

# **COMMENTARY TO AG:PT/T234 - ASPHALT BINDER CONTENT (IGNITION OVEN METHOD)**

## **PREFACE**

This Asphalt Test Method was prepared by the Asphalt Research Review Group on behalf of the Austroads Pavement Technology Review Panel. Representatives of Austroads and the Australian Asphalt Pavement Association have been involved in the development and review of this test method.

## **FOREWORD**

The binder ignition oven test method arose out of a desire to reduce the use of solvents in asphalt laboratories as well as improve the efficiency of binder content determination. Much of the initial development of procedures was done at the National Centre for Asphalt Technology (NCAT) in the USA. Draft ASTM and British Standards have also been prepared and a number of manufacturers offer suitable equipment.

## **SCOPE**

This method details the determination of the binder content of asphalt mixes by ignition at a temperature of not less than 540°C and the subsequent determination of the particle size distribution by sieve analysis.

## **Further Development**

There are no plans for further development.

# ASPHALT BINDER CONTENT (IGNITION OVEN METHOD)

## 1 REFERENCED DOCUMENTS

The following documents are referred to in this method:

### AS /NZS

AS 1141.11	Methods for sampling and testing aggregates: Particle size by dry sieving
AS 1152	Specification for test sieves
AS 2243.1	Safety in Laboratories - General
AS 2891.1	Methods of sampling and testing asphalt: Sampling of asphalt

### Miscellaneous

Manufacturer's manual

## 2 SAFETY

This test method does not purport to address all the safety requirements associated with the conduct of the test. It is the responsibility of those using the method to establish and maintain appropriate health and safety practices and determine the applicability of regulatory limitations prior to use. In developing safe practices, reference shall be made to the information provided in the manufacturer's manual.

The requirements shall stipulate that:

- The door of the oven shall not be opened under any circumstances during the combustion process as the burning binder may emit flames, hot gases and aggregate which could cause injury to the operator. Suitable time safety margins shall be allowed prior to opening the door when using ovens, which are not fitted with a balance
- The total binder load is not to exceed 150 g because of possible excess exothermic heat generation and
- When removing samples and equipment from the oven after ignition is complete, special care must be taken to use adequate protective clothing and handling equipment to handle trays due to the high temperatures involved.

## 3 APPARATUS

The following apparatus is required:

- a. Ignition Oven - a furnace specifically designed for incineration and capable of operating at temperatures above 540°C and maintaining temperatures up to 640°C (see Appendix A). The oven chamber shall be of sufficient size to accommodate samples of up to 2500 g and may or may not be fitted with an in-built electronic balance. The oven must be vented to a hood or to the outside so that there are no

noticeable odours and must be fitted with a fan with the capability to draw sufficient air through the oven to expedite the test and reduce the escape of smoke to the laboratory.

NOTE: The oven may be fitted with an electronic balance of adequate capacity and a data collection system which is capable of controlling the end of the ignition process by measuring loss of mass of the sample during the combustion process. The combustion is considered to be complete when the measured loss of mass of the sample is not greater than 0.1 g over three consecutive one-minute interval readings.

- b. Balance – Approximately 5 kg capacity readable to 0.1 g and with a limit of performance not exceeding  $\pm 0.5$  g
- c. Catch tray - made of metal and of suitable size
- d. Stackable sample trays (3) - made of woven wire mesh or perforated plate, which will permit heat to flow through the sample and of dimensions specified by the manufacturer to provide maximum surface area for the sample while providing sufficient clearance to safely load and unload to and from the oven; and allowing the sample to rest on the tray during ignition and the tray to sit on a catch tray.

NOTE: Mesh or perforated plate with opening sizes between 600  $\mu\text{m}$  and 3.35 mm have been found to perform well.

- e. Oven - thermostatically controlled to operate at a temperature of 105 to 110°C
- f. Sieves - complying with the requirements of AS 1152
- g. Washing sieve – 75  $\mu\text{m}$  complying with the requirements of AS 1152
- h. Sample divider - complying with the requirements of AS 1141.2
- i. Tray lifter - used to insert and remove the sample trays and the catch tray into and from the ignition oven
- j. Safety equipment – full-face shield, insulated gloves and other equipment for handling hot materials
- k. Sample cage, sample tray lid and cool down tray - to provide a safe environment for the hot trays during the cooling down period.

## 4 ADJUSTMENT FACTOR FOR MINERAL MATTER

Determine the loss of mass of mineral matter (aggregate plus filler) and changes to particle size distribution due to the ignition process using the wet or dry method, as applicable, as detailed in Appendix A, for the particular asphalt mix for which the binder determination is being made.

