2024 Edition

Binder Ignition

Binder Ignition

COURSE CONTENT

BINDER IGNITION OVEN TEST

Module 1 Appendix	AASHTO T308	Binder Ignition

BINDER IGNITION

UPDATES

- **2024 - No updates in Methods**
- **2023** - Module 1 – Binder Ignition Oven AASHTO T308- Updates
    - Thermometers for measuring temperature See Appendix Item Equipment for more information on Thermometers.
    - Ignition furnace updates on temperature control, see Appendix Item Equipment
- **2022 –** New manual, but no method updates.

Module 1

Binder Ignition AASHTO T308

MODULE 9

BINDER IGNITION OVEN AC CONTENT AASHTO T308

Rev 10/10/2023

1

SCOPE

This test method AASHTO T308:

- Covers the determination of asphalt binder content of asphalt mixtures by ignition at temperatures that reach the flashpoint of the binder in a furnace.
- Heating may be convection method or direct infrared (IR) irradiation method.
- Two Methods,
  - **Method A** requires an ignition furnace with an internal balance.
  - **Method B** requires an ignition furnace with an external balance.

2

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SIGNIFICANCE AND USE

This method can be used for:

- Quantitative determinations of asphalt binder content.
- Gradation in asphalt mixture and pavement specimens for quality control.
- Specification acceptance.
- Mixture evaluation studies.
- For gradation analysis according to AASHTO T30.

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EQUIPMENT

- **Ignition Furnace** – A forced air oven that heats by convection or direct IR irradiation. The convection type must be capable of maintaining 538 ± 5°C (1000 ± 9°F).
  - For Method A the oven shall have an internal balance.
- Specimen basket assembly consisting of
  - Specimen Baskets
  - Catch Pan
  - Assembly guard
- See appendix, Item #7 for more information on equipment.

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Oven Verification:

- The oven must be "verified' every 12 months and after each move.
  - Temperature
  - Balance

Methods:

- Yearly outside service (usually along with gyro and mold calibrations, etc.)
- In-house

5

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Ignition Oven Basics:

- **% Binder**: Loss in mass of specimen
- **Problem:** Other materials also burn off
  - Moisture
  - Aggregate
  - Miscellaneous

6

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CORRECTIONS

1. Moisture
   - Moisture Content "MC"
2. Aggregate Burn Loss
   - Aggregate Correction Factor "Cf"
3. Temperature effects on weighing
   - Temperature Correction Factor "TCF"

7

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1. Moisture

- Moisture in mix will evaporate.
- This will count as binder unless corrected.
- There are two methods to correct for moisture:

Method 1
- Dry mix to a constant mass at 110 ± 5°C (230 ±9°F) prior to testing.
- "Aging"—must still verify that constant mass has been achieved.

OR

Method 2
- Determine moisture content of mix (AASHTO T 329), subtract it from the apparent binder content.

8

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Moisture Content (AASHTO T 329): Method 2

- Temperature: **(See BT Manual for T329)**
  - Within the JMF mixing temperature range.
  - If unavailable, use 163 ±14°C (325 ±25°F)
- ≥1,000g sample, Initial drying time is 90 ± 5 min.
- Continue drying checking at 30 ± 5 min intervals until the mass changes less than 0.05% (~1g per sample) from the previous mass = Constant Mass.
  Report to nearest 0.01%
- Moisture is calculated based on *dry* weight of HMA.

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Calculate the PERCENT CHANGE as follows:

$$\% \text{ Change} = \frac{(A - B)}{A} \times 100$$

A = Previous mass determination

B = Newest mass determination

REPORT = To the nearest **0.01%**

Reminder from BT certification:

First subtract the container weight from the total weight for A and B then record the weights to the nearest **0.01 g** before calculating % change.

10

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Moisture Content (AASHTO T 329): Method 2

$$\text{Moisture Content} = \frac{(M_i - M_f)}{M_f} \times 100$$

Where:

M_i = Mass of initial, moist test sample

M_f = Mass of the final, dry test sample

Report = % Moisture to the nearest **0.01%**

Updated slide

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Moisture Content (AASHTO T 329): Method 2

$$\text{Moisture Content} = \frac{(M_i - M_f)}{M_f} \times 100$$

Classroom Practice

M_i = 1134.9

M_f = 1127.3

% Moisture = _____ %

Report to the nearest 0.01%

Moisture Content Ans: 0.67% Updated slide

12

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Method 2

Rounding:

- When calculating, moisture content, binder content, and Cf, round to nearest 0.01%

Side note:

Binder Content: When comparing to specification, round binder content to nearest 0.1%.

Moisture Content

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Moisture Testing Frequency:

"Common Wisdom" as needed . . .

- High RAP/RAS mixtures especially prone to moisture.
- Rainy weather
- "Warm mix"
- New aggregate
- If plant operator reports burning more fuel to maintain temperature.
- Fluctuating volumetrics or binder contents
- Watering piles per DNR.
- Same stockpiles
- Dry weather
- No moisture when tested

Moisture Content

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2. Aggregate Burn Loss

Aggregate Correction Factor :

- To correct for loss of mass during the mix ignition due to aggregate burn-off.
- Determined during mix design by mix designer (usually QC).
- Re-determined if mix design changes (e.g. >5% change in stockpiled aggregate proportions).
- Re-determined if a different oven is used (QA or QC).

Aggregate Correction

15

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C_F Procedure:

- Mix specimen in lab with dry aggregate at a known (***actual***) % binder.
- Input "zero" for the C_F
- Burn, obtain ***measured*** **(*apparent*)** % binder.
- The difference between the ***measured*** and the ***actual*** % binder is the Asphalt Binder Correction Factor (C_F).
- If the C_F is > 1.0%, re-determine at a lower temperature.

Aggregate Correction **16**

16

Definitions:

- **M** = mass (g)
- **Mi(dry)** = Mass of mix before burning, dry already.
- **Mf** = Final mass of mix after burning (binder and some aggregate burned off).
- **(Mi(dry) – Mf)** = Binder & aggregate burned off.
- **Magg** = Initial unburned mass of just the aggregate, dry.
- **(Mi(dry) – Mi(agg))** = Mix mass minus aggregate mass is the mass of binder, initially.

Aggregate Correction **17**

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C_F Calculations:

$$C_f = Measured - Actual$$

- Lab-produced sample (dry)

$$C_f = \left[\frac{M_{i(dry)} - M_f}{M_{i(dry)}}\right] - \left[\frac{M_{i(dry)} - M_{i(agg)}}{M_{i(dry)}}\right]$$

- The difference is the aggregate mass loss
- The ***Measured*** binder content can be from the oven ticket
- The ***Actual*** binder content can be from a bench scale
- If the C_F is > 1.0%, re-determine at a lower temp.
- Report to the nearest 0.1%

Aggregate Correction **18**

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Two types of Ovens

Infrared Oven

Convention Oven

New Slide

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Convection Oven Temperatures :

- **AASHTO**:
  - Normal: 538 °C (1000.4 °F)
  - High C_F 's (>1.0%): 482 °C (899.6 °F)
- **MoDOT**:
  - Normal: 538 °C (1000.4 °F)
  - High C_F 's: if >1.0% try 482 C (899.6 °F)
  - Very high C_F 's: if >1.0% at 482 C, use 427 C
    Very high C_F 's: if >1.0% at (899.6 °F), use (800.6°F)

Aggregate Correction

20

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Cf Determination:

Number of Replicate Specimens

- Use two
- If the difference in measured asphalt contents is > 0.15%, test two more replicates.
- For the four replicates, discard the high and low results.

