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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 binder content of bituminous paving mixtures by removing the binder at approximately 570°C by ignition in a furnace.

The results of this test method may be affected by the type of aggregate in the mixture because different aggregates lose mass on ignition to varying degrees. Accordingly, a correction factor is determined for each mix type.

B. APPARATUS

Ignition Furnace, having a temperature control capability of $\pm 5^\circ\text{C}$ at between 420 and 580°C. It shall accommodate sample sizes of at least 3000 g and have a blower/fan to pull air through the ignition chamber to expedite the test and to minimize any smoke/emissions that may be discharged into the laboratory during sample removal. The furnace must also incorporate an afterburner and filter system to reduce emissions during testing to an acceptable level.

The ignition furnace may be either of the following types:

Type 1 shall have an internal balance capable of measuring, to 0.1 g, the mass of the catch pan, basket(s) and sample. It shall

have a data collection/processing system that permits the input of a calibration factor, determines and displays the mass loss during the test, detects when the mass loss during a 3 min ignition interval does not exceed 0.01 % of the mass of the initial sample, and then activates an audible alarm and an indicator light. The furnace shall then provide a printed ticket with the initial specimen mass, specimen mass loss, temperature compensation, calibration factor, and corrected asphalt content.

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

Balance or scale, accurate to 0.01 % of the mass of the sample and readable to 0.1 g.

Sample Basket Nests of a size that allows the sample to be spread in thin layers and allows air to flow up through and around the sample particles. The baskets shall nest 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 baskets and retain aggregate particles that fall through the sample basket openings during the 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 sample basket(s) and catch pan during the cooling period.

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

Mixing Apparatus, Hobart Model A 200 or equal and a mixing bowl (11 L ±).

NOTE 2: Standard 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, but rather costly.

Oven, for drying and/or preheating ingredients, etc. prior to batching or testing.

C. CORRECTION FACTOR

1. Obtain samples of the aggregate and the asphalt cement that will be used on the project in accordance with CT 125.

NOTE 3: The sample shall have the same mass (2000 g) and have the same gradation as that to be tested on the project. When the mass of the sample exceeds the capacity of the equipment, the test sample may be divided into suitable increments. The increments may then be tested and the results combined to determine the correction factor.

2. Dry the aggregate at a temperature of no more than 160°C to a constant mass.

3. Heat the aggregate and binder to approximately 150°C. Heat all mixing bowls and tools to approximately 150°C.

NOTE 4: Prior to mixing the samples, prepare an initial or "butter" mix to condition the mixing equipment. 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 were a sample, leaving a coating of mix residue. Discard the material that is removed.

4. Prepare two samples at the design binder content. Record the mass of dry aggregate used in each sample as M_{agg} .
5. Determine the mass of the sample basket(s) and catch pan. Record this mass as M_c .
6. Evenly distribute a sample in the sample basket(s), taking care to keep the material at least 25 mm from the edges of the basket(s).
7. Determine the total mass of the sample, sample basket(s), and catch pan. Record this initial mass as M_1 .
8. Set the furnace temperature at 538°C. If it is adjustable, the afterburner temperature should be set per the furnace manufacturer's recommendations for the type of mix being tested.

NOTE 5: The furnace 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. Heat a sample 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 set point at the end of the initial 25 min, continue heating for 5 min increments until the temperature drops to the set-point.

10. Remove the sample and catch pan from the furnace, place them in the protective cage, and allow them to cool to approximately room temperature.

An alternative temperature of 100°C may be selected to expedite testing and minimize moisture absorption from the air. If 100°C is selected, insulation must be provided to reduce heat transfer to the balance or scale.

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 and catch pan after ignition. Then place them back into the furnace and heat the sample for another 10 min.
12. Remove the sample and catch pan from the furnace, place them in the protective cage, and allow them to cool to the selected 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 and catch pan does not exceed 0.01 % of the initial mass (M₁).
14. Record the last value obtained as the mass (M₂) of the sample after ignition. Measure M₂ at the same temperature as M₁ ± 3°C. Also record the total ignition time required to obtain M₂ and the increment of time between return to set-point temperature and completion of ignition.

For Type 2 furnaces, skip steps 15 - 17 and proceed with step 18.

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

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

16. Heat the sample. When the change in mass of the sample over a 3-min interval does not exceed 0.01 % of the initial mass (M₁), remove the sample from the oven.
17. Record the mass (M₂) of the sample and catch pan after ignition. Also record the total ignition time to obtain M₂. This mass can be obtained upon completion of ignition from the printout or display.
18. Calculate the measured percent binder as follows:

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

Where:

- A = percent "binder" by mass of dry aggregate,
- M₁ = total mass of the sample, sample basket(s), and catch pan prior to ignition, (batched with dry aggregate),
- M₂ = total mass of the sample, sample basket(s), and catch pan after ignition,
- M_e = total mass of the sample basket(s) and catch pan determined in Part C.5.