NOTES: It has been found that mixes containing limestone aggregate or lime filler require the adjustment factor determination to be made using the wet method. Calibrations should be undertaken every six months or when there are significant changes to the mix, such as a change in an aggregate source.

## 5 SAMPLE PREPARATION

- a. Obtain a sample of the asphalt in accordance with AS 2891.1.
- b. If necessary, warm the sample in an oven at  $110 \pm 5^\circ\text{C}$  until the sample can be loosened and quartered

- c. Reduce the sample by quartering as described in AS 2891.1 to obtain a test portion of 1200 to 1500 g. Record the actual sample mass.
- d. When moisture content or total volatiles content is to be determined, quarter a separate portion of about 1000 g.

## 6 BINDER CONTENT DETERMINATION

- a. Either:
  - I. Dry the first test portion to constant mass in an oven operating at a temperature of 105 to 110°C to remove moisture and volatiles, use this portion in Step (c) ; or
  - II. On the separate portion obtained in Step 5(d), determine the moisture content ( $w$ ) in accordance with AS 2891.10; or
  - III. On the separate portion obtained in Step 5(d), determine the mass of the test portion ( $m_{sw}$ ). Dry this test portion to constant mass in an oven at 105 to 110°C to remove volatiles and moisture and determine the dry mass ( $m_{sd}$ ).
- b. Determine the mass of the sample trays plus catch trays ( $m_t$ ) to the nearest 0.1g.
- c. Evenly spread the test portion, obtained in Step 5(c) or 6(a)(i), on the sample trays and determine the mass ( $m_3$ ) of test portion plus the catch tray plus sample trays.
- d. Place the test portion and trays in the ignition oven using the tray litter and appropriate safety equipment.
- e. Heat the test portion in the ignition oven to 540°C until the binder is completely burnt from the mineral matter.

NOTE: Ovens fitted with an internal balance will automatically determine the appropriate time by measuring the change in mass until the change in mass over a three one-minute intervals does not exceed 0.1 g. Ovens not fitted with a balance require tests to determine the suitable time for ignition (plus a safety margin).

- f. Allow the sample to cool to less than 400°C and remove the trays and test portion from the ignition oven using the tray lifter and appropriate safety equipment. Place trays in the cooling tray and allow to cool to touch in the sample cage.
- g. Determine the mass ( $m_2$ ) of the test portion after ignition plus the catch tray plus sample tray to the nearest 0.1 g.

## 7 PARTICLE SIZE DISTRIBUTION

When the ignition process causes fines to agglomerate at the surface of larger particles, wash the test portion obtained in Step 6(e) over a 75  $\mu\text{m}$  sieve and dry the material retained on the sieve to constant mass.

Determine the particle size distribution of the mineral matter in accordance with AS 1141.11.

NOTE: A representative portion of the test portion obtained in Step 6(e) or Step 7 as appropriate to meet the requirements of Table 1 of AS 1141.11 may be used.

## 8 CALCULATIONS

Calculate, as appropriate:

- a. When the moisture content is determined on a separate test portion in accordance with AS 2891.10:

$$m_s = (m_3 - m_t) \times \frac{(100 - w)}{100}$$

where:

- $m_s$  = mass of the dried test portion, in grams  
 $w$  = moisture content of the separate test portion, in percent  
 $m_3$  = mass of the test portion plus trays, in grams  
 $m_t$  = mass of the trays, in grams

- b. When the moisture content and volatiles are determined on a separate test portion as in Step 6(a)(iii):

$$w_v = 100 \times \frac{(m_{sw} - m_{sd})}{m_{sd}}$$

$$m_s = (m_3 - m_t) \times \frac{(100 - w_v)}{100}$$

where:

- $w_v$  = moisture plus volatiles content of the separate test portion, in percent  
 $m_s$  = mass of the dried test portion, in grams  
 $m_3$  = mass of the test portion + trays, in grams  
 $m_t$  = mass of the trays, in grams  
 $m_{sw}$  = mass of the separate test portion, in grams  
 $m_{sd}$  = mass of the dried separate test portion, in grams.

- c. The mass of the binder in the asphalt:

$$m_b = m_5 - \frac{(m_2 - m_1)}{\left(1 - \frac{C_d}{100}\right)}$$

where:

$m_b$  = mass of binder, in grams

$m_s$  = mass of the dried test sample, in grams

$m_2$  = mass of the test portion + trays after ignition, in grams

$m_t$  = mass of the trays, in grams

$C_d$  = adjustment factor for mineral matter, in percent (see Appendix A)

d. The binder content of the asphalt:

$$B = \frac{m_b}{m_s} \times 100$$

where:

B = binder content, in percent by mass

$m_b$  = mass of binder, in grams

$m_s$  = mass of the dried test portion, in grams

e. Calculate the percentage of material passing each sieve as detailed in AS 1141.11 using the mass ( $m_2 - m_t$ ) after ignition as the total mass of mineral matter.