Aggregate Correction

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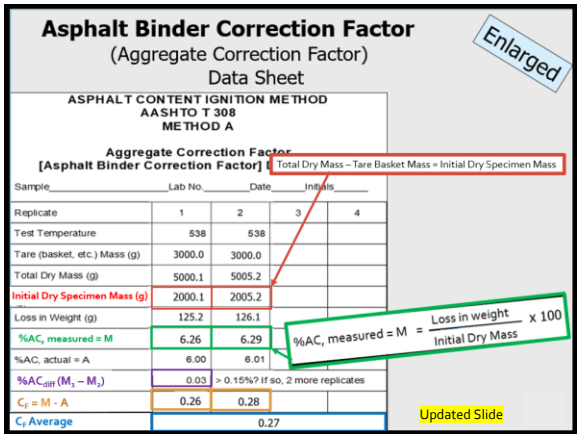
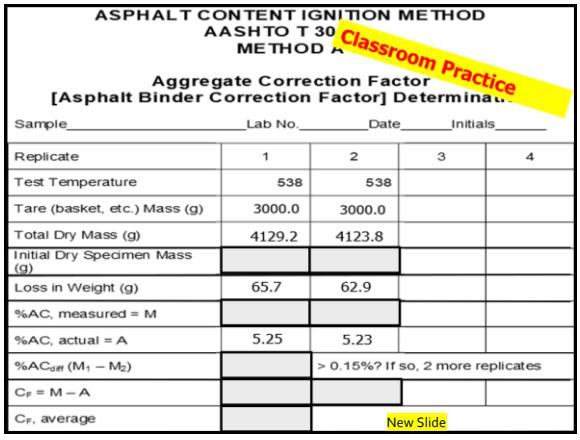
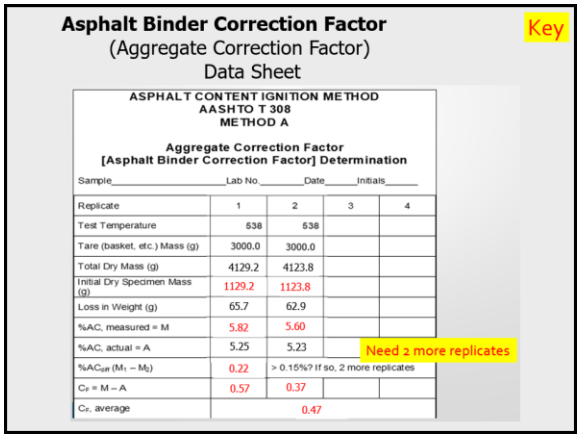
DO NO


Asphalt Binder Correction Factor
(Aggregate Correction Factor)
Data Sheet
Enlarged
ASPHALT CONTENT IGNITION METHOD
AASHTO T 308
METHOD A
Aggregate Correction Factor
[Asphalt Binder Correction Factor] Determination
Total Dry Mass – Tare Basket Mass = Initial Dry Specimen Mass
Sample Lab No. Date Initials
Replicate 1 2 3 4
Test Temperature 538 538
Tare (basket, etc.) Mass (g) 3000.0 3000.0
Total Dry Mass (g) 5000.1 5005.2
Initial Dry Specimen Mass (g) 2000.1 2005.2
Loss in Weight (g) 125.2 126.1
%AC, measured = M 6.26 6.29
%AC, actual = A 6.00 6.01
%AC$_{diff}$ ($M_1 - M_2$) 0.03 > 0.15%? If so, 2 more replicates
C_F = M - A 0.26 0.28
C_F Average 0.27
%AC, measured = M = Loss in weight / Initial Dry Mass x 100
Updated Slide

22


ASPHALT CONTENT IGNITION METHOD
AASHTO T 30
METHOD A
Classroom Practice
Aggregate Correction Factor
[Asphalt Binder Correction Factor] Determinat
Sample Lab No. Date Initials
Replicate 1 2 3 4
Test Temperature 538 538
Tare (basket, etc.) Mass (g) 3000.0 3000.0
Total Dry Mass (g) 4129.2 4123.8
Initial Dry Specimen Mass (g)
Loss in Weight (g) 65.7 62.9
%AC, measured = M
%AC, actual = A 5.25 5.23
%AC$_{diff}$ ($M_1 - M_2$) > 0.15%? If so, 2 more replicates
C_F = M – A
C_F, average
New Slide

23


Asphalt Binder Correction Factor
(Aggregate Correction Factor)
Data Sheet
Key
ASPHALT CONTENT IGNITION METHOD
AASHTO T 308
METHOD A
Aggregate Correction Factor
[Asphalt Binder Correction Factor] Determination
Sample Lab No. Date Initials
Replicate 1 2 3 4
Test Temperature 538 538
Tare (basket, etc.) Mass (g) 3000.0 3000.0
Total Dry Mass (g) 4129.2 4123.8
Initial Dry Specimen Mass (g) 1129.2 1123.8
Loss in Weight (g) 65.7 62.9
%AC, measured = M 5.82 5.60
%AC, actual = A 5.25 5.23
%AC$_{diff}$ ($M_1 - M_2$) 0.22 > 0.15%? If so, 2 more replicates
C_F = M – A 0.57 0.37
C_F, average 0.47
Need 2 more replicates

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Asphalt Binder Correction Factor

(Aggregate Correction Factor) Data Sheet

Enlarged

ASPHALT CONTENT IGNITION METHOD
AASHTO T 308
METHOD A

Aggregate Correction Factor
[Asphalt Binder Correction Factor]

Total Dry Mass – Tare Basket Mass = Initial Dry Specimen Mass

Sample_____ Lab No._____ Date_____ Initials_____

Replicate	1	2	3	4
Test Temperature	538	538		
Tare (basket, etc.) Mass (g)	3000.0	3000.0		
Total Dry Mass (g)	5000.1	5005.2		
Initial Dry Specimen Mass (g)	2000.1	2005.2		
Loss in Weight (g)	125.2	126.1		
%AC, measured = M	6.26	6.29		
%AC, actual = A	6.00	6.01		
$\%AC_{diff}$ $(M_1 - M_2)$	0.03	> 0.15%? If so, 2 more replicates		
$C_F = M - A$	0.26	0.28		
C_F Average	0.27			

$$\%AC, measured = M = \frac{\text{Loss in weight}}{\text{Initial Dry Mass}} \times 100$$

Updated Slide

ASPHALT CONTENT IGNITION METHOD
AASHTO T 30
METHOD A

Classroom Practice

Aggregate Correction Factor
[Asphalt Binder Correction Factor] Determinati

Sample_____Lab No._____Date_____Initials_____

Replicate	1	2	3	4
Test Temperature	538	538		
Tare (basket, etc.) Mass (g)	3000.0	3000.0		
Total Dry Mass (g)	4129.2	4123.8		
Initial Dry Specimen Mass (g)				
Loss in Weight (g)	65.7	62.9		
%AC, measured = M				
%AC, actual = A	5.25	5.23		
$\%AC_{diff}$ ($M_1 - M_2$)		> 0.15%? If so, 2 more replicates		
$C_F = M - A$				
C_F, average		New Slide		

