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DETERMINATION OF ASPHALT CONTENT OF BITUMINOUS MIXTURES BY THE IGNITION METHOD

CAUTION: Prior to handling test materials, performing equipment setups, and/or conducting this method, testers are required to read "**SAFETY AND HEALTH**" in Section G of this method. It is the responsibility of the user of this method to consult and use departmental safety and health practices and determine the applicability of regulatory limitations before any testing is performed.

A. SCOPE

This test method provides a procedure to determine the asphalt binder content of bituminous paving mixtures by removing the asphalt binder via pyrolysis. Bituminous mixture samples are placed in a furnace and heated past the autoignition point of the asphalt binder (typically ranging from 420 to 570°C). The asphalt binder is ignited and burned off leaving the aggregate intact.

The type of aggregate in the bituminous paving mixture may affect the results of this test method. Different aggregates may lose mass, to varying degrees, due to the pyrolytic action. Accordingly, a correction factor is determined for each type of bituminous paving mixture.

This test method employs appendices to modify the basic test method for equipment requiring specific manufacturer operational procedures.

B. APPARATUS

Ignition Furnace, having a temperature control capability of $\pm 5^\circ\text{C}$ between the range of 420 and 580°C. The furnace shall accommodate sample sizes of at least 3000 g. The furnace shall have a blower/fan to move air within the ignition chamber in order to expedite the materials testing and to minimize any smoke/emissions that may be discharged into the laboratory during asphalt binder removal. The furnace must also incorporate a means (e.g., an afterburner and/or filter system) to minimize or eliminate emissions during asphalt binder removal.

The ignition furnace shall be either of the following types:

Type 1 – The Type 1 ignition furnace shall have an internal balance (readable to 0.1 g and with a sensitivity of 0.05 g) capable of measuring the combined masses of the catch pan, the sample basket(s), and the sample. The furnace shall have a data collection/processing system that permits the input of factory calibration data and an asphalt content correction factor, determines and displays the mass loss during the test, detects the end point (i.e., when the mass loss during a 3 min ignition interval does not exceed 0.01% of the initial mass of the sample), and employs an audible alarm and visual display system and/or indicator lights. The furnace shall also provide a printout (or ticket) with the elapsed time, temperature, initial sample mass, sample mass loss, correction factor, corrected asphalt content, and factory temperature compensation.

Type 2 – The Type 2 ignition furnace has no internal balance or end point detection equipment. The duration of the ignition cycle must be established by manually measuring the sample's mass outside of the furnace to determine when a constant mass has been achieved.

Balance or scale, capable of measuring the combined masses of the catch pan, the sample basket(s), and the sample (capacity of 6000 g, minimum), readable to 0.1 g, and with a sensitivity of 0.05 g.

Temperature Probe, suitable for measuring sample temperatures within the sample basket(s).

Sample Basket(s), of a size that allows the sample to be spread in relatively thin layers, and that allows air to flow through and around the sample's particles. The sample basket(s) shall be stackable and completely enclose the sample.

NOTE 1: Perforated steel sheets, 40% of which consists of 3.175 ±0.175 mm holes, or 6 mm expanded metal mesh, can be used.

Catch Pan, of sufficient size to hold the sample basket(s) and retain aggregate particles that fall through the sample basket(s) openings during the material testing.

Handling Apparatus, suitable for inserting and removing the catch pan and sample basket(s).

Assorted spatulas, pans, bowls and wire brushes.

Protective Gloves, well insulated and capable of withstanding 590°C.

Protective Cage, for isolating the catch pan and sample basket(s) during the cooling period.

Face Shield, to provide protection from heat, smoke/emissions, etc.

Oven, for drying at 110°C and/or preheating ingredients, etc. at 110°C to 165°C prior to batching or testing.

Mixing Apparatus, Hobart Model A 200 or equal and a mixing bowl (11 L ±), or Caltrans 3-Unit or 5-Unit Mixer with mixing pots.

NOTE 2: Standard Hobart mixing paddles will have to be modified using flexible spring steel for bowl contact edges to prevent paddle breakage. Stainless steel paddles are also acceptable and available.

