Standard Method of Test for

Determination of Asphalt Binder Content of Asphalt Mixtures using the Ignition Oven

SCDOT Designation: SC-T 75 (rev. 06/2021)

1. SCOPE

This method covers the determination of asphalt binder content of asphalt mixtures using an ignition oven.

Safety Notice: This procedure involves temperatures in the range of 1200°F and will require the technician to wear appropriate safety protection during the testing. Some steps in the procedure, which are known to involve high temperatures, are highlighted with a notice concerning the use of proper safety equipment. The absence of a warning does not necessarily mean that all material and equipment is safe to handle. The technician should use caution during each step of the procedure.

2. REFERENCED DOCUMENTS

2.1 AASHTO Standards:

- M 231

2.2 SC Test Methods:

- SC-T 62
- SC-T 72
- SC-T 93
- SC-T 102

3. SUMMARY OF TEST METHOD

3.1 The asphalt binder is burned in a furnace in accordance with this procedure. The asphalt binder content is calculated as the difference between the initial and ending weights, with a correction factor for the mixture and temperature. The final asphalt binder content is expressed as a percentage of mass loss.

4. SIGNIFICANCE AND USE

4.1 The purpose of this procedure is to accurately determine the asphalt binder content from asphalt mixtures.

5. APPARATUS

5.1 A forced air ignition furnace, capable of maintaining 1200°F, with an internal balance or load cell thermally isolated from the furnace chamber and accurate to 0.1 g. The balance shall be capable of weighing a 3500 g sample in addition to the sample baskets. If needed, the furnace shall calculate a temperature compensation factor for the change in weight of the sample baskets (**See note*). The furnace shall provide a printed ticket with the initial specimen weight, specimen weight loss at one minute intervals, temperature compensation (if needed), aggregate correction factor, correct asphalt binder content (%), test time and test temperature. The furnace chamber must have an internal volume of at least 0.85 ft^3, and provide a method for reducing furnace emissions. The furnace shall provide an audible alarm, an indicator light and an automatic shut-off device when the sample weight loss does not

exceed 0.01% of the total mass of the sample for three consecutive minutes. The furnace door shall be locked until the completion of the test procedure.

* Note: Not all ovens will require the use of a temperature compensation factor. Check with the oven manufacturer to determine if this factor is necessary.

5.2 Two or three tempered stainless steel No. 8 (2.36 mm) mesh or otherwise perforated baskets, dimensioned to properly fit inside the oven. The baskets shall be nested and shall be provided with screening on the legs to confine the aggregate.

5.3 One stainless steel catch pan with dimensions slightly wider and longer than the stainless steel baskets and approximately 1 inch in height.

5.4 Oven capable of maintaining 257 $\pm$ 9°F, with an inside volume of at least 2.5 ft^3.

5.5 Balance, 8 kg or greater capacity, sensitive to 0.5 g for weighing sample in baskets, meeting the requirements of AASHTO M 231.

5.6 Miscellaneous Equipment: Pan dimensions 15 x 15 x 2 in. minimum for transferring samples after ignition, spatulas, bowls and wire brushes.

5.7 Safety equipment: Safety glasses, face shield, high temperature gloves, long sleeve jacket or apron. Additionally, a heat resistant surface capable of withstanding 1200°F and a protective cage capable of surrounding the sample baskets.

6. TEST SPECIMEN

6.1 The sample shall be the end result of quartering a larger sample taken in accordance with SC-T 62, and must be within the range of the sample size listed in Table 1 below. The sample will be properly quartered to the required testing size following SC-T 72 or SC-T 93. Samples prepared by the contractor and placed in sample boxes will be tested using the whole sample. Any sample that does not meet the sample requirements in the table below will be noted on the sample test report. Boxed samples may be preheated at 257 +/- 9 °F to remove any potential moisture and assist with sample removal.

Nominal Maximum Aggregate Size (see job mix formula)	Sample Size, g
No. 4	1200 – 1600
3/8 in.	1200 – 1600
1/2 in.	1500 – 1900
3/4 in.	2000 – 2400
1.0 in.	3000 - 3400

Table 1 – Size of sample

6.2 If the mixture is not sufficiently soft to separate with a spatula or trowel, place it in a heating oven on a flat pan if necessary and warm it to 257 $\pm$ 9°F for at least 25 minutes.

6.3 A specimen for moisture determination may be made as deemed necessary. This specimen may not be used for asphalt binder content determination.

7. PROCEDURE

7.1 Mixture Correction Factor - General*:* Before testing is performed on a production asphalt mixture, a mixture correction factor must be determined. The use of aggregate-only correction will not be permitted.