Use of Cf :

- Before production, when Cf is the *unknown*:

Cf = Measured Content – Actual Content

- During production, when Actual Content is *unknown*:

Actual = Measured Content – Cf

Aggregate Correction

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Infrared Burn Profiles:

- **"Default"**
  Most mixes
- **"Option 1"**
  (Less) - For C_f > 1.0% e.g., RAP containing dolomite.
- **"Option 2"**
  (More) – Hard to burn mixes

Aggregate Correction

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RAP Aggregate Correction Factor :
(Asphalt Binder Correction Factor)

- **Follow TM-77:**
  - Assumes aggregate C_F for RAP aggregate is same as C_F for virgin aggregate.
  - Follow the standard procedure as if there was no RAP, i.e., use only the virgin aggregate, and only the binder content associated with the virgin aggregate portion when fabricating the specimen.
  - So, the Cf from the virgin materials test is used as the Cf for the whole mix.

Aggregate Correction

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3. Temperature Effects on Weighing Temperature Compensation Factor (TCF)

Convection Oven:

- Material "weighs" differently at elevated temperatures.
- Mass loss shown on the oven printout must be corrected.
- Oven calculates and prints the "Temperature Correction Factor (TCF)" for the particular test run.
- ***TCF = Apparent loss in mass due to heating.***

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Use of Temperature Correction Factor:

- When determining the Aggregate Correction Factor, if the oven printout is used for determination of the Measured Asphalt Content, include the Temperature Correction Factor (TCF).
- If all weighing is performed outside of the oven and specimen is cooled to room temperature, do not use the TCF

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Second Generation Infrared oven:

- No Temperature Correction Factor
- **Anecdotal**: Scale is better insulated from the chamber.

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PROCEDURE FOR T308

Determining the Asphalt Binder Content of Asphalt Mixtures by the Ignition Method

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Test Methods

- Method A – Furnace with internal scale
- Method B – Furnace without internal scale

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SAMPLING/REHEATING

EPG 403.1.5 Link: Engineering_Policy_Guide (modot.org)

Sampling:

- Obtain samples of Loose Mix according to AASHTO R97. (See Module 5 on Sampling)

Reheating:

- Place the box or bucket of sample in an oven 110 ± 5°C (230 ± 9°F)

gently warm the sample until workable.

- Remove the sample from box or bucket.

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Reducing:

- Reduce the sample per AASHTO R47 (see module 6) to amount listed on Table 1.
- Spread sample in a large pan or two.

  If needed, reheat the pan just until sample is workable. 110 ± 5°C (230 ± 9°F)

NOTE: Monitor the heating, do not leave sample in the oven too long.

Sampling

34

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Ignition Oven Specimen Size (TABLE 1)

Mix	NMS, in.	Specimen Size, g
SP048 & BP-3	#4	1200-1700
SP095	3/8	1200-1700
SP125, BP-1 & BP-2	1/2	1500-2000
SP190 & Bit Base	3/4	2000-2500
SP250	1	3000-3500

Sampling

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PROCEDURE
Method A
Using the Convection Oven

- Preheat the furnace to 538±5°C (1000±9°F), or use temperature determined by the correction factor.
- Enter the ***chamber set point*** .

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At the bench…

- Record weight of empty basket assembly. (0.1g)
- Place ~ half of the mix in each basket.
- Use a spatula or trowel to level and move the mix about **one inch** away from the edges of the basket.

Method A

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- Cool to room temp.
- Weigh the test specimen and basket on external bench scale. (0.1g)
- Calculate and record the initial weight of the sample.
- Record to nearest 0.1g

	Total weight$_{initial}$
-	Empty Basket weight
=	Sample Weight$_{initial}$

Method A

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- Input the initial sample weight in whole grams into the ignition furnace controller.
- Enter the ***asphalt correction factor (C_F).***
- Reset the internal scale to zero.

Method A

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- Put on safety gear.
- Open the chamber door and place the specimen basket with sample in the furnace.
  - Make sure basket is not touching the walls.
- Close the door.

Method A

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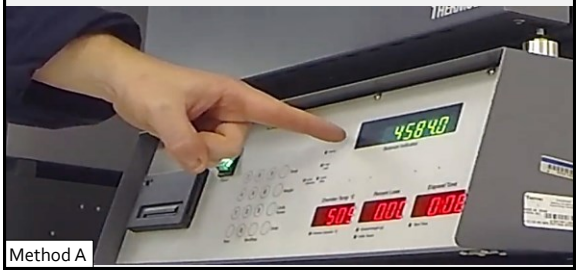
- Verify that the specimen weight is displayed on the furnace scale equals the **total mass$_{inital}$** weighed on bench scale **± 5 grams**.
- Start the oven. "Burn"



Method A

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- Oven will stop when burn is complete.
- Tare off ticket of burn results.
- Put on safety gear, open the door, carefully pull out the basket and place it on a cooling plate.
- Place a protective cage on top of the basket assembly.
- Allow to cool to room temperature. ~ 60min.

Method A

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- Move the basket assembly with sample to a scale and record the total weight after ignition. (0.1g)
- Calculate and record the final weight of the specimen to nearest 0.1g

Method A

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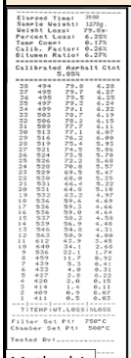
CALCULATION/REPORTING



- The furnace will calculate % binder based on the:
  - Original specimen weight entered
  - Total loss
  - Asphalt correction factor (C_F) that you entered.
  - "Temperature Compensation Factor" that the oven calculates = apparent loss in weight due to heating.
- ***You*** must then correct (subtract) for ***moisture*** if started with a wet sample.

Method A

44

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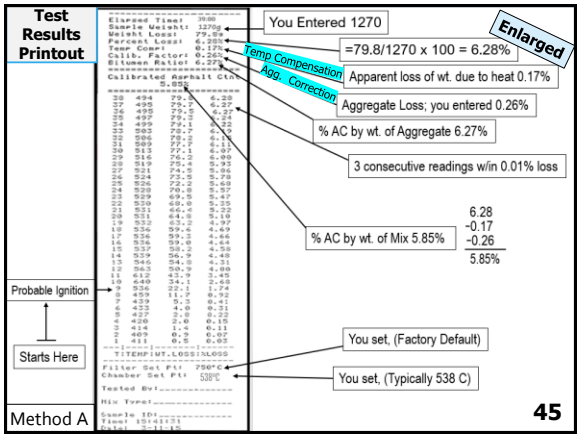