C. CORRECTION FACTOR

1. In accordance with CT 125, obtain samples of the aggregate, additives (if any), and the asphalt cement that will be used on the project. Dry (if necessary) and then sieve the aggregate per CT 201 prior to batching for this test method.

NOTE 3: All samples prepared for the determination of a correction factor shall be tested using the same batched aggregate mass (2200 g with no more than +10 g allowed to compensate for moisture loss), and shall have the same gradation (batched, per CT 304, to the target values

of the mix design and including additives), and asphalt cement binder as that to be used on the project. The correction factor determined by this test method shall be used only with the furnace and with the mix design used to establish the factor. If the mix design and/or the equipment are changed, then a new correction factor shall be determined.

2. Record the mix design (including additives and the type of asphalt cement) to be used for the project. Split and batch enough aggregate for ten samples (keep in mind that up to 14 samples may be required per mix design). Save one of the batched aggregate samples for gradation analysis comparisons. Dry the remaining aggregate samples to a constant mass at a temperature of no more than 165°C. Aggregate samples may be oven dried to a constant mass at 110 ±5°C until there is less than a 0.1% difference in the mass measured for a 60 min interval of drying time (refer to CT 226).
3. Heat the batched aggregate samples, additives, and asphalt cement to the appropriate mixing temperature for the mix design's asphalt binder (refer to CT 304). Heat all mixing bowls and tools to the appropriate mixing temperature for the mix design's asphalt binder.

NOTE 4: Prior to mixing the samples, prepare an initial (or "butter") mix to condition the mixing equipment. The "butter" mix shall be the same as the mix design to be tested. The use of the "butter" mix minimizes any bias contributed by residual mix retained in the mixing bowl. Remove this mix from the bowl by scraping, as though it was a sample, leaving a coating of mix residue. Discard the material that is removed. Synchronization of the sample mixing, mass measurement at the cooling temperature (see Section C, Step 10 and Note 6, or Section C, Step 17), and ignition oven and equipment usage is highly recommended.

4. Prepare two samples at the design asphalt binder content. Measure and record the mass of dry aggregate used in each sample as M_{agg} . Measure and record the mass of the asphalt binder used in each sample as M_{ab} . Record the known asphalt binder content for each sample, in percent of dry aggregate, as AC_{known} .
5. Measure the mass of the sample basket(s) and catch pan. Record this mass as M_c .

6. Evenly distribute one sample in the sample basket(s), in as relatively thin a layer(s) as possible. Whenever possible, take care to keep the material away from the edges of the basket(s), noting that 25 mm is the recommended spacing (keep in mind that not all sample baskets will be large enough for this spacing recommendation, and the material may be placed against the sides of the basket(s)). Whenever multiple stacked baskets are used, also take care to distribute the sample as evenly as possible amongst the sample baskets. Place the other sample in a 110°C oven until ready to test per Section C, Step 19. Do not keep the second sample in the 110°C oven for more than 60 min (synchronize equipment usage).
7. Measure the total mass of the sample, sample basket(s), and catch pan. Record this initial mass as M_1 . Record the temperature of the bituminous mixture. This mass shall be measured when the sample cools down to the selected cooling temperature, either 110°C or room temperature, as noted in Section C, Step 10 and Note 6, or Section C, Step 17 of this test method.
8. Set the furnace temperature at 538°C (the set point). If it is adjustable, the afterburner temperature should be set per the furnace manufacturer's recommendations for the type of bituminous mixture being tested.

NOTE 5: The furnace chamber temperature will increase during the ignition phase of the test.

For Type 1 furnaces, skip Steps 9 through 14 and proceed with step 15.

9. Perform the sample "burn" in the furnace for 25 min. Monitor and record temperature with time, taking note of the time when the temperature drops back down to the set point (538°C). If the temperature has not returned to the set point at the end of the initial 25 min, continue heating for 5 min increments until the temperature drops to the set point. Monitor and record the 5 min increments versus temperature. This incremental time record is required in other parts of this test method.
10. Remove the sample, sample basket(s), and catch pan from the furnace. Place them in the protective cage, and allow them to cool to either 110 ±5°C or approximately room temperature.