7.1.1 This ignition oven procedure may be affected by the type of aggregate in the mixture. Therefore, to optimize accuracy, a correction factor will be established by testing at least three samples at optimum binder content for each mix. This procedure must be completed before any acceptance testing is performed.

7.1.2 Correction factor specimens conforming to the size requirements of Table 1 shall be prepared by an SCDOT Asphalt Level II technician at the optimum design asphalt binder content. All aggregates used for correction factor samples must be batched properly using aggregate proportioning by correct size and weight. A butter mix shall be prepared at the design asphalt binder content, mixed and discarded prior to mixing any of the correction factor specimens. Aggregate, RAP, RAS, hydrated lime, liquid anti stripping, and asphalt binder used for the correction factor specimens shall be representative of the material used in the mix. This may require the use of various materials sampled from current stockpiles located at the plant for which the mix is, or will be, produced.

7.1.3 Reset the ignition furnace to 1000 ± 18°F**. Record the furnace temperature prior to the initiation of the test (set point).

**Note: The temperature listed above is to be used on most mixes; however, some mixes may have more aggregate breakdown at this high temperature than others. If it is determined during testing that the mix is breaking down excessively, a lower ignition temperature may be used. If a lower temperature is used for correction then this temperature shall be recorded and used on future acceptance tests involving that mix. Using a lower temperature will cause the time for complete burning to increase.

7.1.4 Weigh and record the weight of the sample baskets and batch pan (with guards in place) as W_b.

7.1.5 Place the first freshly mixed specimen directly into the sample baskets. If the specimen was allowed to cool, preheat it in an oven at 257 ± 9°F until the sample is soft enough to quarter to testing size. Samples should not be heated more than 4 hours (reheated bag samples). It is not necessary to preheat the sample baskets.

7.1.6 Place the sample baskets into the catch pan. Evenly distribute the correction factor specimen in the baskets taking care to keep the material away from the edges of the baskets. Evenly distribute the specimen in the baskets using a spatula or trowel to level the specimen. Weigh and record the total weight of the sample, baskets, catch pan and basket guards (W_T). Calculate (Eqn. 1) and record the initial weight of the sample specimen (W_i).

$W_i = W_T - W_b$ .....Eqn. (1)

7.1.7 Input the initial weight of the sample specimen (W_i) into the ignition furnace controller. Verify the correct weight has been entered.

7.1.8 Enter the correction factor of *0.0* in the ignition furnace.

7.1.9 **For this next step, appropriate safety gear should be worn.** Open the chamber door and place the sample baskets in the furnace. Be careful not to slide the basket on the floor of the furnace. ***Close the chamber door and verify that the total sample weight displayed on the furnace scale or load cell equals the total weight recorded as W_T (Eqn. 1), within $\pm$ 5 g. A difference greater than 5 g or failure of the furnace scale to stabilize may indicate that the sample baskets are contacting the furnace wall.***

Initiate the test by pressing the start/stop button. At this point the chamber door will lock and will not open until the test is complete. The printer will begin recording the test results. Allow the test to continue until the stable light, audible stable indicator and the automatic shut off indicates the test is complete (three consecutive readings within 0.01%). The final weight of the sample will be denoted W_f.

7.1.10 **Wearing protective gear**, open the chamber door and remove the sample baskets using the proper tool and place on a temperature resistant block. Cover the baskets with a protective cage and allow to cool to room temperature (approx. 30 minutes).

7.1.11 **Repeat steps 7.1.4 – 7.1.10 for each of the remaining two correction factor specimens.**

7.1.12 Once all of the correction factor specimens have been burned, determine the difference ($\%AC_{DIFF}$) between the actual ($\%AC_{ACT}$) and measured ($\%AC_{MEAS}$) asphalt binder contents for each sample (Eqn. 2).

$$\%AC_{DIFF} = \%AC_{ACT} - \%AC_{MEAS} \quad \text{.....Eqn. (2)}$$

7.1.13 The mix correction factor (C_F) is the average of the measured differences of the three samples (Eqn. 3).

$$C_F = [\%AC_{DIFF}\,(\text{optimum}) + \%AC_{DIFF}\,(\text{optimum}) + \%AC_{DIFF}\,(\text{optimum})]/3 \quad \text{.....Eqn. (3)}$$

Note: The correction factor (C_F) is the number (either + or -) that will bring the tested asphalt binder content back to the original amount entered.