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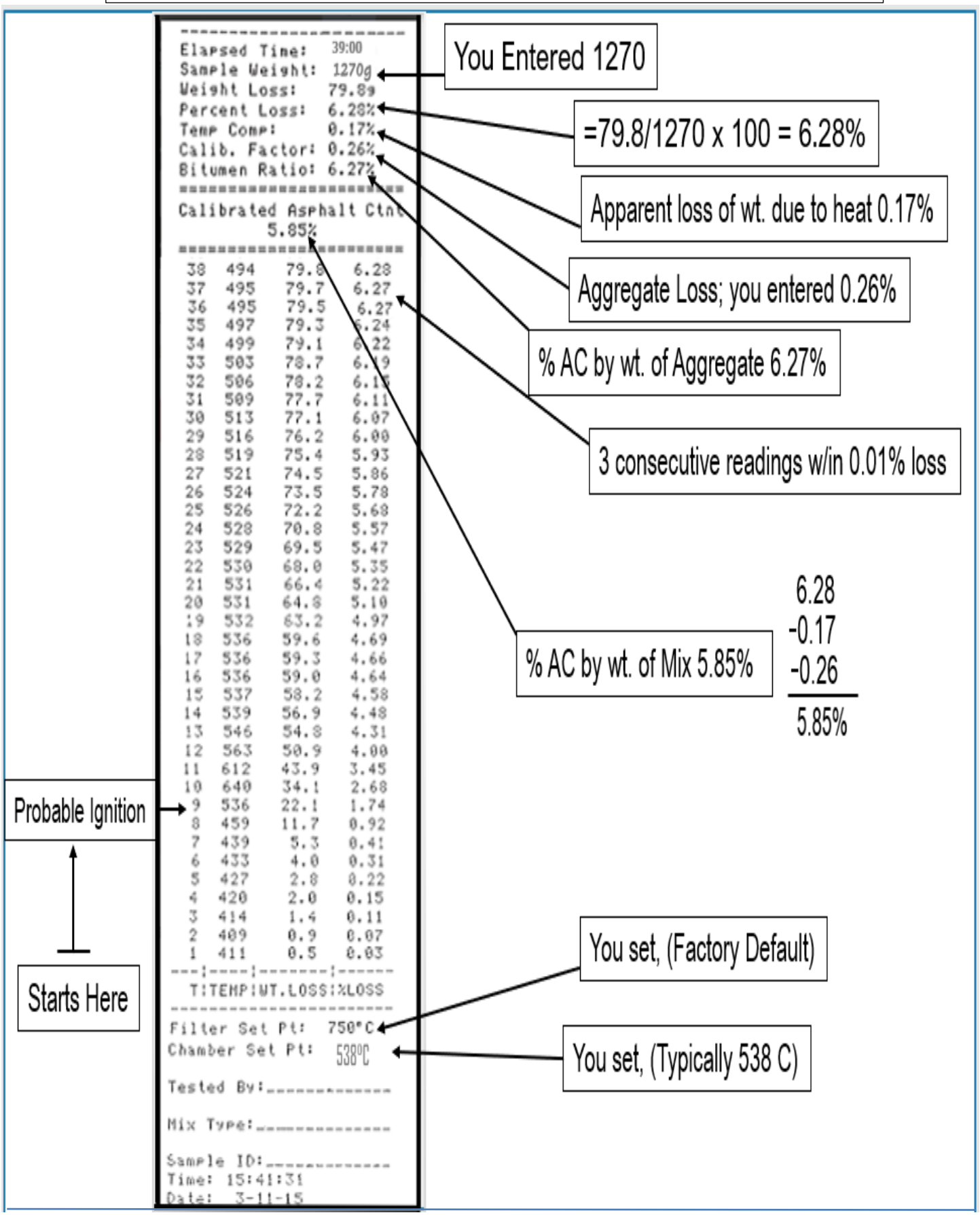
TEST RESULTS PRINT OUT FROM IGINITION OVEN



Asphalt Content Ignition Method
(AASHTO T 308-10) Method A
Reproducing Oven Ticket Values

Enlarged

Classroom Practice

*If w_i = wet

Project No.	Job No.	Route	C
hician	Date	Sublot No.	Mix No.

Empty Basket Assembly Weight (g), [T_e]	3000.2
Basket Assembly + Wet (or dry) Sample Weight (g), [T_i]	4270.2
Wet (or dry) Sample Weight (g), [$W_i = (T_i - T_e)$]	
Loss in Weight (g), [L] (from tape)	
Total % Loss, [$P_L = (L / W_i) \times 100$]	
Temperature Compensation (%), [C_{tc}] (from tape)	
% AC, uncorrected, [$P_{bu} = P_L - C_{tc}$]	
Aggregate Correction (Calibration) Factor (%), [C_f] (from tape)	
Calibrated %AC (from ignition oven tape), [$P_{bcal} = P_{bu} - C_f$]	
% Moisture Content, [MC] (previous test)*	0.13
% AC, corrected (by weight of mix), [$P_b = P_{bcal} - MC$]*	

Method A

Asphalt Content Ignition Method
(AASHTO T 308-10) Method A
Reproducing Oven Ticket Values

Enlarged

*If w_i = wet

Classroom Practice

Project No. / Job No. / Route / County	
Technician / Date / Sublot No. / Mix No.	
Empty Basket Assembly Weight (g), [T_a]	3000.2
Basket Assembly + Wet (or dry) Sample Weight (g), [T_i]	4270.2
Wet (or dry) Sample Weight (g), [$W_i = (T_i - T_a)$]	
Loss in Weight (g), [L] (from tape)	
Total % Loss, [$P_L = (L / W_i) \times 100$]	
Temperature Compensation (%), [C_{tc}] (from tape)	
% AC, uncorrected, [$P_{bu} = P_L - C_{tc}$]	
Aggregate Correction (Calibration) Factor (%), [C_f] (from tape)	
Calibrated %AC (from ignition oven tape), [$P_{bcal} = P_{bu} - C_f$]	
% Moisture Content, [MC] (previous test)*	0.13
% AC, corrected (by weight of mix), [$P_b = P_{bcal} - MC$]*	

Method A

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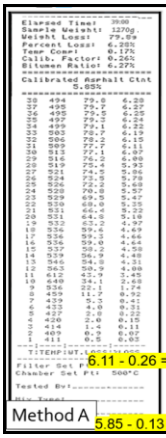

6.11 - 0.26 = 5.85

5.85 - 0.13 = 5.72

Asphalt Content Ignition Method
(AASHTO T 308-10) Method A
Reproducing Oven Ticket Values

KEY

*If w_i = wet

Project No. / Job No. / Route / County	
Technician / Date / Sublot No. / Mix No.	
Empty Basket Assembly Weight (g), [T_a]	3000.2
Basket Assembly + Wet (or dry) Sample Weight (g), [T_i]	4270.2
Wet (or dry) Sample Weight (g), [$W_i = (T_i - T_a)$]	1,270.0
Loss in Weight (g), [L] (from tape)	79.8
Total % Loss, [$P_L = (L / W_i) \times 100$] (79.8 / 1270.0) X 100 = 6.289	6.28
Temperature Compensation (%), [C_{tc}] (from tape)	0.17
% AC, uncorrected, [$P_{bu} = P_L - C_{tc}$] 6.28 – 0.17 = 6.11	6.11
Aggregate Correction (Calibration) Factor (%), [C_f] (from tape)	0.26
Calibrated %AC (from ignition oven tape), [$P_{bcal} = P_{bu} - C_f$]	5.85
% Moisture Content, [MC] (previous test)*	0.13
% AC, corrected (by weight of mix), [$P_b = P_{bcal} - MC$]*	5.72

Method A

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Asphalt Binder Correction Factor
(Formerly Aggregate Correction Factor)
Calculation

If final weighing is performed on bench top scale, calculation:

$$P_b = \left[\frac{M_i - M_f}{M_i} \times 100 \right] - C_f - MC$$

Where:

M_i = initial weight of mix, wet or dry
M_f = final mass of mix
MC = % moisture
C_f = Asphalt Binder Correction Factor
(old Aggregate Correction Factor)

Method A

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PROCEDURE
Method B

- Note the special heat resistant shirt.