The recommended alternative cooling temperature of 110 ±5°C may be selected to expedite testing and minimize moisture absorption from the air. If 110 ±5°C is selected, insulation must be provided to reduce heat transfer to the balance or scale (i.e., for prevention of balance or scale damage).

NOTE 6: The cooling temperature selected for this step shall be used for all testing that incorporates the correction factor determined by this procedure.

11. Measure and record the mass (M) of the sample, sample basket(s), and catch pan after ignition. Then, place them back into the furnace and let the furnace return to the set point. Then heat the sample for another 10 min.
12. Remove the sample, sample basket(s), and catch pan from the furnace. Place them in the protective cage, and allow them to cool to the selected cooling temperature. Again, measure and record the mass (M) of the sample and catch pan.
13. Repeat steps 11 and 12 until the change in measured mass (M) of the sample, sample basket(s), and catch pan does not exceed 0.01% of the initial mass (M_1).
14. Record the last value obtained as the mass (M_2) of the sample, sample basket(s), and catch pan after ignition. Measure M_2 at the same temperature as M_1 ± 3°C. Also, record the total ignition time (as found in Step 9, and Steps 11 through 13) required to obtain M_2 and the incremental time (as found in Step 9) to return to the set point temperature (538°C).

For Type 2 furnaces, skip Steps 15 through 17 and proceed with Step 18.

15. After placing the sample, sample basket(s), and catch pan in the furnace, close the door and verify that the mass of the sample, sample basket(s), and catch pan indicated by the internal balance is within ±5 g of the mass recorded in Section C, Step 7.

NOTE 7: For some furnaces, this mass must be entered by the technician based on an external measurement. Differences of more than 5 g or failure of the balance to stabilize may indicate that the sample basket(s) and catch pan are in contact with the furnace wall. If necessary, reposition the sample basket(s) and catch pan in the furnace.

16. Perform the sample "burn" in the ignition oven. When the change in mass of the sample over a 3 min interval does not exceed 0.01% of the initial mass (M_1), remove the sample, sample basket(s), and catch pan from the oven. Place them in the protective cage, and allow them to cool to approximately 110°C or room temperature.
17. Record the mass (M_2) of the sample, sample basket(s), and catch pan after the ignition process. Also, record the total ignition time to obtain M_2 . This mass and time can be obtained upon completion of the ignition process from the printout or display. The mass can also be obtained (and should be verified) at the cooling temperature used to measure M_1 , either 110 ±5°C or room temperature, on the external scale. For either mass measurement or verification, the 110°C cooling temperature is recommended to prevent sample moisture absorption (use an insulating material on the scale to prevent scale damage).
18. Calculate the measured percent asphalt binder as follows:

$$A = \frac{M_1 - M_2}{M_2 - M_e} \times 100$$

Where:

- A = measured percent asphalt binder by mass of dry aggregate,
- M_1 = total mass of the sample, sample basket(s), and catch pan prior to ignition, as determined in Section C, Step 7,
- M_2 = total mass of the sample, sample basket(s), and catch pan after ignition, as determined in Section C, Step 14 or Step 17, and
- M_e = total mass of the sample basket(s) and catch pan as determined in Section C, Step 5.
19. Repeat Steps 5 through 18 for the second sample prepared at the known asphalt binder content.

NOTE 8: If the difference (higher value – lower value) between $A_{(1)}$ and $A_{(2)}$ is less than or equal to 0.15, then compute the correction factor as an average of the two test results as determined by Section C, Step 20. If the difference (higher value – lower value) between $A_{(1)}$ and $A_{(2)}$ exceeds 0.15, repeat the two tests. Discard the high and low numbers from the four test results. Then, compute the correction factor as an average of the remaining two test results as determined by Section C, Step 20. If the calculated correction factor exceeds 0.5, lower the furnace set point to 482°C and repeat the test procedure. If the calculated correction factor continues to exceed 0.5, lower the furnace set point to 427°C and repeat the test procedure. Do not lower the temperature set point more than two times. Use the correction factor from the last temperature set point tested. The temperature set point used to test bituminous mix field samples per Section D, "Test Procedure," must be the same temperature set point used to establish the correction factor.

