D".

(d) Immerse the paraffin coated specimen in the water bath at 25 ± 1°C for one hour.

(e) Transfer the paraffin coated specimen to the basket and suspend it in water from the balance, avoiding the inclusion of air bubbles. Obtain the mass to the nearest 0.1 g and designate this mass as "E".

(f) Determine the density of the paraffin wax at 25°C according to Test Method T502. Designate this as "F" g/mL.

7. Calculations for Dense Graded Mixtures

(a) Calculate the volume of the wax coating by:

$$\frac{D - A}{F} \text{ mL}$$

(b) Calculate the volume of the wax coated briquette by:

$$\frac{D - E}{0.997} \text{ mL (Density of water at 25°C = 0.997)}$$

(c) Calculate the volume of the original briquette by:

$$\frac{D - E}{0.997} - \frac{D - A}{F} \text{ mL}$$

(d) Bulk density of the compacted briquette:

(e) $$d = \frac{A}{\frac{D-E}{0.997} - \frac{D-A}{F}} \text{ g/mL}$$

Where

A = Mass in grams of the dry specimen in air.
D = Mass in grams of the dry specimens plus paraffin wax coating in air.
E = Mass in grams of the dry specimens coated with paraffin wax in water at 25°C.
F = Density at 25°C of the paraffin wax.

Note: The voids relationships of a bituminous mixture may be calculated using the bulk density (d) of the compacted briquette in conjunction with the maximum theoretical density, the bulk density of the aggregate combination and the binder content as shown in the attached appendix.

8. Techniques

(a) If a stream of air bubbles escapes from the paraffin coated specimen when immersed in water, the test on this specimen must be abandoned.

(b) If the specimen has been obtained from a pavement and contains moisture which is slow to dry out, it is necessary to correct the masses "A", "D" and "E" for the mass of residual moisture present, i.e. after determining "A", "D" and "E", determine the percentage of residual moisture by means of drying in an air oven at 105°C or by other suitable means and make the necessary corrections to the mass "A", "D" and "E".

(c) It is assumed that the test specimen is at room temperature before commencing the test. If not so, then the time of immersion of the specimen in the water bath must be increased up to four hours to ensure that the specimen reaches the equilibrium temperature 25 ± 1°C.

9. Procedure

9.1 Open Graded Mixtures

(a) Weigh the compacted specimen to the nearest 0.2 g.

(b) Using the appropriate micrometer, measure the height of the specimen as the average, to the nearest 0.02 mm, of at least five readings (each to the nearest 0.02 mm) taken at equally spaced intervals around the circumference about 20 mm in from the edge.

(c) Using the appropriate micrometer, measure the diameter of the specimen as the average, to the nearest 0.02 mm, of at least five readings (to the nearest 0.02 mm) taken at equally spaced intervals around the circumference at each of three levels, i.e. near the top, middle and bottom.

10. Calculations for Open Graded Mixtures

The following shall be calculated:

(a) Bulk density of compacted specimen.

$$d = \frac{A}{V} \text{ g/mL}$$

Where

A = Mass in air of the compacted specimen, in grams

V = Calculated volume (from diameter and height) of the compacted specimen, in millilitres

11. Report

Report the voids percentage of the compacted specimen to the nearest first decimal place.

Appendix A

A.1 Calculations of Voids Relationships of Bituminous Mixtures

The voids relationships of bituminous concrete mixes are calculated by using the following formulae:

(a) Air voids percent = $\frac{D-d}{D} \times 100$

(b) Percent voids in the compacted mineral aggregate:

$$VMA = \frac{\frac{100}{d} - \frac{100-B}{D_a}}{\frac{100}{d}} \times 100$$

(c) Percent voids in the mineral aggregate filled with bitumen:

$$V_f = \frac{\frac{100}{D} - \frac{100-B}{D_a}}{\frac{100}{d} - \frac{100-B}{D_a}} \times 100$$

Where

d	=	Bulk density of the compacted briquette.
D	=	Maximum Theoretical Density of the material.
Da	=	Bulk density of the aggregate combination.
B	=	Total Binder Content as a percentage of the mass of the mix.