Use SAFETY gear!

Dr. Richardson

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Method B - No internal scale – Manual Weigh

- Weigh out specimen.
- Burn for about 45 minutes.
- Remove, cool, weigh.
- Burn for another 15 minutes.
- Remove, cool, weigh.
- Keep repeating the 15-minute burn intervals until 2 consecutive mass weighings do not change by > 0.05%.
- Subtract moisture % if necessary.

Method B

50

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Method B - No internal scale – Manual Weigh

Information needed for the report:

- Moisture = 0.05%
- C_f = 0.22%
- Initial wet mass = 5400.2 g
- Final burned mass (after cooling to room temperature) = 5256.2 g

Weight = Mass
Mass = Weight

Method B

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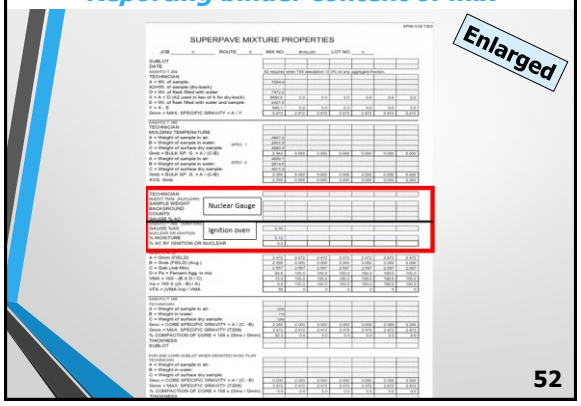
Reporting binder content of mix



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Reporting binder content of mix

Binder Portion

Enlarged

TECHNICIAN								
MoDOT TM54 (NUCLEAR)								
SAMPLE WEIGHT								
BACKGROUND								
COUNTS								
GAUGE % AC								
AASHTO T 308 (IGNITION)								
GAUGE %AC	5.35							
NUCLEAR OR IGNITION								
% MOISTURE	0.12							
% AC BY IGNITION OR NUCLEAR	5.2							

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Binder content of RAP

RAP Binder Content

- **Per Spec 403.19.3;** RAP binder content must be determined.
- **QC:** 1 per 4 sublots
- **QA:** 1 per project
- T164 (solvent extraction)
- Can use T308 (ignition) if a correction factor is determined which is the difference between T164 & T308 (best to use your own oven when T164 is determined by another lab).

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SUPERPAVE MIXTURE PROPERTIES

JOB 0 ROUTE 0 MIX NO. #VALUE! LOT NO. 0

SUBLOT							
DATE							
AASHTO T 209	A2 required when T85 absorption >2.0% on any aggregate fraction.						
TECHNICIAN							
A = Wt. of sample:	1594.4						
A2=Wt. of sample (dry-back):							
D = Wt. of flask filled with water:	7472.2						
X = A + D (A2 used in lieu of A for dry-back)	9066.6	0.0	0.0	0.0	0.0	0.0	0.0
E = Wt. of flask filled with water and sample:	8421.5						
Y = X - E	645.1	0.0	0.0	0.0	0.0	0.0	0.0
Gmm = MAX. SPECIFIC GRAVITY = A / Y	2.472	2.472	2.472	2.472	2.472	2.472	2.472

AASHTO T 166								
TECHNICIAN								
MOLDING TEMPERATURE								
A = Weight of sample in air:		4867.8						
B = Weight of sample in water:	SPEC. 1	2801.9						
C = Weight of surface dry sample:		4880.4						
Gmb = BULK SP. G. = A / (C-B)		2.342	0.000	0.000	0.000	0.000	0.000	0.000
A = Weight of sample in air:		4899.1						
B = Weight of sample in water:	SPEC. 2	2814.5						
C = Weight of surface dry sample:		4911.9						
Gmb = BULK SP. G. = A / (C-B)		2.336	0.000	0.000	0.000	0.000	0.000	0.000
AVG. Gmb		2.339	0.000	0.000	0.000	0.000	0.000	0.000

TECHNICIAN							
MoDOT TM54 (NUCLEAR)							
SAMPLE WEIGHT							
BACKGROUND							
COUNTS							
GAUGE % AC							
AASHTO T 308 (IGNITION)							
GAUGE %AC	5.35						
NUCLEAR OR IGNITION							
% MOISTURE	0.12						
% AC BY IGNITION OR NUCLEAR	5.2						

Nuclear gage

Ignition oven

AASHTO R 35							
A = Gmm (FIELD)	2.472	2.472	2.472	2.472	2.472	2.472	2.472
B = Gmb (FIELD) (Avg.)	2.339	0.000	0.000	0.000	0.000	0.000	0.000
C = Gsb (Job Mix)	2.557	2.557	2.557	2.557	2.557	2.557	2.557
D = Ps = Percent Agg. in mix	94.8	100.0	100.0	100.0	100.0	100.0	100.0
VMA = 100 - (B X D / C)	13.3	100.0	100.0	100.0	100.0	100.0	100.0
Va = 100 X ((A - B) / A)	5.4	100.0	100.0	100.0	100.0	100.0	100.0
VFA = (VMA-Va) / VMA	59	0	0	0	0	0	0

AASHTO T 166							
TECHNICIAN							
A = Weight of sample in air:	1255						
B = Weight in water:	710						
C = Weight of surface dry sample:	1260						
Gmc = CORE SPECIFIC GRAVITY = A / (C - B)	2.282	0.000	0.000	0.000	0.000	0.000	0.000
Gmm = MAX. SPECIFIC GRAVITY (T209)	2.472	2.472	2.472	2.472	2.472	2.472	2.472
% COMPACTION OF CORE = 100 x (Gmc / Gmm)	92.3	0.0	0.0	0.0	0.0	0.0	0.0
THICKNESS							
SUBLOT							

FOR 2ND CORE SUBLOT WHEN DENOTED IN QC PLAN							
TECHNICIAN							
A = Weight of sample in air:							
B = Weight in water:							
C = Weight of surface dry sample:							
Gmc = CORE SPECIFIC GRAVITY = A / (C - B)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Gmm = MAX. SPECIFIC GRAVITY (T209)	2.472	2.472	2.472	2.472	2.472	2.472	2.472
% COMPACTION OF CORE = 100 x (Gmc / Gmm)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
THICKNESS							
SUBLOT							

Binder Portion

TECHNICIAN							
MoDOT TM54 (NUCLEAR)							
SAMPLE WEIGHT							
BACKGROUND							
COUNTS							
GAUGE % AC							
AASHTO T 308 (IGNITION)							
GAUGE %AC	5.35						
NUCLEAR OR IGNITION							
% MOISTURE	0.12						
% AC BY IGNITION OR NUCLEAR	5.2						

Binder content of RAP

RAP & RAS

- Some contractors stockpile RAP & RAS, prepare (grind) it, and sample it.
- Send sample to a commercial lab to have extractions run (T164), obtain binder content & gradation.
- This is what is submitted to MoDOT during mix design.
- During production, RAP is sampled, and ignition oven used to get binder content & gradation.

