

COMMENTARY TO AG:PT/T052 - ABSORPTION OF BITUMINOUS BINDER INTO AGGREGATE

PREFACE

This test method was prepared by the Bituminous Surfacing Research Review Group on behalf of Austroads. Representatives of Austroads, ARRB Group and the Australian Asphalt Pavement Association have been involved in the development and review of this method.

FOREWORD

This test has been adapted from a Queensland Main Roads test for asphalt mixtures. The applicability of this test to sprayed seals is still under consideration.

SCOPE

This method describes the procedure for the determination of the quantity of binder absorbed by an aggregate. The volume of aggregate is determined from its bulk particle density in a saturated surface dry condition. The volume of binder free aggregate is also determined following immersion in hot binder under specified conditions. Binder absorption is then measured by volume difference and expressed as a percentage by mass.

Further Development

Applicability of this test is still being investigated.

ABSORPTION OF BITUMINOUS BINDER INTO AGGREGATE

1 REFERENCED DOCUMENTS

The following documents are referred to in this method:

AS /NZS

- | | |
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| 2341.7 | Methods of testing bitumen and road related products – Determination of density using density bottle |
| 1141.6.1 | Methods for sampling and testing aggregates – Particle density and water absorption of coarse aggregate: Weighing in water method |
| 1152 | Specification for test sieves |

DMRQ

Test Method Q331 for coarse fraction sub-sample

2 APPARATUS

The following apparatus is required:

- a. Test oven capable of maintaining a temperature of 150 to 160°C and of sufficient capacity to hold two sample containers.
- b. Drying oven capable of maintaining a temperature of 105 to 110°C preferably with forced draft ventilation.
- c. Balance of at least 10 kg capacity, readable to 0.1 g with a limit of performance within the range of ± 0.5 g. It shall be capable of weighing a sample suspended beneath the balance.
- d. Wire basket of suitable mesh and capacity to hold the aggregate sample.
- e. Apparatus to suspend the wire basket under the balance and into the water container.
- f. Water container of suitable size and shape to hold the wire basket.
- g. Sample containers, two containers of at least 4 L capacity fitted with wire handles.
- h. Hotplate.
- i. Localised heating device, such as an infrared lamp or hot air blower.
- j. A partial immersion liquid in glass thermometer with a range of at least 0 to 40°C, graduated in subdivisions of 0.5°C or less, with an uncertainty of no more than 0.5°C.
- k. Two suitable metal stirring rods or spatulas.

- l. A range of sieves complying with AS1152 including a 2.36 mm sieve.
- m. A suitable absorbent lint-free cloth.
- n. A desiccator cabinet of suitable capacity to contain the aggregate sample.

3 SAMPLE PREPARATION

Four representative sub-samples of material retained on the 2.36 mm sieve shall be prepared as detailed in Australian Standard AS 1141.6.1: Clause 5, for coarse fraction sub-sample. The mass of each sub-sample shall be approximately 1.5 kg.

4 PROCEDURE

4.1 Bulk Particle Density

This test shall be performed in duplicate.

- a. A sub-sample is dried to a constant mass in the drying oven (Note (a)) and the mass recorded to the nearest 0.1 g (m_1).
- b. The sub-sample shall be immersed in water at room temperature for at least 24 hours.
- c. Remove the sub-sample from the water and place on a large absorbent cloth. The aggregate shall be rolled and wiped on the cloth, taking care to minimise evaporation, until all visible films of water have been removed but the surface of the aggregate still appears damp.
- d. The aggregate shall be weighed in this saturated-surface-dry condition and the mass recorded to the nearest 0.1 g (m_2).
- e. The wire basket shall be suspended from the balance and completely immersed in the water. The mass of the immersed wire basket shall be recorded to the nearest 0.1 g (m_3). The height of the water above the basket shall be noted.
- f. The wire basket shall be removed and the saturated-surface-dry sub-sample placed in the basket.
- g. The wire basket and the test sample shall be suspended from the balance and completely immersed in the water.
- h. The wire basket shall be agitated to remove any entrapped air from the test sub-sample and the height of the water adjusted to the same height as that noted in Step 6.1 (e).
- i. The mass of the immersed wire basket and test sub-sample shall be recorded to the nearest 0.1 g (m_4).
- j. The temperature of the water shall be recorded to the nearest 1°C.

4.2 Binder Absorption

This test shall be performed in duplicate.

- a. One sub-sample shall be dried to a constant mass in the drying oven (Note (a)) and then placed in the desiccator until required.
- b. The binder shall be heated on the hotplate until sufficiently fluid to pour. Approximately 1,500 g binder shall be poured into a sample container.
- c. A stirring rod shall be placed in the container and the binder shall be stirred to remove entrapped air. Any bubbles remaining on the surface of the binder shall be removed using a localised heating device (Note (b)).
- d. The container (containing binder and stirring rod) shall be allowed to cool to room temperature in a dust free environment. It shall then be weighed and the mass recorded to the nearest 0.1 g (m_5).
- e. The container shall be weighed while completely immersed in water and the mass recorded to the nearest 0.1 g (m_6). The height of the water above the container shall be noted.
- f. The water temperature shall be recorded to the nearest 1°C.
- g. The container shall be dried using the lint-free cloth and then placed in the test oven for 4 hours together with the sub-sample prepared in Step 6.2 (a).
- h. The container and the prepared sub-sample shall be removed from the oven. The aggregate shall be added slowly to the binder with constant stirring for 5 minutes to remove entrapped air. Any bubbles remaining on the surface of the binder shall be removed using a localised heating device.
- i. The container shall be allowed to cool to room temperature in a dust free environment. It shall then be weighed and the mass recorded to the nearest 0.1 g (m_7).
- j. The container shall be weighed while completely immersed in water to the same height as that noted in Step 6.2 (e). The mass shall be recorded to the nearest 0.1 g (m_8).
- k. The water temperature shall be recorded to the nearest 1°C.

