1. **SCOPE**

1.1 **Description Of Test**

These test methods cover the determination of asphalt content of asphalt concrete (AC) mixtures and pavement samples by removing the asphalt cement at 540°C by ignition in a furnace.

2. **SUMMARY OF TEST METHODS**

The asphalt cement in the asphalt concrete is ignited using the furnace equipment applicable to the particular method (see the furnace manufacturer’s instruction manual). The asphalt content is calculated by difference from the mass of the residual aggregate and moisture content. The asphalt content is expressed as mass percent of moisture-free mixtures. Test Method A is intended for furnaces with an internal, automated weighing system. Test Method B is intended for furnaces without an internal weighing system.

3. **APPLICATION OF TEST**

This test method can be used for quantitative determination of asphalt content in asphalt concrete paving mixtures and pavement samples for quality control, specification acceptance, and mixture evaluation studies. This test method does not require the use of solvents.

4. **APPARATUS**

Balance, readable to 0.1 g, and capable of measuring the mass of sample, sample trays and catch pan.

Sample Tray(s), of appropriate size that allows the samples to be thinly spread and allows air to flow up through and around the sample particles. The sample shall be completely enclosed with screen mesh or perforated stainless steel plate or other suitable material.

Catch Pan, of appropriate size to hold the sample trays so that aggregate particles and melting asphalt binder falling through the screen mesh are caught.
Catch Pan/Sample Tray(s) Handling Apparatus, suitable for inserting catch pan and sample tray(s) into furnace and removing hot catch pan and sample tray(s) from furnace.

Assorted Spatulas, Pans, Bowls, and Wire Brushes for preparing asphalt concrete mixtures and removing aggregate from sample tray(s) and catch pan.

Protective Gloves, well insulated and capable of withstanding 580°C.

Ovens, mechanical oven, convection or forced draft, shall be provided for drying aggregates and AC mixtures, preheating AC mixtures prior to ignition testing.

Ignition Furnace.

5. **SAMPLING**

5.1 Obtain samples of aggregate in accordance with STP 105.

5.2 Obtain samples of asphalt concrete in accordance with STP 103.

5.3 Preparation of Test Specimens:

5.3.1 If the mixture is not soft enough to separate with a spatula or trowel, place it in a large, flat pan and warm in an oven set at 110 ± 5°C until it can be separated or mixed. Split or quarter the material, in accordance with STP 103, until the mass of material required for the test is obtained.

5.3.2 The size of the test sample shall be governed by the nominal maximum aggregate size of the mixture and shall conform to the mass requirement shown in Table 1.

5.4 Obtain samples of asphalt cement in accordance with STP 102.

<table>
<thead>
<tr>
<th>Nominal Maximum Aggregate Size Standard, mm</th>
<th>Minimum Mass of Sample, kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.5</td>
<td>1</td>
</tr>
<tr>
<td>12.5</td>
<td>1.5</td>
</tr>
</tbody>
</table>
6. **HAZARDS**

The temperature of the furnace, sample, sample tray(s) and catch pan after removal from the furnace is extremely high. Caution, therefore, must be exercised at all times when handling these items as failure to do so could result in serious injury, severe burns or fire. The sample, sample tray(s) and catch pan should be placed inside a safety cage and should not be allowed to cool near any materials that are subject to ignition at the high temperatures used in this procedure. Furnace manufacturer’s instruction manual must be followed to take all necessary precautions.

