AS/NZS 2891.7.1:2015

Australian/New Zealand Standard™

Methods of sampling and testing asphalt

Method 7.1: Determination of maximum density of asphalt—Water displacement method

PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee CE-006, Asphalt and Sprayed Surfacing, to supersede AS 2891.7.1—2004. It is based on Vicroads (Roads Corporation trading as VicRoads) method CRB 202.01, *Void Free Bulk Density of Asphalt (After Rice)* (August 1976).

The objective of the Standard is to determine the maximum density of asphalt by displacement of water, using either an on balance or under balance method.

The objective of this revision is to introduce the method for determining the maximum density using the under balance method using a Buchner type flask or other suitable apparatus.

METHOD

1 SCOPE

This Standard determines the maximum density of asphalt by displacement of water using either an on balance method or an under balance weighing method.

2 REFERENCED DOCUMENT

The following document is referred to in this Standard:

AS/NZS
2891 Methods of sampling and testing asphalt
2891.1.1 Method 1.1: Sampling—Loose asphalt

3 SAFETY DISCLAIMER

WARNING: THE USE OF THIS STANDARD MAY INVOLVE HAZARDOUS MATERIALS, OPERATIONS AND EQUIPMENT. THIS STANDARD DOES NOT PURPORT TO ADDRESS ALL OF THE SAFETY PROBLEMS ASSOCIATED WITH ITS USE. IT IS THE RESPONSIBILITY OF THE USER OF THIS STANDARD TO ESTABLISH APPROPRIATE SAFETY AND HEALTH PRACTICES AND DETERMINE THE APPLICABILITY OF REGULATORY LIMITATIONS PRIOR TO USE.

4 DEFINITIONS

For the purpose of this Standard the definitions in AS/NZS 2891.1.1 apply.

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5 MATERIALS

The following materials are required:

(a) Potable water.

(b) Optional detergent solution with 5 mL of commercial grade concentrate diluted with 1000 mL of water.

NOTE: Use of detergent in the water whilst vacuuming will increase the efficiency of the removal of air from the sample.

6 APPARATUS

The following apparatus is required:

(a) *Pycnometer for on balance method* A flat bottomed thick-walled flask, able to withstand a vacuum of –90 kPa gauge pressure or lower, of about 2 L capacity; the top of the mouth of the pycnometer shall be ground flat. The flask shall either have a side arm for attachment of the vacuum line or be fitted with a rubber stopper with provision for a vacuum tube.

(b) *Pycnometer lid* A glass plate slightly larger than the top of the pycnometer and ground flat on one or both sides.

(c) *Flask for under balance method* A flat bottomed thick-walled flask or vacuum pot of plastic or alloy, with transparent cover of sufficient capacity to allow vacuum evacuation of the specimen fully immersed in water with rubber seal and a connection for vacuum. The flask shall be capable of withstanding a vacuum of –90 kPa gauge pressure or lower.

NOTE: Suitable forms of vacuum flasks and pycnometers of alloy and heavy gauge plastic are available commercially for determination of maximum density of asphalt using the methods given in this Standard.

(d) *Water/vapour trap* Fitted in line before the vacuum pump to prevent the transfer of water and water vapour to the vacuum pump.

(e) *Vacuum system* Comprising a vacuum pump capable of maintaining a vacuum of –90 kPa gauge pressure or lower in the pycnometer or flask, tubing and an inline device for measuring the vacuum such as a vacuum gauge.

NOTE: The inline device for measurement of the vacuum should be fitted using a ‘T’ piece type connector and should be located towards the end of the vacuum line near the pycnometer or flask.

(f) *Water bath* The bath shall have a means of maintaining a constant temperature of 25 ±1°C or within 1°C of an alternative test temperature. The bath should be emptied and cleaned at regular intervals to ensure that the water in the bath is clean and not contaminated. For the on balance method, the bath shall be filled with clean water and have sufficient capacity to contain the immersed body of the pyconometer. For the under balance method, the bath shall be fitted with an overflow and filled with clean water to the level of the overflow at all times. The dimensions of the bath shall be such that the fully immersed flask shall be at least 50 mm from the sides and bottom of the bath.

(g) *Balance* Of suitable capacity and with a limit of performance not exceeding ±0.5 g.

(h) *Balance attachment* To support the flask whilst fully submersed in the water bath. The attachment shall be constructed of non-absorbent corrosion resistant material and fitted to ensure errors to weighing due to buoyancy effects from water levels on the attachment do not affect the required accuracy of the results.

(i) *Oven* To heat asphalt so that it can be prepared satisfactorily.