7.1.14 Determine if the individual correction factors are within acceptable tolerances (Table 2).

Allowable Difference	Re-run Sample?
$C_F - AC_{DIFF(\text{for all 3 individual samples})} \leq 0.10$	No
$C_F - AC_{DIFF(1\text{-}3)} > 0.10$	Yes

Table 2 - Correction factor Allowable Difference

7.1.15 If the calculated allowable difference ($C_F - AC_{DIFF}$) exceeds the allowable tolerance, two additional correction factor samples must be tested. To calculate the correction factor, use the average of correction factors after dropping the highest and lowest difference from the $\%AC_{ACT}$ and average the remaining (3) samples for the correction factor. If samples still do not fall within allowable tolerance, the QC Manager must immediately investigate.

7.2 Verification and Update of Correction Factor - All mix corrections must be kept in an organized manner for review as needed by the SCDOT. The mix correction factor should be checked and updated when any changes are made to the optimum binder content (job mix revision) on a monthly basis if the current correction factor is greater than ±0.20 from optimum asphalt content. Any current mix correction factor equal to or less than ±0.20 from optimum asphalt content may continue to be verified on a monthly

basis, or at the contractor's discretion, be reduced to verifying no more than every 12 months. Anytime a trend of non-comparing split samples is found in the field, the AME may request the contractor to batch check samples, or OMR may send check samples, to investigate the ignition oven accuracy. The following steps indicate how to properly verify and update the mix correction factor:

7.2.1 Prepare a specimen at the optimum asphalt binder content in the same manner in which specimens were prepared in the mixture correction factor. Instead of three correction factor specimens there will only be one at optimum binder content.

7.2.2 Preset the ignition furnace to 1000 $\pm$ 18°F. Record the furnace temperature prior to the ignition of the test (set point). If a lower oven temperature was used for correction factor, record and use that temperature for verification testing as well.

7.2.3 Place the freshly mixed specimen directly into the sample baskets. If the specimen was allowed to cool, preheat it in an oven at 257 $\pm$ 9°F for 25 $\pm$ 5 minutes. Do not preheat the sample baskets.

7.2.4 Enter a correction factor of *0.0* in the ignition furnace. Weigh and record the weight of the sample baskets and catch pan (with guards in place) as W_b.

7.2.5 Follow the same steps as outlined in the mixture correction factor procedure to completely burn the specimen. When the test is complete use the following formula to calculate the % AC difference ($\%AC_{DIFF\ (Verify)}$).

$$\%AC_{DIFF\ (Verify)} = \%AC_{ACT} - \%AC_{MEAS} \quad \text{.....Eqn. (4)}$$

7.2.6 The % AC difference from Eqn. 4 is to be factored into the current correction factor being used for the mix design as a weighted average using the following method:

Add the new % AC difference (from Eqn. 4) to three times (3x) the current correction factor and divide the total by four. See Eqn. 5 for more detail. This becomes the new correction factor to be used for that job mix formula.

$$C_{F\ (New)} = [\%AC_{DIFF\ (Verify)} + (3 * C_{F\ (Current)})\ ] / 4 \quad \text{.....Eqn. (5)}$$

Allowable Difference from Current Correction Factor (C_f - $C_{f\ (New)}$)	Status
≤ 0.03	$C_{F\ (New)}$ is valid
> 0.03	Repeat 7.1 and reestablish new C_F

Table 3- Allowable Difference –Verification

Each time the correction factor is verified, the new correction factor should be averaged into the previous correction factor using Eqn. 5. If $C_{F(New)}$ is less than the allowable difference in figure Table 3, $C_{F\ (New)}$ can be utilized. If the $C_{F(New)}$ is calculated and found to be outside of the allowable difference, a new correction factor must be re-established in accordance to section 7.1.

7.3 Asphalt Binder Content Determination Test Procedure

7.3.1 Allow ignition furnace to preheat to 1000 ± 18°F. Record the furnace temperature (set point) prior to the initiation of the test. If needed, the temperature correction factor will be denoted T_{CF}. If a lower oven temperature was used for correction factor, record and use that temperature for sample testing as well. At room temperature, weigh the sample baskets and catch pan (with guards in place). Record this weight as W_b.

7.3.2 Prepare the sample as described in Section 6, Test Specimen, by heating until sample is soft enough to quarter and reduce to sample size in an oven at 257 ± 9°F. Samples should not be heated more than 4 hours (reheated bag samples). It is not necessary to preheat the sample baskets. Place the sample basket in the catch pan. Evenly distribute the sample in the baskets taking care to keep the material away from the edges of the baskets. Use a spatula or trowel to level the specimen.

7.3.3 Weigh the sample, baskets, catch pan and basket guards and record weight as W_T. Calculate and record the initial weight of the sample specimen (W_i) using Eqn. 1.

7.3.4 Input the initial weight of the sample specimen (W_i) into the ignition furnace controller. Verify that the correct weight has been entered.

