1853 DETERMINATION OF THE ASPHALT BINDER CONTENT OF PLANT MIXED ASPHALT BY THE IGNITION METHOD

AASHTO Designation T 308, Test Method "A" (MN/DOT Modified)

1853.1 SCOPE

This test method covers the determination of asphalt content of mixed bituminous paving mixtures by removing the asphalt cement at 538 °C (1000 °F) in a forced air ignition furnace. Aggregate obtained by the test method can be used for sieve analysis; however, aggregate properties such as specific gravity, absorption and fractured faces can be altered by this testing.

NOTE 1: This procedure differs from AASHTO T308 as follows: Mn/DOT requires a standard temperature of 482 °C (900 °F) in determining the percent asphalt when the sample contains more than 20 percent Class "B" Carbonate. The testing mass is not governed by the maximum aggregate size. (The test sample is 2000 - 2100 grams.). Mn/DOT does not base the %AC on the oven's printout. Mn/DOT requires the use of an independent balance for the initial and final weighing. Correction factors are based upon a chemical extraction of the actual production mixture.

1853.2 SUMMARY OF TEST METHODS

The asphalt cement in the paving mixture is ignited using the furnace equipment with an internal, automated weighing system. The asphalt binder content is calculated as the difference between the initial mass of the asphalt mixture and the mass of the residual aggregate, the calibration factor and the moisture content. The measured AC content obtained from the ignition test is always higher than the actual AC in the mixture. This is due to the combustion of some of the mineral aggregate and the loss of some fines caused by convection during ignition. The asphalt content is expressed as mass percent of moisture-free mixture.

Mn/DOT recommends Test Method "A" which designates the use of a furnace equipped with an internal balance. The precision statements were originally determined only from mixes using Method "A". For ignition furnaces that have no internal balance refer to Method "B" of AASHTO T-308. Adhere to all the steps under that test procedure. Adhere to the ending mass loss percentage of 0.01 percent. Follow the appropriate sections, notes, temperatures and times that are outlined in Mn/DOT's Modified Test Method "A" when determining all correction factors and asphalt contents.

1853.3 SIGNIFICANCE AND USE

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

NOTE 2: The results of this test method may be affected by the type of aggregate in the mixture because aggregates lose mass upon ignition to varying degrees. Accordingly, to optimize accuracy, a calibration factor shall be established by testing two calibration samples for each mix type (Mixture Calibration – Section 1853.7) The calibration process should be repeated each time there is a change in the mixture ingredients or design.

NOTE 3: Calibration factors may vary from furnace to furnace. Inputting another furnace's correction factor may provide inaccurate results. Each individual oven requires it's own distinct calibration factor to be determined for a specific mixture blend.

NOTE 4: Carbonate aggregates have been identified as being highly susceptible to large significant variations in testing when using the incinerator. Mixtures comprised of large quantities of limestone tend to show more asphalt than was actually put in the mixture. The testing of this mixture type may exhibit highly variable results.

1853.4 SAMPLING

A. Obtain samples of aggregate in accordance with Mn/DOT Lab Manual Sections 1002 and 1201.

B. Obtain a plant mix asphalt sample in accordance with Mn/DOT Standard Specification 2360.

C. Sample size submitted to a MN/DOT laboratory shall be 10,000g, minimum.

1853.5 APPARATUS

A. Balance - Conforming to the requirements of AASHTO M231 with a readability and sensitivity of 0.1 gram and an accuracy of 0.1 gram or 0.1 %. The balance must have sufficient capacity to weigh the basket assembly and its contents.

B. Sample Tray/Basket - Of appropriate size that allows the sample 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 grate or other suitable material to hold the sample trays so that aggregate particles and melting asphalt binder falling through the screen mesh are caught.

C. Catch Pan – A pan will be used, having sufficient size to hold the sample tray(s) so that the aggregate particles and melting asphalt binder falling through the screen mesh are caught.

D. Catch Pan/Sample Tray(s) Handling Apparatus – Suitable for inserting catch pan and sample trays) into the furnace and removing the hot assembly from the furnace.

E. Assorted Spatulas, Pans, Bowls and Wire Brushes - For preparing Hot mix asphalt mixtures and removing aggregate from sample tray(s) and catch pan.