**TEST METHOD A: for furnaces with an automated internal weighing system**

7. **APPARATUS**

7.1 Furnace, having a minimum temperature capability of 580°C and having an internal weighing system capable of measuring the mass of sample sizes of at least 2500 g. The furnace chamber shall be of sufficient size to accommodate sample sizes of at least 2500 g. A data collection system shall also be included so that the sample mass loss can be automatically determined to an accuracy of 0.1 g and displayed during a test. The test is deemed complete when the difference between consecutive measured mass loss does not exceed 0.01% of the sample mass for three consecutive one-minute intervals. The equipment shall provide a printout of the test results. A system capable of reducing furnace emissions to an acceptable level shall also be incorporated in the furnace. The furnace shall be vented into a hood or to the outside and when set up properly will have no noticeable odors escaping into the laboratory. The furnace will have a fan with the capability to pull air through the furnace to expedite the test and to reduce the escape of smoke into the laboratory. The furnace shall be equipped so that the door cannot be opened during the ignition test.

8. **CALIBRATION**

8.1 The results of this test method may be affected by the type of aggregate in the mixture because different aggregates lose mass on ignition to varying degrees. Accordingly, to optimize accuracy, establish a calibration factor by testing three calibration samples for each mix type. Perform the calibration on a prepared sample of asphalt mixture.

8.2 Obtain samples of blended aggregate to be used in AC in accordance with 5.1. The sample should be approximately the same mass and gradation as that to be used for the AC test sample (see 9.1).

8.3 Obtain samples of asphalt cement to be used in AC in accordance with 5.4.
<table>
<thead>
<tr>
<th>Section:</th>
<th>ASPHALT MIXES</th>
<th>Subject:</th>
<th>ASPHALT CONTENT BY IGNITION OVEN METHOD</th>
</tr>
</thead>
</table>

8.4 Oven-dry the aggregate samples to a constant mass to remove all moisture.

8.5 Set the furnace temperature to 540 ± 5°C for calibration using mixtures.

8.6 Heat the aggregates and asphalt cement to approximately 150°C. Heat all mixing bowls and tools to approximately 150°C.

8.7 Prior to mixing of calibration samples, an initial or “butter” mix is required to condition the mixing equipment. Remove and discard the “butter” mix from the bowl by scraping, leaving a uniform coating of asphalt mix residue.

Note 1 - The “butter” mix prevents calibration samples from being biased by residual asphalt mix retained in the mixing bowl.

8.8 Prepare three calibration samples at the design asphalt cement content ($P$).

8.9 Determine and record the mass of the sample tray(s) and catch pan to the nearest 0.1 g.

8.10 Evenly distribute the sample in the sample tray(s).

8.11 Determine the mass of the sample, sample tray(s) and catch pan to the nearest 0.1 g. Calculate and record the initial mass of the sample ($M_I$).

8.12 Heat the calibration sample in the furnace at 540 ± 5°C until the change in mass of the sample during three consecutive one-minute intervals does not exceed 0.01% of the sample mass ($M_I$).

8.13 Measure and record the mass ($M_L$) of the sample after ignition to the nearest 0.1 g. The mass can be obtained immediately upon completion of the test from printout or display.

8.14 Calculate the calibration factor ($C_F$) as follows:

$$C_F = \left( \frac{M_I - M_L}{M_I} \right) \times 100$$

Or

$$C_F = \text{Printout} - P$$

Where:

- $M_I$ = total mass of the mixture calibration sample prior to ignition, and
- $M_L$ = total mass of the mixture calibration sample after ignition, and
- $P$ = percentage of actual asphalt cement in the mix by mass of the total mix expressed as a percentage.
8.15 Repeat these steps for two additional calibration samples. Calculate the average calibration factor ($C_F$) by averaging the three $C_F$ values.

8.16 The temperature for testing asphalt concrete samples in 9.3 shall be the same temperature selected for testing mixture calibration samples.

9. **PROCEDURE**

9.1 Obtain an asphalt concrete sample in accordance with the 5.2. The sample mass should be approximately the same as that used for calibration.

9.2 Oven-dry the asphalt concrete sample to constant mass at a temperature of 105 ± 5°C or determine the moisture content of samples, according to STP 204-1, so that the measured mass loss can be corrected for moisture.