20. Calculate the correction factor as follows:

$$CF = \frac{[A_{(1)} - AC_{known(1)}] + [A_{(2)} - AC_{known(2)}]}{2}$$

Where:

CF = the correction factor as percent asphalt binder, and

AC_{known} = known percent asphalt binder added to each laboratory prepared sample (by dry mass of aggregate).

Use the correction factor (CF) determined from this step to adjust the measured asphalt binder content obtained in Section D, "Test Procedure."

D. TEST PROCEDURE

1. In accordance with CT 125, obtain and split a bituminous mixture field sample from the project. The field sample size shall be 4000 to 4800 g (split the sample into 2200 ±200 g for CT 382, and 2200 ±200 g for CT 370).
2. When performing this test procedure in the field (i.e., for mobile laboratory usage), determine the moisture content of the bituminous mixture field samples according to CT 370 so that the measured mass loss can be corrected for moisture content. When

performing this test procedure under fixed laboratory locations and under non-time critical operations, the field samples may be oven dried to a constant mass at $110 \pm 5^\circ\text{C}$ until there is less than a 0.1% difference in the mass measured for a 60 min interval of drying time (refer to CT 226). No mass loss corrections for moisture content are necessary for samples oven dried to a constant mass. The oven drying technique should be used whenever there has been more than a 15 min difference between sampling and testing, and/or when a sealed container has not been used to transport the field sample to the laboratory.

3. Determine the mass of the sample basket(s) and catch pan. Record this mass as M_e .
4. Evenly distribute the 2200 ± 200 g sample in the sample basket(s), and in as relatively thin a layer(s) as possible. Whenever possible, take care to keep the material away from the edges of the basket(s), noting that 25 mm is the recommended spacing (keep in mind that not all sample baskets will be large enough for this spacing recommendation, and the material may be placed against the sides of the basket(s)). Whenever multiple stacked baskets are used, also take care to distribute the sample as evenly as possible amongst the sample baskets.
5. Measure the mass of the sample, sample basket(s), and catch pan. Record this initial mass as M_{initial} . Record the temperature of the bituminous mixture. This mass shall be measured when the sample cools down to the selected cooling temperature, either $110 \pm 5^\circ\text{C}$ or room temperature, as noted in Section C, Step 10 and Note 6, or Section C, Step 17 of this test method.
6. Set the furnace temperature set point at 538°C , or the appropriate lower temperature set point as established during the determination of the correction factor. If it is adjustable, the afterburner temperature should be set per the furnace manufacturer's recommendations for the type of bituminous mixture being tested.

NOTE 9: The furnace chamber temperature will increase during the ignition phase of the test.

For Type 1 furnaces, skip Steps 7 through 13 and proceed with Step 14.

7. Perform the sample "burn" in the furnace for the ignition time as recorded in Section C, Step 14.

Additionally, if the furnace controller permits, program the furnace to heat for the time to return to the set point (the actual end of the test) as recorded in Section C, Step 14. This total time should be equal to the total ignition time plus the incremental time as recorded in Section C, Step 14.

8. Remove the sample, sample basket(s), and catch pan from the furnace, place them in the protective cage and allow them to cool to the temperature selected in Section C, Step 10.
9. Measure and record the mass (M) of the sample, sample basket(s), and catch pan after ignition.
10. Place the sample, sample basket(s), and catch pan back into the furnace and let the furnace return to the temperature set point. Heat the sample for an additional 3 min.
11. Remove the sample, sample basket(s), and catch pan from the furnace, place them in the protective cage and allow them to cool to the temperature selected in Section C, Step 10. Measure and record the mass (M) of the sample, sample basket(s), and catch pan.
12. Repeat Steps 10 and 11 until the change in mass of the sample, sample basket(s), and catch pan during a 3 min period does not exceed 0.01% of the initial mass (M_{initial}).
13. Record the last value obtained as the mass (M_2) of the sample, sample basket(s), and catch pan after ignition. Measure M_2 at the same temperature as $M_{\text{initial}} \pm 3^\circ\text{C}$. If the total ignition time to obtain M_2 exceeds the total ignition time recorded in Section C, Step 14, by 10 min or more, a new correction factor is required and Section C of this test method is to be performed again.