19. Repeat steps 5 through 18 for the second correction sample.

NOTE 8: If the difference between A₍₁₎ and A₍₂₎ exceeds 0.15, repeat the two tests, discard the high and low number and average the

remaining two results. If the difference exceeds 0.5, lower the furnace setting to 482°C and repeat the procedure. If the difference continues to exceed 0.5, lower the furnace to 427°C and repeat the procedure. The temperature used to test bituminous mix samples per Section D must be the same temperature used to obtain the correction factor.

20. Calculate the correction factor as follows:

$$CF = \frac{A_{(1)} + A_{(2)}}{2} - AC$$

Where:

CF = the correction factor as % binder,

AC = % binder added to each correction sample by dry weight of aggregate.

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

D. TEST PROCEDURE

1. Obtain a bituminous mix sample from the project in accordance with CT 125. The sample size shall be 4000 g (2000 g for CT 382, 2000 g for CT 370).
2. Determine the moisture content of the bituminous mix according to CT 370 so that the measured mass loss can be corrected for moisture.
3. Determine the mass of the sample basket(s) and catch pan. Record this mass as M_e .
4. Evenly distribute the 2000 g sample in the sample basket(s), taking care to keep the material at least 25 mm from the edges of the basket(s).
5. Determine the mass of the sample, sample basket(s) and catch pan. Record this initial mass as M_1 .
6. Set the furnace temperature at 538°C or an appropriate lower temperature as established during calibration. If it is adjustable, the afterburner temperature should be set per the furnace manufacturer's recommendations for the type of mix being tested.
7. Heat the bituminous mix sample in the furnace for the total ignition time recorded in Part C, 14. Alternatively, if the furnace controller permits, program the furnace to heat for a selected time from return to set-point to end of test. This time should be equal to or more than the increment of time determined in Part C, 14.
8. Remove the sample from the furnace, place it in the protective cage and allow it to cool to the temperature selected in Part C, 10.
9. Measure and record the mass (M) of the sample after ignition.
10. Place the sample back into the furnace and heat the sample for an additional 3 min.
11. Remove the sample from the furnace, place it in the protective cage and allow it to cool to approximately room temperature. Measure and record the mass (M) of the sample.
12. Repeat steps 10 and 11 until the change in mass of the sample during a 3-min period does not exceed 0.01 % of the initial mass (M_1).

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

For Type 1 furnaces, skip steps 7 through 13 and proceed with step 14.

13. Record the last value obtained as the mass (M_2) of the sample after ignition. Measure M_2 at the same temperature as $M_1 \pm 3^\circ\text{C}$. If the total ignition time to obtain M_2 exceeds the total ignition time recorded in Part C, 14, by 6 min or more, a new calibration is required.

For Type 2 furnaces, skip steps 14 - 16 and proceed with step 17.

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

NOTE 10: For some furnaces, this mass must be entered by the technician based on external weighing. Differences of more than 5 g or failure of the balance to stabilize may indicate that the sample basket(s) are in contact with the furnace wall.

15. Heat the sample in the furnace until the change in mass of the sample over a 3-min interval does not exceed 0.01 % of the initial mass (M_1).
16. Record the mass (M_2) of the sample and catch pan after ignition. This mass can be obtained upon completion of ignition from the printout or display. If a temperature correction factor is not used, measure M_2 at the same temperature as $M_1 \pm 3^\circ\text{C}$. Record the total ignition time to obtain M_2 . If this total ignition time to obtain M_2 exceeds the total ignition time recorded in Part C, 17, by 6 min or more, a new calibration is required.

17. Determine the corrected asphalt content as follows:

$$\% \text{ AC} = \frac{M_1 - M_2}{M_2 - M_e} 100 - \text{CF}$$

Where:

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

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

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

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

M_e = total mass of the sample basket(s) and catch pan determined in Part D, 3.

CF = correction factor per Part C, 20, and

H_2O = moisture, percent of mix, per Part D, 2.

E. REPORT

1. The report shall include the following:
 - (a) Date
 - (b) Identification of aggregate, binder and mix type
 - (c) Sample location
 - (d) Test number
 - (e) Furnace Type (1 or 2)
 - (f) Calibration data
 - (g) Ignition time
 - (h) Mass of sample before and after ignition

- (i) Moisture content of bituminous mix
- (j) Corrected 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.

Analysis of these data for within laboratory and between laboratory precision provide 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 and 370

End of Text (California Test 382 contains 6 pages)