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Aggregate Gradation

Gradation Samples

- MoDOT allows gradation sample testing to be satisfied by using the residue from the HMA ignition oven sample.
- An aggregate (gradation) correction factor (AGCF) may be necessary to account for the breakdown in rock.
- RAP gradation in the field is determined with ignition oven.

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Aggregate Gradation

RAS Gradation

- Not recommended to use T308 on RAS (too dangerous).
- Fan will suck fines out.
- Use extraction to get gradation or use the standard gradation.

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Aggregate Gradation

RAS Gradation

- Ground to minus 3/8 inch.
- Gradation from solvent extraction, or assumed from table:

Sieve Size	% Passing
3/8"	100
#4	95
#8	85
#16	70
#30	50
#50	45
#100	35
#200	25

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Aggregate Gradation

Mix Gradation Samples

- When determining the ***aggregate (gradation) correction factor*** (AGCF), prepare an aggregate blank (no binder) specimen.
- Do a washed gradation analysis (*AASHTO -T 30 Test for Mechanical Analysis of Extracted Aggregate*) of the blank.
- Do a washed gradation analysis of the burned HMA specimen (T 30): Two replicates.

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When is Aggregate Gradation Correction Factor Required?

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Gradation Samples
Burned and Unburned
Plus #200 Portion

- Determine a difference for each sieve, each replicate, say, for the #4 sieve:

$(\%\text{-}\#4)_{blank}$ - $(\%\text{-}\#4)_{burned\ ,\ replicate\ \#1}$

$(\%\text{-}\#4)_{blank}$ - $(\%\text{-}\#4)_{burned,\ replicate\ \#2}$

- Calculate the average difference for that sieve (#4).
- The difference is called the AGCF for #4 sieve material.

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Gradation Samples
Burned and Unburned
Plus #200 Portion

- If the difference on ***any*** sieve exceeds the allowable (see below), then each sieve must have its own AGCF applied to the result.
- **Allowable differences**:
  - ≥ #8: ± 5.0%
  - ≥ #200 to < #8: ± 3.0%
  - ≤#200 ± 0.5%

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Gradation Samples
Passing the #200 Portion

- If only the #200 sieve exceeds the limit, apply the AGCF only to the #200 sieve

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Example

Enlarged

Adapted From FHWA "Addendum T308"

Sieve	Burned Rep#1	Burned Rep#2	Unburned Blank	Rep#1 Diff	Rep#2 Diff	Avg. Diff= AGCF	Allowable
1"	100.0	100.0	100.0	0.0	0.0	0.0	±5.0
¾"	100.0	100.0	100.0	0.0	0.0	0.0	±5.0
½"	86.5	89.5	89.7	3.2	0.2	1.7	±5.0
3/8"	69.3	72.1	70.4	1.1	-1.7	-0.3	±5.0
#4	52.1	55.6	53.9	1.8	-1.7	0.1	±5.0
#8	38.5	42.3	41.0	2.5	-1.3	0.6	±3.0
#30	32.7	37.0	34.4	1.7	-2.6	-0.5	±3.0
#40	16.1	17.9	18.3	2.2	0.4	1.3	±3.0
#50	12.6	13.4	14.5	1.9	1.1	1.5	±3.0
#200	6.8	7.4	7.1	0.3	-0.3	0.0	±0.5

For #4 sieve:

Rep#1: 53.9-52.1 = 1.8

Rep#2: 53.9-55.6 = -1.7

Avg diff = [1.8 + (-1.7)] /2 = 0.05 = 0.1 (rounded)

Compare to ±5.0: 0.1 < 5.0 OK

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Common Testing Errors
of
Non-Comparison/Early Shut-off

- Starting test when oven is cold: incomplete burn; can affect TCF.
- Neglecting to push "Start" (binder burns but is not recorded).
- Not cleaning oven & vents often enough.
  - Tip: Perform "Lift" test regularly to verify clean oven.
- Using vent pipe less than 4 in, diameter.

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- Asphalt correction factor (C_F) not used.
- Not cleaning baskets.
- Allowing scale plate or support tubes to rub.
- Not spreading specimen out.
- Not tearing off ticket before opening oven door.
- Allowing door to not latch correctly.
- Not correcting for moisture (e.g., when plant speed increases, etc.).

Common Testing Errors

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Example

Adapted from FHWA "Addendum T308"

Sieve	Burned Rep#1	Burned Rep#2	Unburned Blank	Rep# 1 Diff	Rep# 2 Diff	Avg Diff= AGCF	Allowable
1"	100.0	100.0	100.0	0.0	0.0	0.0	±5.0
¾"	100.0	100.0	100.0	0.0	0.0	0.0	±5.0
½"	86.5	89.5	89.7	3.2	0.2	1.7	±5.0
3/8"	69.3	72.1	70.4	1.1	-1.7	-0.3	±5.0
#4	52.1	55.6	53.9	1.8	-1.7	0.1	±5.0
#8	38.5	42.3	41.0	2.5	-1.3	0.6	±3.0
#30	32.7	37.0	34.4	1.7	-2.6	-0.5	±3.0
#40	16.1	17.9	18.3	2.2	0.4	1.3	±3.0
#50	12.6	13.4	14.5	1.9	1.1	1.5	±3.0
#200	6.8	7.4	7.1	0.3	-0.3	0.0	±0.5

For #4 sieve:

Rep#1: 53.9-52.1 = 1.8

Rep#2: 53.9-55.6 = -1.7

Avg diff = [1.8 + (-1.7)] /2 = 0.05 = 0.1 (rounded)

Compare to ±5.0: 0.1 < 5.0 OK

- Using an oversize specimen.
- Not using the same size specimen for asphalt correction factor (C_F) determination and all production tests.
- Using a plant-made specimen instead of a lab-made specimen for (C_F) determination.
- Not double-checking specimen weight on oven scale against exterior scale weight.

Common Testing Errors

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- Materials used for (C_F) determination not the same as project materials.
- Inaccurate asphalt contents used for (C_F) determination.
- QA & QC starting with different temperature specimens.
- Door left open too long between loadings.
- Wrong chamber set point.
- Wrong burn profile.
- Weighing on bench balance when specimen is hot.

Common Testing Errors

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Operation Problems

- Oven won't shut itself off—it's OK to manually shut off as long as **3** consecutive readings show less than 0.01% loss, and the sample appears to be completely burned (EPG 403.1.5).

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Premature Burn Stop

- Vibrations
- Basket or strap up against wall or top of chamber.
- Clogged port
- Used U.S. date, not European date (1998-2000 NCAT models).

More information on Binder Ignition in the Appendix item #5.