For Type 2 furnaces, skip Steps 14 through 16 and proceed with Step 17.

14. After placing the sample, sample basket(s), and catch pan in the furnace, close the door and verify that the mass of the sample, sample basket(s), and catch pan indicated by the internal balance is within ± 5 g of the initial mass recorded in Section D, Step 5.

NOTE 10: For some furnaces, this initial mass must be entered by the technician based on the external measurement (Section D, Step 5). Differences of more

than 5 g, or failure of the balance to stabilize, may indicate that the sample basket(s) and catch pan are in contact with the furnace wall. If necessary, reposition the sample basket(s) and catch pan in the furnace.

15. Perform the sample "burn" in the ignition oven until the change in mass of the sample over a 3 min interval does not exceed 0.01% of the initial mass (M_{initial}).

16. Record the mass (M_2) of the sample, sample basket(s), and catch pan after ignition. This mass can be obtained upon completion of the ignition process from the printout or display. Alternatively, or if a verification is desired, M_2 can be measured at the same temperature as $M_{\text{initial}} \pm 3^\circ\text{C}$ on the external scale. Record the total ignition time (from the printout or the display) to obtain M_2 . If this total ignition time to obtain M_2 exceeds the total ignition time recorded in Section C, Step 17, by 10 min or more, a new correction factor is required and Section C of this test method is to be performed again.

17. Determine the corrected asphalt binder content as follows:

$$AC = \left[\frac{M_1 - M_2}{M_2 - M_e} \times 100 \right] - CF$$

Where:

AC = corrected percent asphalt binder content, by mass of dry aggregate,

M_{initial} = total initial mass of the sample, sample basket(s), and catch pan as determined by Section D, Step 5,

M_1 = total mass of the sample (adjusted for moisture content), sample basket(s), and catch pan prior to ignition, calculated as follows:

$M_1 = M_{\text{initial}}$ for oven dried samples, or

$$M_1 = \frac{M_{\text{initial}} - M_e}{1 + (H_2O/100)} + M_e$$

M_2 = total mass of the sample, sample basket(s), and catch pan after

ignition as determined in Section D, Step 13 or Step 16,

M_e = total mass of the sample basket(s) and catch pan as determined in Section D, Step 3,

CF = correction factor per Section C, Step 20, and

H_2O = moisture, percent of mix, per Section D, Step 2.

E. REPORT

1. The report (see Figure 1) shall include the following:

- (a) Date,
- (b) Identification of aggregate, additives (if any), asphalt binder, and mix type,
- (c) Sample location, project identification, and Resident Engineer,
- (d) Test number,
- (e) Furnace Type (1 or 2), make, model, and serial number,
- (f) Correction Factor determination data,
- (g) Ignition time and incremental time,
- (h) Mass of sample before and after ignition,
- (i) Moisture content of bituminous mixture (when required), and
- (j) Corrected percent asphalt binder content.

F. PRECISION AND BIAS

Data to establish the following precision statements were obtained from a round robin study on carefully batched samples of dense graded asphalt concrete. This was reported by the National Center for Asphalt Technology in 1995.

Analyses of these data for within laboratory and between laboratory precision provided the following:

	<u>Asphalt Content, %</u>	
	<u>Standard Deviation (S)</u>	<u>Acceptable Range of Two Results (D2S)</u>
Within laboratory	0.04	0.11
Between laboratories	0.06	0.17

The data consisted of measurements using a Type 1 oven and individual batched samples prepared for the round robin testing. There were 4 aggregate types, 4 replicates and 12 laboratories involved.

Developing a calibration factor for each aggregate addresses a known bias. Criteria for other biases such as sampling have not been established.

G. SAFETY AND HEALTH

Do not open the furnace door during ignition. Also, open the door slowly and carefully due to the possibility of flash re-ignition if the sample combustion is incomplete. The temperature of the furnace and door interior, and the sample, sample basket(s) and catch pan during and after removal from the furnace is extremely high. Caution, therefore, must be exercised at all times, as failure to do so could result in severe burns or fire. The sample, sample basket(s) and catch pan must not be placed near any materials which are subject to ignition at the high temperatures used in this procedure, and must always be placed inside the protective cage to prevent accidental contact during the cooling period.