(j) *Thermometer* A thermometer or other suitable temperature-measuring device covering a range of 0°C to 50°C, readable and accurate to 1°C or less.

7 PREPARATION OF TEST PORTION

Unless otherwise specified, the test sample shall be obtained in accordance with AS/NZS 2891.1.1 and prepared as follows:

(a) Warm the test sample in the oven sufficiently to loosen the material and reduce the test sample in accordance with AS/NZS 2891.1.1 to obtain two test portions with a mass complying with Table 1.

(b) Separate the particles of the test portion into the smallest size practical without compromising the binder coating on particles. Aggregations of fine particles shall not be greater than 6 mm in size.

NOTE: Where maximum density is to be determined from a cored or sawn sample, care should be taken to remove aggregate particles with uncoated, cut faces during preparation.

TABLE 1

MINIMUM MASS OF TEST PORTION

Nominal size of mix mm	Minimum mass of test portion g
≤14	1000
20	1500
>20	2000

8 VOLUME OF PYCNOMETER

The procedure to determine the volume of the pycnometer used in Procedure 9.2 shall be as follows:

(a) Weigh the pycnometer and lid and record the mass (m_1).

(b) Fill the pycnometer with water from the water bath and place in the water bath.

(c) Leave the flask in the water bath until the water temperature in the flask and water bath are the same. Record the temperature of the water (t_1).

(d) Top up the pycnometer with water from the water bath and slide on the lid ensuring that no air bubbles are trapped.

(e) If air bubbles are observed repeat Steps (c) and (d) until all air is eliminated.

(f) Carefully dry the outside of the pycnometer. Weigh the pycnometer, lid and water and record the mass (m_2).

(g) Empty and dry the pycnometer.

NOTE: Step (a) to Step (f) of the procedure determine the volume of the flask at the test temperature (t_1). Following an initial determination, only periodic checks need be carried out—at least six monthly.

9 PROCEDURE

9.1 General

Determine the maximum density of each test portion using Clause 9.2 or Clause 9.3. The test is intended to be undertaken at a test temperature of 25°C however, where the test is undertaken at an alternative test temperature, any prior determinations of the volume of a pycnometer or mass of a flask shall be completed at the same temperature as that in Clause 9.2 or Clause 9.3.

9.2 Pycnometer on balance method

The procedure shall be as follows:

(a) Place the test portion in the pycnometer.

(b) Weigh the pycnometer, lid and test portion, and record the mass (m_3).

(c) Pour water into the pycnometer until the water level is about 50 mm above the level of the test portion. 2 mL of detergent solution may be added to the pycnometer to aid evacuation of air from the sample.

(d) Attach the pycnometer to the vacuum pump and evacuate the pycnometer to a vacuum of –90 kPa gauge pressure or lower, and maintain the vacuum for a period of not less than 15 minutes. Vigorously agitate the pycnometer frequently to loosen the particles and release any entrapped air.

NOTES:

1 Care should be taken when applying the vacuum particularly in the initial stages to prevent loss of material.

2 Care should be taken to ensure the sample is not left under vacuum for an excessive period of time as this may lead to rupture of the bitumen film and absorption of water by the aggregate; typically 15–20 minutes of vacuum with frequent agitation is sufficient.

3 Where a glass pycnometer is used a rubber mat below the pycnometer is recommended.

(e) When no entrapped air is observed, release the vacuum slowly and disconnect the vacuum pump from the pycnometer.

(f) Fill the pycnometer with water from the water bath and place in the water bath, ensuring no loss of the test portion during the process and that no air is introduced into the test portion.

(g) Leave the pycnometer in the water bath until the water temperature in the flask and water bath are the same. Record the temperature of the water (t_1).

(h) Top up the pycnometer with water from the water bath and slide on the lid, ensuring that no air bubbles are trapped.

(i) Remove the pycnometer from the water bath and with the lid securely held in place, invert the pycnometer several times.

(j) If air bubbles are observed, repeat Step (h) until all air is eliminated.

(k) Carefully dry the pycnometer. Weigh the pycnometer, lid, test portion and water, and record the mass (m_4).

9.3 Flask under balance method

The procedure shall be as follows:

(a) Weigh the flask and record the mass (m_5).

(b) Place the flask in the water bath allowing it to fill, ensuring no air bubbles are present.

(c) Suspend the fully immersed flask from the balance and record the mass in water (m_6). Record the temperature of the water (t_2).

(d) Remove the flask from the water bath, empty and dry.