NOTE: The amount of material passing the 75  $\mu\text{m}$  sieve may change due to the ignition process, particularly when lime filler is used. Suitable corrections may be determined by performing particle size distribution tests on the samples tested in Appendix A.

## 9 TEST REPORT

Report the following:

- a. The binder content in percent by mass to the nearest 0.1%
- b. The percentage of the sample passing each sieve:
  - (i) to the nearest whole number for sieves larger than 150  $\mu\text{m}$
  - (ii) to the nearest 0.1 for the 150  $\mu\text{m}$  and 75  $\mu\text{m}$  sieves
- c. When applicable, the moisture or total volatiles content in percent to the nearest 0.1%
- d. Reference to the determination of the adjustment factor and date determined, if not determined at the same time as the test
- e. Appropriate asphalt mix identification.

## APPENDIX A

### ADJUSTMENT FACTOR FOR MINERAL MATTER

(Normative)

#### A1 GENERAL

Determine the adjustment factor for the mineral matter for each asphalt mix using either the dry or wet method as follows.

#### A2 DRY METHOD

- a. Prepare at least three test portions of 1200 to 1500 g of the blended oven-dry ingredients of the asphalt mix, excluding binder.
- b. Evenly spread the test portion on the sample tray and determine the mass ( $m_i$ ) of test portion plus the catch tray plus sample trays to the nearest 0.1 g.
- c. Preheat the test portion and trays to about 110°C then place them in the preheated ignition oven using the tray lifter and appropriate safety equipment.
- d. Heat the test portion in the ignition oven to 580°C for the time period which it is expected to heat the asphalt mix
- e. Allow the sample to cool to less than 400°C and remove the trays and test portion from the ignition oven using the tray lifter and appropriate safety equipment. Allow to cool to touch in the sample cage.
- f. Determine the mass ( $m_f$ ) of the test portion after ignition plus the catch tray plus sample tray to the nearest 0.1g.
- g. Repeat steps (b) to (c) for each test portion prepared in step (a).
- h. Calculate the loss in aggregate mass, in percent of the original mass, for each test portion.
- i. Calculate the mean percentage loss in aggregate mass ( $C_d$ ) for the test portions.
- j. If the difference in the loss in aggregate mass in percent exceeds 0.15%, repeat steps (a) to (g) so that at least four test portions have been tested. Discard the highest and lowest test results and repeat step (h) for the other results.
- k. Determine the particle size distribution of each test portion which has been ignited using washed gradings in accordance with AS 1141.11, calculate the mean value for material passing each sieve and calculate corrections that may be required to particle size distribution analysis values.

#### A3 WET METHOD

- a. Prepare a 6 kg sample of the asphalt mix in accordance with AS 2891.2.1, excluding the conditioning requirements. Ensure that the mixing bowl and beaters are coated with a thin film of binder by making a batch of the asphalt mix using the equipment to be used and then scraping it clean leaving a thin film of binder on the surfaces.
- b. Cone and quarter the mix into at least four sub-samples of not more than 1.5 kg.

- c. Determine the loss of mass during ignition of each sub-sample in accordance with Steps 6(b) to 6(f) of this method.
- d. Calculate the adjustment loss ( $C_d$ ) for the mix due to mineral matter using the following equation:

$$C_d = \frac{mt_i \left(1 - \frac{b_c}{100}\right) - mt_f}{mt_i \left(1 - \frac{b_c}{100}\right)} \times 100$$

where:

$C_d$  = adjustment factor for mineral matter, in percent

$mt_i$  = the sum of the individual sub-sample masses prior to ignition, in grams

$mt_f$  = the sum of the individual sub-sample masses after ignition, in grams

$b_c$  = binder content of the asphalt mix, as batched, in percent

- e. Determine the particle size distribution of each sub-sample which has been ignited using washed gradings in accordance with AS 1141.11, calculate the mean value for material passing each sieve and calculate corrections that may be required to particle size distribution analysis values.

#### **A4 REPORT**

Report the following:

- a. the mean loss in aggregate mass ( $C_d$ ), in percent as the adjustment factor for mineral matter, to the nearest 0.1%
- b. correction values to be made to particle size distribution analysis values
- c. the appropriate asphalt mix identification
- d. the date of the determination.

#### **A5 FREQUENCY OF DETERMINATION**

The adjustment factor for the asphalt mix shall be determined at least once every two years or when the aggregate or filler characteristics have changed, whichever is the more frequent.

## 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