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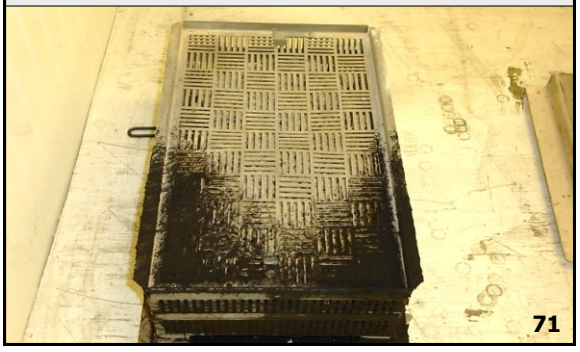
Incomplete Burn Pattern: Shingle Mix



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Soot

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Coke

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AASHTO T 308: Asphalt Content by Ignition; Method A

Trial#	1	2	R
Pre-Production Oven Parameters Checklist: (Demonstrate oven setup)			
Input required parameters for routine production of a particular mix:			
1. Enter TEMP setpoint [chamber temperature]			
2. Enter CALIB. FACTOR [binder (aggregate) correction factor]			
Routine Production Ignition Oven Procedure: (Demonstrate test procedure with proctor instruction)			
3. Obtain weight of empty basket assembly			
4. Place ~½ of hotmix sample in each basket; move mix ~¾" away from sides; re-assemble basket. Cool to room temperature.			
5. Obtain total weight of sample plus basket then calculate initial weight of hotmix sample			
6. Enter initial sample WEIGHT			
7. Zero oven scale (push the number 0)			
8. After putting on safety gloves, face shield, etc., carefully load sample into oven, making sure basket is not touching walls; close door			
9. Check total weight: oven vs. exterior scale: No good if > 5 grams difference: Is it?			
10. Initiates burn-off program by pressing START/STOP			
11. After burn-off stops, remove and examine paper readout			
12. Again, with safety gear on, open oven door, remove basket & place on cooling rack. Cool to room temperature.			
13. Determine and record basket + specimen weight, then calculate and record final specimen weight (for manual calculations and/or verification of %AC).			
14. Obtain Calibrated %AC through calculations (NOTE: in the field, this value will automatically be on the printout tape)			
15. Correct the Calibrated %AC for moisture			
PASS?			
FAIL?			

Proctor_____Date_____

Reviewer_____Date_____

Appendix

Items:

1. Ignition Oven Test Cookbook
2. Equipment Information

ASPHALT CONTENT IGNITION METHOD (AASHTO T 308-18) METHOD A
Asphalt Binder Correction Factor (C_F) Determination
(formerly “aggregate correction factor”)

1. Run a butter mix through the mixing equipment.

2. For a given mix, prepare two asphalt binder correction factor (C_F) specimens at the design asphalt content using oven dry aggregate. It is recommended that the C_F and field verification specimen sizes be the same.

3. Obtain the tare weight of the baskets, pan, and lid.

4. Place the hot mix into the sample basket. If the mix has cooled, oven dry at 110 ± 5°C to constant mass prior to placing in the basket. Spread the mix in the basket, being careful to keep the mix away from the sides. Allow at least ¾” clearance.

5. Test (burn) the specimens as discussed in “Test Procedure.”

6. If the difference between the measured binder contents of the two replicate specimens is more than 0.15%, test two more specimens. Discard the high and low values.

7. Calculate the C_F by determining the difference between the actual and measured asphalt binder contents [Actual %AC – Measured %AC] for each sample, and averaging the two differences. The “Actual %AC” is the amount weighed out in the batching process, expressed as a percent by weight of the mix.

8. If the C_F exceeds 1.0%, MoDOT Standard Specification Section 403.19.3.1.1 modifies AASHTO T 308-18 in the following manner:

   A. According to AASHTO T 308-18, if the C_F exceeds 1.0% at the typical chamber temperature of 538°C (1000°F), lower the chamber temperature to 482 ± 5°C (900 ± 8°F). If the C_F determined at this lower temperature is less than or equal to 1.0%, use that C_F for subsequent testing on that particular mix.

   B. However, according to MoDOT Standard Specification Section 403.19.3.1.1, if the C_F determined at 482 ± 5°C (900 ± 8°F) exceeds 1.0%, lower the chamber temperature to 427 ± 5°C (800 ± 8°F). Use the C_F obtained at 427°C even if it exceeds 1.0%.

ASPHALT CONTENT IGNITION METHOD
(AASHTO T 308-18)
METHOD A

Asphalt Binder Correction Factor (C_F) Determination

Sample_____Lab No._____Date_____Initials_____

Replicate	1	2	3	4
Test Temperature	538	538		
Tare (basket, etc.) Mass (g)	3000.0	3000.0		
Total Dry Mass (g)	4530.0	4517.1		
Initial Dry Specimen Mass (g)				
Loss in Weight (g)	82.5	81.4		
%AC, measured = M				
%AC, actual = A	5.00	5.04		
$\%AC_{diff}$ ($M_1 - M_2$)		> 0.15%? If so, 2 more replicates		
$C_F = M - A$				
C_F, average				

ASPHALT CONTENT IGNITION METHOD (AASHTO T 308-18) METHOD A

Specimen size: Use the following table. It is recommended that the field verification specimen size be the same as the correction factor specimen size.

NMS (mm)	Sieve Size	Minimum Specimen Size* (g)
4.75	#4	1200
9.5	3/8”	1200
12.5	1/2”	1500
19.0	3/4"	2000
25.0	1”	3000
37.5	1 ½”	4000

*Specimen sizes shall not be more than 500g greater than the minimum.

POSSIBLE SETTING CHANGES

1. To change the Stability Threshold:

   A. With oven off, press the “Calibration Factor” key while simultaneously pressing the Power Switch “on.”

   B. Enter new Stability Threshold value. Observe the Percent Loss window for the new value. Maximum allowable = 0.02.

   C. Press the Power Switch “off” then “on” to return oven to normal operation.

2. To change filter (afterburner) temperature (750°C typically):

   A. Press #5 key while simultaneously pressing the Power Switch “on.”

   B. Enter new temperature.

   C. Press “Enter.”

   D. New setpoint will be displayed.

MAINTENANCE

1. To check to see if the venting system is clogged, use the “Lift Test” procedure while the oven is at room temperature. With the power on, initiate a test (push “Start” button) without anything in the oven chamber. The blower fan will turn on. Watch the balance display. The display should read between -4 and -6 grams if the venting is adequate.

2. Burn accumulated soot out of the chamber by running the testing procedure at an elevated temperature without a sample.

TEST PROCEDURE

1. To change setpoint (furnace) temperature (538°C is typical):

   A. Press “Temp”

   B. Enter new setpoint

   C. Press “Enter”

   D. Press “Temp” again to verify new setpoint

2. To change the Asphalt Binder Correction Factor (C_F):

   A. Press “Calib. Factor”

   B. Enter new C_F

   C. Press “Enter”

   D. Press “Calib. Factor” again to verify

3. Preheat the oven to the setpoint, typically 538°C.

4. If the moisture content will not be determined, oven-dry the specimen at 110 ± 5°C to a constant mass.

5. Weigh the empty basket, etc. on an external scale to the nearest gram.

6. Place half the sample in the bottom basket and the other half in the top. Keep the specimen at least ¾” away from the basket sides. For larger samples, some operators make a hole in the middle of the mix.