Prior to handling, testing or disposing of any waste materials, testers are required to read: Part A (Section 5.0), Part B (Sections: 5.0, 6.0 and 10.0) and Part C (Section 1.0) of Caltrans Laboratory Safety Manual. Users of this method do so at their own risk.

REFERENCES:

California Tests 125, 201, 226, 304, and 370

End of Text (California Test 382 contains 7 pages and Appendix)

APPENDIX A

DETERMINATION OF ASPHALT CONTENT OF BITUMINOUS MIXTURES BY THE IGNITION METHOD USING THE MICROWAVE ASPHALT X-CELERATOR (MAX)

A. SCOPE

This appendix specifies modifications that must be made to the basic California Test 382 when determining the

asphalt binder content of bituminous mixtures by the ignition method using the Microwave Asphalt X-celerator (MAX).

B. APPARATUS

Use the apparatus described in the basic test method except that the ignition furnace shall be the MAX. All references to Type 2 furnaces (and procedures for Type 2 furnaces) shall be disregarded.

NOTE 1: MAX operates like traditional (convection) ignition furnaces. The difference is MAX uses microwave energy to heat the furnace in lieu of electric energy.

NOTE 2: MAX software routines default to wet mass (total mass of mix) calculations. As a special modification for MAX units sold only in CA, check to see that "dry aggregate calculation" is activated (turned ON) under the MAX setup Menu/Program Variables. The dry mass calculation will stay activated as long as the software chip is not replaced or the option is not deactivated. The CT 382 methodology uses the dry mass calculation and not the wet mass calculation.

C. CORRECTION FACTOR

The correction factor determined by this test method shall be used only with the furnace and with the mix design used to establish the factor. If the mix design and/or the equipment are changed, then a new correction factor shall be determined (see Note 3 of the basic test method).

Disregard all references to Type 2 furnace procedures. Determine the correction factor as described in the basic test method except as follows (numbers below correspond with the numbers in Section C, "Correction Factor," in the basic test method):

6. Eliminate the 25 mm spacing recommendation for the sample baskets used with the MAX oven.
8. Set the furnace control temperature set point at 538°C and the preheat temperature at 650°C. The preheat temperature is there to compensate for the heat lost when the door is opened and the sample is placed into the furnace. The MAX manufacturer recommends setting the afterburner temperature at 750°C.

NOTE 8: If the procedure to determine the correction factor (with the MAX oven) requires lowering the furnace temperature set point, lower the furnace control temperature set point to 482°C and the preheat temperature to 600°C and repeat the procedure. If the correction factor continues to exceed 0.5, lower the furnace control temperature set point to 427°C and the preheat temperature to 550°C and repeat the procedure. The furnace control temperature set point and the preheat temperature used to test field samples of bituminous mixtures per Section D, "Test Procedure," must be the same temperatures used to obtain the correction factor.

D. TEST PROCEDURE

Disregard all references to Type 2 furnace procedures. Perform the test procedure as described in the basic test method except as follows (number below corresponds with the number in Section D, "Test Procedure," in the basic test method):

4. Eliminate the 25 mm spacing recommendation for the sample baskets used with the MAX oven.
6. Set the furnace control temperature at 538°C and the preheat temperature at 650°C, or the appropriate lower temperatures as established during correction factor determination. The afterburner temperature should be set to 750°C.

E. REPORT

Report as prescribed in the basic test method.

F. PRECISION AND BIAS

The data for producing a precision statement have not been established for this extension of the basic test method.

G. SAFETY AND HEALTH

Observe the safety and health provisions listed in the basic test method.