F. Protective Wear - Well insulated and capable of withstanding 578 °C (1072 °F) and protective eyewear or a full face shield

G. Oven - Capable of maintaining a temperature of 110 ± 5 °C (230 ± 9 °F).

H. Method A Furnace - Having a temperature capability of 578 °C (1072 °F) and having an internal weighing system capable of measuring the mass of sample sizes of at least 2,500 grams. The furnace chamber shall be of sufficient size to accommodate sample sizes of at least 3500 grams. A data collection system shall also be included so the sample mass loss can he automatically determined to an accuracy of 0.1 gram and displayed during a test. The test is deemed complete when the measured mass loss does not exceed 0.01 percent of the sample mass for three consecutive one minute intervals. The equipment shall provide a printout of the test results. A filter 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 escape of smoke into the laboratory. The furnace shall be equipped so the door cannot be opened during the ignition test. (For Method B furnace requirements, refer to AASHTO T 308.)

1853.6 SAFETY

The temperature of the furnace, sample, sample tray (s) and catch pan after removal from the furnace is extremely high. Caution must be exercised at all times when handling these trays. 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 which are subject to ignition at the high temperatures used in this procedure.

1853.7 CALIBRATION USING HOT MIX ASPHALT (HMA)

A. Prepare the mixture calibration sample at design asphalt content in accordance with Mn/DOT Laboratory Manual 1805 or 1820.

When the sample is from plant mix, the correction factor for the actual % binder will be based upon a chemical extraction of the production mixture. Prepare in accordance to 1853 APPENDIX.

B. The test sample shall be the end result of quartering a larger sample in accordance with Section 1805.5, 1809 or 1820.5 whichever is appropriate.

NOTE 5: If the mixture is not sufficiently soft to separate with a spatula and trowel place it in a 110 ± 5 °C (230 ± 9 °F) for 45 minutes.

C. Check the air flow through the furnace.

NOTE 6: To determine if the furnace is drawing the proper amount of air it is necessary to measure the lift on the balance. This must be done when the furnace is at room temperature. It will not work when the chamber is hot.

For NCAT furnaces:

1. Turn on the furnace.

2. Allow the balance to stabilize (about 20 seconds) and then tare balance.

3. Press START button on the keypad.

4. Check the balance display. For older models, it should read from – 4g to – 6g. For newer models, the lift check should read from –3.2g to –8.2 g.

5. If the reading is from zero to –4g on the older models or from zero to – 3.2g on the newer models, the filter system needs to be cleaned.

6. A reading from zero to –2g is an indication of inadequate suction. The furnace and the entire venting system need to be checked.

7. An exhaust flow above the recommended lift may result in fines being blown from the basket.

NOTE 7: Refer to the lift test procedure for each furnace model. Furnace procedures may vary in sequence and procedure.

D. Preheat the ignition furnace to the required testing temperature (See Section 1853.1 – Note #1). Verify the furnace temperature set point prior to the start of the test. Heating may take two hours or more.

E. Enter a correction factor of 0.00 in the ignition furnace.

F. Weigh and record the weight of the basket assembly.

G. From the sample in (Step A) weigh 2000 to 2100 grams of material for calibration testing. Place the bottom sample basket in the catch pan. Evenly distribute approximately one-half of the calibration sample in the lower basket, carefully keeping the material away from the basket edges.

H. Place the upper sample basket on the bottom basket assembly. Evenly distribute the remaining calibration sample in the top basket. Use a spatula or trowel to level the sample. Attach the cover.

I. Weigh and record the weight of the calibration sample and the basket assembly to the nearest 0.1 gram. Calculate and record the initial weight of the calibration sample (Total weight **–** The weight of the sample basket assembly). See form in Section 1853.10 (Fig 1),

J. Input the initial weight of the calibration sample in whole grams into the ignition furnace controller. Verify that the correct weight has been entered.

K. Open the chamber door and place the loaded basket assembly onto the balance platform in the center of the furnace. Close the chamber door and verify the calibration sample weight (including the baskets) displayed on the furnace balance equals the total weight recorded in Section 1853.7I, ± 5 grams. Differences greater than 5 grams or the failure of the furnace balance to stabilize may indicate that the sample baskets are contacting the furnace wall. Initiate the test by pressing the start/stop button. This will lock the sample chamber and start the combustion process.

L. Allow the calibration sample to remain in the furnace until the change in mass of the sample over a three minute interval does not exceed 0.01 percent of the sample mass. The stable light and audible beep will indicate when the testing is finished. Press the start/stop button to end the test. This will unlock the furnace door and cause the device to print out the ignition data.