9.3 Set the furnace temperature to 540 ± 5°C. Samples can be placed in the furnace at significantly lower temperatures since the furnace will quickly heat to the desired temperature once the sample begins to burn. The furnace temperature is likely to increase during the ignition phase of the test.

9.4 Determine and record the mass of the sample tray(s) and catch pan to nearest 0.1 g.

9.5 Evenly distribute the sample in the sample tray(s).

9.6 Determine the mass of the sample, sample tray(s) and catch pan to the nearest 0.1 g. Calculate and record the initial mass of the sample ($M_B$).

9.7 Heat the sample in the furnace at the specified temperature until the difference between consecutive measured mass loss does not exceed 0.01% of the sample mass ($M_B$) for three consecutive one-minute intervals.

9.8 Measure and record the aggregate mass ($M_A$) of the sample after ignition to the nearest 0.1 g. The mass can be obtained immediately upon completion of tests by subtracting the mass loss measured by the furnace from the initial mass of the mix ($M_B$).

9.9 Calculate the corrected asphalt content, by total weight, as follows:

$$\% \ AC = \left( \frac{M_B - M_A}{M_B} \times 100 \right) - C_F \ = \ % \ Moisture$$

Where:

- $AC$ = measured asphalt content percent by mass of the oven-dry asphalt concrete sample,
M_A = total mass of aggregate remaining after ignition,
M_B = total mass of the AC sample prior to ignition,
C_F = calibration factor obtained in Section 8, and
% Moisture = percent moisture content determined according to STP 204-1.

Or the measured asphalt content by dry weight of aggregate can be determined as follows

\[
\% \text{ AC by Dry Wt.} = \frac{\% \text{ AC Total}}{1 - \left( \frac{\% \text{ AC Total}}{100} \right)}
\]

TEST METHOD B for furnaces without an internal weighing system

10. APPARATUS

10.1 In addition to the apparatus listed in Section 4, the following apparatus is required for Test Method B:

10.1.1 Furnace, having a minimum temperature capability of 580ºC and equipped with a fan capable of pulling air through the furnace to expedite the test and to reduce the escape of smoke into the laboratory. The furnace chamber shall be of sufficient size to accommodate samples sizes of at least 2500 g. A system capable of reducing furnace emissions to an acceptable level shall also be incorporated in the furnace. The furnace shall be vented into a hood or to the outside and when set up properly will have no noticeable odors escaping into the laboratory. The furnace shall be equipped so that the door cannot be opened during the ignition test.

11. CALIBRATION

11.1 The results of this test method may be affected by the type of aggregate in the mixture because different aggregates lose mass on ignition to varying degrees. Accordingly, to optimize accuracy, a calibration factor shall be established by testing three calibration samples for each mix type. The calibration shall be performed on a sample of prepared asphalt mixture.

11.2 Obtain samples of blended aggregate to be used in AC in accordance with 5.1. The sample should be approximately the same mass and gradation as that to be used for the AC test sample (see 12.1).

11.3 Obtain samples of asphalt cement to be used in AC in accordance with 5.4.
11.4 Oven-dry the aggregate samples to a constant mass to remove all moisture.

11.5 Set the furnace temperature to 540 ± 5°C for calibration using mixtures.

11.6 Heat the aggregates and asphalt cement to approximately 150°C. Heat all mixing bowls and tools to approximately 150°C.

11.7 Prior to mixing of calibration samples, an initial or “butter” mix is required to condition the mixing equipment. Remove and discard the “butter” mix from the bowl by scraping, leaving a uniform coating of asphalt mix residue.

Note 2 – The “butter” mix prevents calibration samples from being biased by residual asphalt mix retained in the mixing bowl.

11.8 Prepare three calibration samples at the design asphalt cement content.

11.9 Determine and record the mass of the sample tray(s) and catch pan to the nearest 0.1 g.

11.10 Evenly distribute the sample in the sample tray(s).

11.11 Determine the mass of the sample, sample tray(s) and catch pan to the nearest 0.1 g. Calculate and record the initial mass of the sample (M<sub>I</sub>).