7. Cool the loaded assembly to room temperature.

8. Weigh the loaded assembly. Calculate the mass of the specimen.

9. Press the “Weight” key and enter the specimen mass. Press “Enter.”

10. Press the “Weight” key again to verify specimen mass entry.

11. Press the “0” (zero) key to tare the internal balance.

12. Don your clean gloves, safety face shield, and safety attire.

13. Carefully load the specimen into the oven by inserting the basket until the handle tines touch the back of the oven. Make sure the basket is centered and is not touching the walls. Shut the door.

14. Observe the internal scale reading. The displayed value should check with the external scale value of basket assembly + dry specimen within ± 5 grams.

15. Press the “Start/Stop” key to initiate the ignition procedure.

16. When weight loss stabilizes (the change in %AC readings will not exceed 0.01% for three consecutive minutes), the oven will automatically end the test and print out the results. Depending on the oven setup, an alarm may sound and one may have to press the “Start/Stop” key to unlock the door.

17. Remove the printed results before opening the door as the tape is heat-sensitive.

18. Again don the safety gear, open the door, and remove the basket and mount it on the cooling plate. Cover with the cooling cage and allow to cool to room temperature.

19. Determine and record the final mass of the specimen, M_f.

20. From the total % loss, the oven will automatically subtract the C_F and the Temperature Compensation to give the %AC (by weight of mix). The %AC by weight of aggregate is the “Bitumen Ratio.”

21. Check for unburned asphalt (coke). If present, start with a new specimen.

    NOTE: Read the manufacturer’s manual for additional information on safety and more detailed instructions on maintenance and operation.

ASPHALT CONTENT IGNITION METHOD
(AASHTO T 308-18)
METHOD A
Manual Weighing Method

Project No.	Job No.	Route	County
Technician	Date	Sublot No.	Mix No.
Empty Basket Assembly Weight (g), [T_e]			
Initial Basket Assembly + Wet (or dry) Sample Weight (g), [T_i]			
Initial Wet (or dry) Sample Weight (g), [$W_i = T_i - T_e$]			
Final Basket Assembly + Burned Sample Weight (g), [T_f]			
Loss in Weight (g), [$L = T_i - T_f$]			
% Loss, [$P_L = (L / W_i) \times 100$]			
Aggregate Correction (Calibration) Factor (%), [C_f]			
Calibrated %AC, [$P_{bcal} = P_L - C_f$]			
% Moisture Content, [MC]			
% AC, corrected (by weight of mix), [$P_b = P_{bcal} - MC$]			

Ignition Ovens Forms.doc (11-24-06;12-28-06;12-12-08;3-9-10;12-14-10;4-14-11; 12-18-13; 4-22-15;12-9-15; 12-28-16; 12-26-18)

Equipment Information

for

AASHTO T 308

Determining the Asphalt Binder Content of asphalt Mixtures by the Ignition Method

- M 339M/M 339, Thermometers Used in the Testing of Construction Materials

5. APPARATUS

5.1. *Ignition Furnace*—A forced-air ignition furnace that heats the specimens by either the convection or direct IR irradiation method. The convection-type furnace must be capable of maintaining a temperature of 538 ± 5°C (1000 ± 9°F). The furnace chamber dimensions shall be adequate to accommodate a specimen size of 3500 g. The furnace door shall be equipped so that the door cannot be opened during the ignition test. A method for reducing furnace emissions shall be provided. The furnace shall be vented into a hood or to the outside and, when set up properly, shall have no noticeable odors escaping into the laboratory. The furnace shall have a fan capable of pulling air through the furnace to expedite the test and reduce the escape of smoke into the laboratory. The ignition furnace shall be capable of operation at the temperatures required, between at least 530 and 545°C (986 and 1013°F), and have a temperature control accurate within ±5°C (±9°F) as corrected, if necessary, by standardization. More than one furnace may be used, provided each is used within its proper operating temperature range. When measuring temperature during use, the thermometer for measuring the temperature of materials shall meet the

requirements of M 339M/M 339 with a temperature range of at least 530 to 545°C (986 to 1013°F) and an accuracy of ±1.25°C (±2.25°F) (Note 1).

Note 1—Thermometer types suitable for use include ASTM E1 mercury thermometers; ASTM E230/E230M thermocouple thermometer, Type J or K, Special Class; or IEC 60584 thermocouple thermometer, Type J or K, Class 1.

5.1.1. For Method A, the furnace shall also have an internal balance thermally isolated from the furnace chamber and accurate to 0.1 g. The balance shall be capable of weighing a 3500-g specimen in addition to the specimen baskets. A data collection system will be included so that the mass can be automatically determined and displayed during the test. The furnace shall have a built-in computer program to calculate the change in mass of the specimen baskets and provide for the input of a correction factor for aggregate loss. The furnace shall provide a printed ticket with the initial specimen mass, specimen mass loss, temperature compensation, correction factor, corrected asphalt binder content (percent), test time, and test temperature. The furnace shall provide an audible alarm and indicator light when the specimen mass loss does not exceed 0.01 percent of the total specimen mass for 3 consecutive min. The furnace shall also allow the operator to change the ending mass loss percentage to 0.02 percent.

5.2. *Specimen Basket Assembly*—Consisting of specimen basket(s), catch pan, and an assembly guard to secure the specimen basket(s) to the catch pan.

5.2.1. *Specimen Basket(s)*—Of appropriate size to allow the specimens to be thinly spread and allow air to flow through and around the specimen particles. Sets with two or more baskets shall be nested. The specimen shall be completely enclosed with screen mesh, perforated stainless steel plate, or other suitable material.

Note 2—Screen mesh or other suitable material with maximum and minimum openings of 2.36 mm (No. 8) and 0.600 mm (No. 30), respectively, has been found to perform well.

5.2.2. *Catch Pan*—Of sufficient size to hold the specimen basket(s) so that aggregate particles and melting asphalt binder falling through the screen are caught.

5.3. *Oven*—Capable of maintaining 110 ± 5°C (230 ± 9°F). The oven(s) for heating shall be capable of operation at the temperatures required, between 100 and 120°C (212 and 248°F), within ±5°C (±9°F) as corrected, if necessary, by standardization. More than one oven may be used, provided each is used within its proper operating temperature range. The thermometer for measuring the oven temperature shall meet the requirements of M 339M/M 339 with a temperature range of at least 90 to 130°C (194 to 266°F) and an accuracy of ±1.25°C (±2.25°F) (Note 3).

Note 3—Thermometer types suitable for use include ASTM E1 mercury thermometers; ASTM E2877 digital metal stem thermometer; ASTM E230/E230M thermocouple thermometer, Type J or K, Special Class, Type T any Class; IEC 60584 thermocouple thermometer, Type J or K, Class 1, Type T any Class; or dial gauge metal stem (bi-metal) thermometer.

5.4. *Balance*—Of sufficient capacity and conforming to the requirements of M 231, Class G 2.

5.5. *Safety Equipment*—Safety glasses or face shield, dust mask, high-temperature gloves, long-sleeved jacket, a heat-resistant surface capable of withstanding 650°C (1202°F), and a protective cage capable of surrounding the specimen baskets during the cooling period.

5.6. *Miscellaneous Equipment*—A pan larger than the specimen basket(s) for transferring the specimen after ignition, spatulas, bowls, and wire brushes.