CT 382: Determination of Asphalt Content of Bituminous Mixtures by the Ignition Method

Sample I.D. _____ Project I.D. _____ Resident Engineer _____
 Location of Sample _____
 Furnace Make and Model _____ Serial No. _____
 Furnace Type (1 or 2) _____ Furnace Temperature Set Point (circle one) 538°C 482°C 427°C
 Testing Laboratory _____ Mobile Lab Unit I.D. _____

 Technician Name _____
 Date of Test _____
 Aggregate Source _____ Type of Asphalt Cement _____
 Type of AC Mix and Design Specifications (use table below and note if additives are used):
 Type __: __ mm Maximum, _____ (Design Asphalt Binder Content = _____ %)

Sieve Size	Project Mix Design		Specifications (% Passing)		Sample Gradation	
	Mass	% Passing	Operating Range	Limits	Mass	% Passing
25 mm (1")						
19 mm (3/4")						
12.5 mm (1/2")						
9.5 mm (3/8")						
6.35 mm (1/4")						
4.75 mm (No. 4)			X ± 5			
2.36 mm (No. 8)			X ± 5			
1.18 mm (No. 16)						
600 µm (No. 30)			X ± 5			
300 µm (No. 50)						
150 µm (No. 100)						
75 µm (No. 200)						

Where X = the gradation proposed by the Contractor.
 See Standard Specifications or the Contract's Special Provisions for the Specifications.
 Sample Gradations may be run after the completion of the ignition process.

Correction Factor Determination Data

- (1) _____ (2) _____ = M_{agg} , mass of the dry aggregate.
- (1) _____ (2) _____ = M_{ab} , mass of the asphalt cement.
- (1) _____ (2) _____ = AC_{known} , known asphalt binder content.
- (1) _____ (2) _____ = M_e , mass of sample basket(s), and catch pan.
- (1) _____ (2) _____ = M_1 , initial mass of sample, sample basket(s), and catch pan at selected cooling temperature of _____ °C (_____ °F.).
- (1) _____ (2) _____ = M_2 , final mass of sample, sample basket(s), and catch pan after the ignition process.
- (1) _____ (2) _____ = Total ignition time.
- (1) _____ (2) _____ = Incremental time, if applicable; use "N/A" if not applicable.
- (1) _____ (2) _____ = A, measured percent asphalt binder content.
- _____ = Difference between $A_{(1)}$ and $A_{(2)}$ (see Note 8 of the test method).
- _____ = CF, the Correction Factor.

$$A = \left[\frac{M_1 - M_2}{M_2 - M_e} \times 100 \right] \quad CF = \frac{[A_{(1)} - AC_{known (1)}] + [A_{(2)} - AC_{known (2)}]}{2}$$

FIGURE 1a. CT 382 Test Report Form

Asphalt Binder Content Determination Data

Sample I.D. _____ Project I.D. _____ Resident Engineer _____
 Location of Sample _____
 Furnace Make and Model _____ Serial No. _____
 Furnace Type (1 or 2) _____ Furnace Temperature Set Point (circle one) 538°C 482°C 427°C
 Testing Laboratory _____ Mobile Lab Unit I.D. _____

 Technician Name _____
 Date of Test _____
 Aggregate Source _____ Type of Asphalt Cement _____
 Type of AC Mix and Design Asphalt Binder Content _____

- _____ = M_e , mass of sample basket(s), and catch pan.
- _____ = $M_{initial}$, initial mass of sample, sample basket(s), and catch pan at selected cooling temperature of _____ °C (_____ °F.).
- _____ = M_2 , final mass of sample, sample basket(s), and catch pan after the ignition process.
- _____ = Total ignition time; check for differences of more than 10 minutes.
- _____ = Moisture Content of sample, from CT 370 test results.
- _____ = M_1 , mass of sample (adjusted for moisture content), sample basket(s), and catch pan.
- _____ = CF, the Correction Factor.
- _____ = AC, corrected measured percent asphalt binder content.

[Note: Sample Gradations may be run after the completion of the ignition process.]

$$AC = \left[\frac{M_1 - M_2}{M_2 - M_e} \times 100 \right] - CF \qquad M_1 = \frac{M_{initial} - M_e}{1 + \left(\frac{H_2O}{100} \right)} + M_e$$

Sample I.D. _____ Project I.D. _____ Resident Engineer _____
 Location of Sample _____
 Furnace Make and Model _____ Serial No. _____
 Furnace Type (1 or 2) _____ Furnace Temperature Set Point (circle one) 538°C 482°C 427°C
 Testing Laboratory _____ Mobile Lab Unit I.D. _____

 Technician Name _____
 Date of Test _____
 Aggregate Source _____ Type of Asphalt Cement _____
 Type of AC Mix and Design Asphalt Binder Content _____