M. Open the door and remove the sample and basket assembly. ALLOW TO COOL TO ROOM TEMPERATURE. (30 ± 5 minutes) Weigh and record the final weight. See form in Section 1853.10 (Fig 1), line D.

NOTE 8: Since the dry aggregate absorbs moisture when exposed to air containing moisture determine the mass of the aggregate immediately after cooling to room temperature (30 ± 5 minutes).

N. Repeat steps (A) through (M) for the second calibration sample.

O. Calculation of the mix correction factor.

Step 1) Determine the Correction factor for each calibration sample by subtracting the known % asphalt binder for the sample from the total %loss determined in step 1.

$$C_{fm} = \frac{100 \times (C - E)}{C} - Pb$$

Cfm = The correction factor by weight of mixture.
C = Total weight of mixture sample prior to burn
E = Total weight of aggregate after the burn
Pb = Known % AC in mix (see note 9)

NOTE 9: The Pb for a given sample is determined from either 1) a known amount of asphalt binder that was added to the specific sample (at mix design) or 2) a result from a solvent extraction that determined the % binder in the sample (plant production mix).

Step 2) Determine the difference between the two calibration samples. If the results from the first calibration sample are within 0. 15 of the second calibration sample, average the two results and record the correction factor.
If the difference between the two correction factors is more than 0.15 (percent), repeat the calibration procedure with a third sample. Average the three results.

NOTE 10: The difference for any individual calibration factor shall not vary from the average by more than 0.15 percent. Discard a calibration factor more than 0.15 percent from the average and recalculate the average.

Step 3) The reported average correction factor (C_{fm}) is calculated as follows:

$$\text{Average} = \frac{C_{S1} + C_{S2}}{2} \quad \text{or} \quad \frac{C_{S1} + C_{S2} + C_{S3}}{3}$$

Where:

C_{S1} & C_{S2} = The measured weight loss (percent) of samples 1 & 2
C_{S3} = The measured weight loss (percent) of sample 3 (Which is run when samples 1 & 2 are out of tolerance.)

1853.8 TEST PROCEDURE TO DETERMINE THE ASPHALT CONTENT

A. Obtain a plant mix sample in accordance with Sections 1809 or 1812 as appropriate.

B. Oven-dry the mixture sample to a constant mass at a temperature of 110 ± 5 °C (230 ± 9 °F) or determine the moisture content of the sample so that the measured mass loss can be corrected for moisture.

NOTE 11: A minimum drying time of 45 minutes at 110 ± 5 °C (230 ± 9 °F) has been adopted for most mixtures that are free of moisture. However, when determining the moisture content the following applies: A constant weight for mixtures shall be defined as the mass at which further drying at 110 ± 5 °C (230 ± 9 °F) does not alter the mass by more than 0.05 percent The sample shall be initially dried for 2 hours. Then continue drying for 30 minute intervals until a constant weight is reached. (On a 2000 gram sample this amounts to a difference of 1.0 grams or less.)

C. Check air flow. See Section 1853.7C.

D. Preheat the ignition furnace to the required testing temperature. (See Section 1853.1 – Note #1) Verify the furnace temperature set point prior to initiation of the test. Heating may take two hours or more.

NOTE 12: The temperature for testing HMA samples shall be the same as selected for the mixture calibration samples.

E. Enter the mixture aggregate calibration factor for the specific mixture to be tested, as determined above, in the ignition furnace.

F. Weigh and record the weight of the two sample baskets and catch pan (with guard in place). See Section1853.14 (Fig.4), line A.

G. Weigh 2,000 to 2100 grams of mixture from the preheated sample. Place the bottom sample basket in the catch pan. Evenly distribute approximately one half of the specimen in the lower basket taking care to keep the material away from the edges of the basket.

H. Place the upper sample basket on the bottom basket assembly. Evenly distribute the remaining specimen in the top basket.

I. Weigh and record the sample and basket assembly to the nearest 0.1 gram. (For use in "K" below.) Then calculate and record the initial weight of the sample specimen (total weight - weight of the sample basket assembly). See form in Section 1853.11 (Fig.2), line B.

J. Input the initial weight of the sample specimen in whole grams into the ignition furnace controller. Verify the correct weight of the sample specimen (total weight - weight of the sample basket assembly). See form in Section 1853.11 (Fig.2), line C.