NOTE: Step (a) to Step (d) determine the mass of the flask in water at the test temperature (t_2). Following an initial determination, only periodic checks need be carried out for each specific flask—at least six monthly.

(e) Place the test portion into the flask and record the mass of the test portion (m_7). Pour water into the flask until the water level is about 50 mm above the level of the test portion. 2 mL of detergent solution may be added to the flask to aid evacuation of air from the sample.

(f) Seal the flask and connect it to the vacuum pump and evacuate the flask to a vacuum of –90 kPa gauge pressure or lower and maintain the vacuum for a period of not less than 15 minutes. Vigorously agitate the flask frequently to loosen the particles and release any entrapped air.

NOTES:

1 Care should be taken when applying the vacuum particularly in the initial stages to prevent loss of material.

2 Care should be taken to ensure the sample is not left under vacuum for an excessive period of time as this may lead to rupture of the bitumen film and absorption of water by the aggregate. Typically 15–20 minutes of vacuum with frequent agitation is sufficient.

3 Where a glass flask is used a rubber mat below the flask during agitation is recommended.

(g) When no entrapped air is observed, release the vacuum slowly and disconnect the vacuum pump from the flask.

(h) Submerge the flask carefully into the water bath ensuring no loss of the test portion during the process and that no air is introduced into the test portion. Suspend the fully submerged flask from the balance.

(i) Record the mass of the test portion and flask in water (m_8).

(j) Record the temperature of the water in the bath (t_2).

10 CALCULATIONS

10.1 On Balance method

The maximum density (ρ_{max}) for each test portion shall be calculated from the following equation:

$$\rho_{max} = \frac{(m_3 - m_1)\rho_w}{(m_3 - m_1) - (m_4 - m_2)} \quad \ldots 1$$

where

ρ_{max} = the maximum density, in tonnes per cubic metre

m_3 = the mass of the pycnometer, lid and test portion, in grams

m_1 = the calibrated mass of the pycnometer and lid, in grams

ρ_w = the density of water from Table 2 at temperature (t_1) of the water, in t/m^3

m_4 = the mass of the pycnometer, lid, test portion and water, in grams

m_2 = the calibrated mass of the pycnometer and lid and water, in grams

The maximum density of the sample calculated as the average of the results for the two test portions, in tonnes per cubic metre (t/m^3).

NOTES:

1 If the difference between the two results is greater than 0.02 t/m^3 additional portions should be tested to give two values with results within 0.02 t/m^3 of each other.

2 If water bath temperatures other than 25°C are used, users should ensure that mass (m_2) of the calibrated pycnometer and lid and water are determined at the same temperature as the test procedure.

10.2 Under balance method

The maximum density (ρ_{max}) for each test portion shall be calculated from the following equation:

$$\rho_{max} = \frac{(m_7 - m_5)}{\frac{(m_7 - m_8) - (m_5 - m_6)}{\rho_w}} \quad \ldots 2$$

where

ρ_{max} = the maximum density, in tonnes per cubic metre

m_7 = the mass of the flask and test portion, in grams

m_5 = the mass of the flask, in grams

m_6 = the mass of the flask in water, in grams

m_8 = the mass of the flask and test portion in water, in grams

ρ_w = the density of water from Table 2 at temperature (t_2) of the water, in t/m^3

The maximum density of the sample calculated as the average of the results of two test portions, in tonnes per cubic metre (t/m^3).

NOTES:

1 If the difference between the two results is greater than 0.02 t/m^3 additional portions should be tested to give two values with results within 0.02 t/m^3 of each other.

2 If water bath temperatures other than 25°C are used, users should ensure that mass (m_6) of the flask in water are determined at the same temperature as the test procedure.

11 TEST REPORT

The following shall be reported:

(a) The maximum density of the sample to the nearest 0.001 tonnes per cubic metre.

(b) Reference to this Standard, i.e. AS/NZS 2891.7.1.

TABLE 2

WATER DENSITY (t/m^3)

Temperature °C	Density
19	0.998
20	0.998
21	0.998
22	0.998
23	0.998
24	0.997
25	0.997
26	0.997
27	0.997
28	0.996
29	0.996
30	0.996

NOTES

This Australian/New Zealand Standard was prepared by Joint Technical Committee CE-006, Asphalt and Sprayed Surfacing. It was approved on behalf of the Council of Standards Australia on 9 April 2015 and on behalf of the Council of Standards New Zealand on 10 April 2015 and published on 24 April 2015.

The following are represented on Committee CE-006:

ARRB Group—Australian Road Research Board
Australian Asphalt Pavement Association
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