- _____ = M_e , mass of sample basket(s), and catch pan.
- _____ = $M_{initial}$, initial mass of sample, sample basket(s), and catch pan at selected cooling temperature of _____ °C (_____ °F.).
- _____ = M_2 , final mass of sample, sample basket(s), and catch pan after the ignition process.
- _____ = Total ignition time; check for differences of more than 10 minutes.
- _____ = Moisture Content of sample, from CT 370 test results.
- _____ = M_1 , mass of sample (adjusted for moisture content), sample basket(s), and catch pan.
- _____ = CF, the Correction Factor.
- _____ = AC, corrected measured percent asphalt binder content.

[Note: Sample Gradations may be run after the completion of the ignition process.]

FIGURE 1b. CT 382 Test Report Form

APPENDIX B

DETERMINATION OF ASPHALT CONTENT OF BITUMINOUS MIXTURES BY THE IGNITION METHOD USING THE NEW TECHNOLOGY OVEN (NTO)

A. SCOPE

This appendix specifies modifications that must be made to the basic California Test 382 when determining the asphalt binder content of bituminous mixtures by the ignition method using the New Technology Oven (NTO).

B. APPARATUS

Use the apparatus described in the basic test method except that the ignition furnace shall be the NTO, temperature control specifications shall be replaced with "NTO burn profiles," emission control equipment specifications for afterburners and filters shall not be required, and all references to Type 2 furnaces (and procedures for Type 2 furnaces) shall be disregarded.

NOTE 1: The NTO does not operate like convection-type ignition furnaces. The difference is that the NTO uses an irradiation method to directly heat the sample. Unlike convection-type ignition furnaces in which the chamber air is heated and thus the sample, in the NTO infrared energy is used to excite the molecules in the bituminous mixture. The result of the irradiation method is a significant reduction in emissions and chamber temperatures while completing pyrolysis of the asphalt binder.

NOTE 2: Because the NTO does not rely on the chamber temperature to heat the sample, it is not necessary to check or verify the chamber temperature. The displaced chamber temperature is simply a reference.

NOTE 3: The NTO manufacturer's preset software selections for sample burn profiles can be used for the testing purposes. However, proper burn profiles should be established for bituminous mixtures from various aggregate sources. Burn profile consultation with the oven's manufacturer is recommended. This test also uses the dry mass calculation and not the wet mass calculation to determine the asphalt binder content of the samples tested in the ignition oven. The

oven's software routines must be set to use the dry mass of aggregate calculation.

C. CORRECTION FACTOR

Disregard all references to Type 2 furnace procedures. Determine the correction factor as described in the basic test method except as follows (numbers below correspond with the numbers in Section C, "Correction Factor," in the basic test method):

6. Eliminate the 25-mm requirement for sample baskets with perforated sides and bottoms.
8. Change furnace temperature control requirements to burn profile control requirements. Eliminate the afterburner temperature control requirements.

NOTE 8: Should read: If the difference between $A_{(1)}$ and $A_{(2)}$ exceeds 0.15, repeat the two tests, and then discard the high and low numbers from the four test results. Average the remaining two results, and then compute the correction factor. If the correction factor exceeds 0.5, lower the burn profile energy level and repeat the procedure. If the correction factor continues to exceed 0.5, lower the burn profile energy level and repeat the procedure. Do not lower the burn profile energy level more than two times. Use the correction factor from the last burn profile energy level tested. The burn profile used to test bituminous mix samples per Section D must be the same burn profile used to establish the correction factor.

D. TEST PROCEDURE

Disregard all references to Type 2 furnace procedures. Perform the test procedure as described in the basic test method except as follows (numbers below correspond with the number in Section D, "Test Procedure," in the basic test method):

4. Eliminate the 25-mm requirement for sample baskets with perforated sides and bottoms.
2. Change furnace temperature control requirements to burn profile control requirements. Eliminate the afterburner temperature requirements.

E. REPORT

Report as prescribed in the basic test method.

F. PRECISION AND BIAS

The data for producing a precision statement have not been established for this extension of the basic test method.

G. SAFETY AND HEALTH

Observe the safety and health provisions listed in the basic test method.