7.3.5 **For this next step, appropriate safety gear should be worn.** Open the chamber door and place the sample baskets in the furnace. Close the chamber door and verify that the total sample weight displayed on the furnace scale or load cell equals the total weight recorded in Eqn. 1 as W_T, within ± 5 g. A difference greater than 5 g or failure of the furnace scale to stabilize may indicate that the sample baskets are contacting the furnace wall.

Initiate the test by pressing the start/stop button. At this point the chamber door will lock and will not open until the test is complete. The printer will begin recording the test results. Once the printer has printed the initial sample information, identify on the ticket with the LOT number and Sample number (i.e. 1-1) with a permanent pen. At no time will it be permissible to wait more than 5 min after starting a test to identify the SCDOT acceptance test. Duplicate samples will not permitted to be used for acceptance or verification tests. In the event of an oven malfunction (i.e. - power outage or scale malfunction), the contractor must identify the sample re-burn (send original sample burn ticket) and allow the DAM to determine if the re-burn was necessary, and whether the re-burn sample can be used for acceptance. A split sample must be obtained by the DAM to check the contractor's acceptance result regardless of the total tons on the project if a re-burn is performed. Allow the test to continue until the stable light and audible stable indicator indicates that the test is complete (three consecutive readings within 0.01%). The final weight of the sample will be denoted as W_f.

7.3.6 Wearing protective gear, open the chamber door and remove the sample baskets using the proper tool and place on a temperature resistant block. Cover the baskets with a protective cage and allow to cool to room temperature (approx. 30 minutes). If a gradation analysis is desired, empty the contents of the baskets into a flat pan (be sure all fines are removed) and perform the gradation analysis according to SC-T-102.

8. CALCULATION – ASPHALT BINDER CONTENT

8.1 The ignition oven shall automatically calculate the corrected asphalt binder content of the sample based on Eqn. 6 and Eqn. 7. **Be sure to use the correct sign (+ or -) when using the correction factors.**

$AC_{UNCORRECTED} = [(W_i - W_f)/W_i] * 100\%$.....Eqn. (6)

$\%AC_{CORRECTED} = \%AC_{UNCORRECTED} - C_F - T_{CF}$ .....Eqn. (7) used in NCAT and Newer Troxler Ovens

$\%AC_{CORRECTED} = \%AC_{UNCORRECTED} + C_F - T_{CF}$ .....Eqn. (7) used in Troxler Ovens*

* (old versions prior to 2018)

8.2 Example Calculation

8.2.1 Example Mixture Correction factor (3 Specimens), all weights in grams.

Sample No.		1	2	3
Test Temperature	T (°F)	1000	1000	1000
Known % AC	AC_{ACT}	6.2	6.2	6.2
Wt. Basket	W_b	3326.2	3326.1	3324.3
Wt. Basket + Sample	W_T	4718.7	4719.2	4718.4
Wt. Sample	$W_i = W_T - W_b$	1392.5	1393.1	1394.1
Measured % AC	AC_{MEAS}	6.12	6.15	6.18
Difference	$AC_{DIFF} = AC_{ACT} - AC_{MEAS}$	0.08	0.05	0.02
Correction Factor*	$C_F = [\text{Sum } AC_{DIFF}] /3$	-0.05 (NCAT) or + 0.05 (Troxler)		

* see equation No. 7 above

Table 4- Example Mixture Correction Factor

8.3 Example Test Procedure (Unknown Specimen)

Correction Factor	C_F	-0.05
Test Temperature	T (°F)	1000
Temperature Compensation Factor	T_{CF}	0.22
Wt. Basket	W_b	3325.8
Wt. Basket + Sample	W_T	4716.5
Wt. Sample (Initial)	$W_i = W_T - W_b$	1390.7
Wt. Sample (Final)	W_f	1305.7
Uncorrected % AC	$\% AC_{UNCORRECTED} = [(W_i - W_f)/W_i] * 100\%$	6.11
Corrected % AC	$\% AC_{CORRECTED} = \% AC_{UNCORRECTED} - C_F - T_{CF}^{**}$	5.94

Table 5 - Example test procedure

9. REPORT

9.1 Information to be reported is: corrected asphalt binder content, mix correction factor, temperature compensation factor, total percent loss, sample mass and test temperature. **Attach the original ignition oven ticket showing mass loss at one minute intervals to the report.** Field test calculations are shown on Form 400.03 (Ignition Oven Worksheet) and reported on Form 400.05 (Asphalt Plant Report). Verification data and calculations are shown on worksheet Form 968 (Asphalt Mixture Worksheet), and recorded on Forms MD418-421 (Asphalt Mixture Reports). Mix correction factor and verification data must be reported on Form 400.06 and Form 400.07.