11.12 Heat the calibration sample in the furnace at 540 ± 5°C for at least 45 minutes.

11.13 Remove the sample from the furnace and allow it to cool to approximately room temperature.

11.14 Measure and record the mass M<sub>L</sub> of the sample after ignition to the nearest 0.1 g.

11.15 Place the sample back into the furnace.

11.16 After the furnace reaches the set point temperature, heat the calibration sample for 5 to 15 minutes.

11.17 Remove the sample from the furnace and allow it to cool to approximately room temperature.

11.18 Measure and record the mass (M<sub>L</sub>) of the sample after ignition to the nearest 0.1 g.

11.19 Repeat 11.15 to 11.18 until the change in measured mass (M<sub>L</sub>) of the sample after ignition does not exceed 0.01% of the initial sample mass (M<sub>I</sub>).
11.20 Record the last value obtained for \( M_L \) as the mass \( M_L \) of the sample after ignition.

11.21 Calculate the calibration factor \( C_F \) as follows:

\[
C_F = \left( \frac{M_I - M_L}{M_L} \times 100 \right) - P_{dry \; weight}
\]

where:

\[ M_L = \text{total dry mass of the calibration sample after ignition}, \]
\[ M_I = \text{total mass of the calibration sample prior to ignition}, \]
\[ P = \text{percentage of asphalt cement in the mix by dry weight of the aggregate}. \]

11.22 Repeat these steps for two additional calibration samples. Calculate the average calibration factor \( C_F \) by averaging the \( C_F \) values.

11.23 The temperature for testing AC samples in 12.3 shall be the same temperature selected for testing mixture calibration samples.

12. PROCEDURE

12.1 Obtain an AC sample in accordance with 5.2. The sample mass should approximately be the same as that used for calibration.

12.2 Oven-dry the AC sample to constant mass at a temperature of 105 ± 5°C or determine the moisture content of samples, according to STP 204-1, so that the measured mass loss can be corrected for moisture.

12.3 Set the furnace temperature to 540 ± 5°C. Samples can be placed in the furnace at significantly lower temperatures since the furnace will quickly heat to the desired temperature once the sample begins to burn. The furnace temperature is likely to increase during the ignition phase of the test.

12.4 Determine and record the mass of the sample tray(s) and catch pan to the nearest 0.1 g.

12.5 Evenly distribute the sample in the sample tray(s).

12.6 Determine the mass of the sample, sample tray(s) and catch pan to the nearest 0.1 g. Calculate and record the initial mass of the sample \( M_B \).

12.7 Heat the AC sample in the furnace at 540 ± 5°C for the amount of time determined in the calibration process as referred to in 11.16.
12.8 Remove the sample from the furnace after ignition and allow it to cool to approximately room temperature.

12.9 Measure and record the mass \( M_A \) of the sample after ignition to the nearest .01 g.

12.10 Calculate the corrected asphalt content as follows:

\[
\text{% } AC = \left( \frac{M_B - M_A}{M_A} \times 100 \right) - C_F - \text{% Moisture}
\]

where:

- \( AC \) = measured asphalt content percent by dry weight of the aggregate,
- \( M_A \) = total mass of dry aggregate sample remaining after ignition,
- \( M_B \) = total mass of the AC sample prior to ignition,
- \( C_F \) = calibration factor, obtained in Section 11, and
- \( \text{% Moisture} \) = percent moisture content determined according to STP 204-1.

13. **REPORT**

13.1 Report the following information:

13.1.1 Date,

13.1.2 Identification of aggregate and mix type,

13.1.3 Test number,

13.1.4 Calibration data,

13.1.5 Mass of AC sample before and after ignition (nearest 0.1 g),

13.1.6 Measured asphalt content (nearest 0.01%) and

13.1.7 Aggregate gradation if performed.

14. **Reference:**

ASTM D 6307