5 CALCULATIONS

5.1 Bulk Particle Density

The bulk particle density of each of the two sub-samples shall be calculated using the formula:

$$\delta_{bulk} = \frac{m_1 \times \delta_v}{m_2 - (m_4 - m_3)}$$

Where

δ_{bulk} = bulk particle density of sub-sample (t/m³)

m_1 = oven dry mass of sub-sample (g)

- m_2 = saturated-surface-dry mass of sub-sample (g)
 m_3 = mass of immersed wire basket (g)
 m_4 = mass of immersed wire basket and sub-sample (g)
 δ_w = density of water at test temperature (t/m^3) (Table 1)

Provided that the results of the two sub-samples do not differ by more than 0.030 t/m^3 , the average results shall be calculated and recorded as the bulk particle density of the sample to the nearest 0.001 t/m^3 .

5.2 Binder Absorption

The binder absorption of each of the two sub-samples shall be calculated using the formula:

$$A_B = 100P_B \left(\frac{1}{\delta_{bulk}} + \frac{(m_5 - m_6)}{(m_7 - m_5)\delta_{w6}} - \frac{(m_7 - m_8)}{(m_7 - m_5)\delta_{w8}} \right)$$

Where

- A_B = binder absorption of sub-sample
 δ_{bulk} = bulk density of sub-sample (t/m^3)
 m_5 = mass of container & binder & stirring rod (g)
 m_6 = mass of immersed container & binder & stirring rod (g)
 m_7 = mass of container & binder & stirring rod & aggregate (g)
 m_8 = mass of immersed container & binder & stirring rod & aggregate (g)
 P_B = density of binder (t/m^3) (Note (c))
 δ_{w6} = density of water at test temperature for m_6 (t/m^3)
 δ_{w8} = density of water at test temperature for m_8 (t/m^3) (Table 1)

Provided that the results of the two sub-samples do not differ by more than 0.13 percentage units, the average result shall be calculated and recorded as the binder absorption of the sample to the nearest 0.01 percentage units.

6 INFORMATION TO BE REPORTED

- a. Mix identification
- b. The binder absorption of the sample shall be reported to the nearest 0.05 percentage units.
- c. Reference to this method, i.e. AG:PT/T052.

NOTES

- a. For this method, drying to constant mass shall mean repeated operations of heating in the drying oven, cooling to room temperature and weighing to the nearest 0.1 g. Constant mass shall be reached when successive weighings do not differ by more than 1.8 g. The mass recorded in the last weighing shall be the constant mass value. A minimum drying period of one hour is recommended.
- b. The five minutes stirring time recommended in the method can be inadequate in removing the air bubbles for some aggregates. For these aggregates the recommended procedure is as follows:
 - Stir in a circular motion for 20 to 30 seconds.
 - Use the localised heat source to burst bubbles as they rise to the surface.
 - Move the stirring rod down the side wall of the container and across the bottom to about mid point of the bottom. Retrace the path but ensure that the tip of the stirring rod remains submerged.
 - Move the stirring rod (with tip still submerged) along the side wall about 1/16th of a revolution and repeat the procedure of moving down the side wall and across the bottom to mid way and return.
 - Repeat the procedure progressively around the circumference of the container.
 - As the binder cools it will become more difficult to stir and air can become entrapped during the stirring if attempted when cold. It is recommended that stirring be halted when less than three air bubbles rise to the surface during a single stir.
 - Density of binder may be determined using Australian Standard AS 2341.7.

TABLE 1
Density of Water

Temp (°C)	Density (t/m ³)	Temp (°C)	Density (t/m ³)	Temp (°C)	Density (t/m ³)
0	1.000	14	0.999	28	0.996
1	1.000	15	0.999	29	0.996
2	1.000	16	0.999	30	0.996
3	1.000	17	0.999	31	0.995
4	1.000	18	0.999	32	0.995
5	1.000	19	0.998	33	0.995
6	1.000	20	0.998	34	0.994
7	1.000	21	0.998	35	0.994
8	1.000	22	0.998	36	0.994
9	1.000	23	0.998	37	0.993
10	1.000	24	0.997	38	0.993
11	1.000	25	0.997	39	0.993
12	1.000	26	0.997	40	0.992
13	0.999	27	0.997		

AMENDMENT RECORD

Amendment No.	Clauses amended	Action	Date
1	Commentary Page	New	June 2005
	Footer and header	Format	
	Applied revised test method number	Format	
	Applied new styles	Format	

Key

Format	Change in format
Substitution	Old clause removed and replaced with new clause
New	Insertion of new clause
Removed	Old clauses removed