K. Open the chamber door and place the loaded basket assembly onto the balance platform in the center of the furnace. Close the chamber door and verify that the sample weight (including the baskets) displayed on the furnace balance equals the total weight (± 5 grams) recorded in Section 1853.8I. Differences greater than 5 grams or the failure of the furnace balance to stabilize may indicate that the sample baskets are contacting the furnace wall.

Initiate the test by pressing the start/stop button. This will lock the sample chamber and start the combustion process.

L. Allow the test to continue until the stable light and audible stable indicator indicates the test is complete. The change in mass shall not exceed 0.01 percent for three consecutive minutes. Press the start/stop button. This will unlock the furnace door and cause the device to print out the data.

M. Open the chamber door, remove the sample baskets and allow to COOL TO ROOM TEMPERATURE (30 ± 5 minutes). Record the final weight on line D Section 1853.11 (Fig.2).

N. Calculations:

$$\text{Corrected AC \%} = \frac{(C - E) \times 100}{C} - CF$$

Where:

C = Initial weight of the basket and sample minus the basket
E = Final weight of the basket and sample minus the basket
CF = Correction factor

Note 13: If there's a moisture correction for the sample, subtract it from the "Corrected AC%" before reporting.

1853.9 GRADATIONS

A. Empty the cooled sample into a flat pan using a small wire brush to ensure that any residual fines are removed from the baskets.

B. Perform a gradation analysis according to Manual Section 1203.5.

1853.10 MIXTURE CALIBRATION WORKSHEET

IGNITION FURNACE ID _____

MIXTURE CALIBRATION WORKSHEET

S.P. _____ **T.M.** _____ **PLANT** _____

MIX TYPE _____

CONTRACTOR_____

DATE_____

Basket Number or I.D.				
Weight of Basket (g)	**A**			
Initial Weight of Basket + Sample (g)	**B**			
Weight of Sample (g)	**B – A = C**			
Final Weight of Basket + Sample (g)	**D**			
Final Weight of Sample (g)	**D – A = E**			
Percent of Asphalt in Mix	**Pb**			
Mixture Calibration Factor (C_{fm})	$\frac{100 \times (C-E)}{C}$ **- Pb**			

Note: Tolerance of 0.15 between Cfm

AVERAGE MIXTURE CALIBRATION FACTOR _____

1853.11 ASPHALT CONTENT DETERMINATION WORKSHEET

IGNITION FURNACE ID_____

ASPHALT CONTENT DETERMINATION WORKSHEET

PROJECT NO. _____ **T.H.** _____ **PROJ. ENGR.** _____

MIX TYPE _____ **MDR NO.** _____ **T.M. NO.** _____

DATE SAMPLED_____ **DATE TESTED** _____ **FIELD I.D.** _____

TESTED BY _____ **CONTRACTOR** _____ **TEST NO.** _____

Basket Number		
Weight of Basket (g)	**A**	
Initial Weight Basket + Sample (g)	**B**	
Weight of Sample (g)	**C = B – A**	
Final Weight Basket + Sample (g)	**D**	
Final Weight of Sample (g)	**E = D – A**	
Mixture Calibration Factor	**Cfm**	
Corrected Asphalt Content (%)	$\frac{(C - E) \times 100}{C}$ - **Cfm**	

Establishing an Ignition Oven Correction Factor on Production Mix

1. The Contractor will obtain a 90lb (approx. 4 cylinders of mix) representative sample of mixture sampled from behind the paver. The Contractor will split the sample evenly between Mn/DOT and the Contractor.

2. The Contractor shall deliver the Mn/DOT sample to the Mn/DOT District Laboratory.

3. The Mn/DOT District Laboratory will perform a centrifuge extraction to determine an extracted asphalt binder content of the mixture. Mn/DOT lab procedure 1852 will be followed.

4. The contractor has the option to run their own centrifuge extraction following Mn/DOT 1852 or accept Mn/DOT's value.

5. When both the Contractor and Agency determine the extracted asphalt content the following shall apply:

   A.) If results between both parties are within the 0.4 tolerance of each other, the two results are averaged.
   B.) If the two results are not within 0.4 of each other, retests of the material shall be conducted by Mn/DOT. If the retests fail to meet tolerances, Mn/DOTs test results will be used.

6. Mn/DOT and the contractor will each burn two ignition calibration samples from the same split sample (step 1). Mn/DOT lab procedure 1853 will be followed.

7. Mn/DOT and the contractor will each determine their ignition oven correction factors based on the value from step 3 or step 5.

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