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METHOD OF TEST FOR DETERMINING MOISTURE CONTENT OF BITUMINOUS MIXTURES OR GRADED MINERAL AGGREGATES USING MICROWAVE OVENS

A. SCOPE

This test method describes the procedure for determining the moisture content of either bituminous mixtures or graded mineral aggregates used in bituminous mixtures. The use of this test method on bituminous mixtures is limited to those using asphalt binders. Emulsions or liquid asphalt grades may yield erroneous results.

B. APPARATUS

1. Microwave oven capable of testing the entire split sample mass (500 g minimum) plus the sample container.
2. Microwave safe sample containers (paper, glass or ceramic containers) capable of holding the entire split sample mass.
3. Balance having a minimum capacity of 3000 g and capable of measuring the combined mass of the sample and the sample container to an accuracy of 0.1 g.
4. Sample splitters for aggregate; riffle type in accordance with California Test 201.
5. Sample splitters for bituminous mixtures rotating pan type (in accordance with California Test 304, Figure 1) or riffle type splitter in accordance with California Test 201. Hand quartering methods may also be used.
6. Spatula approximately 25 mm wide and 250 mm long.
7. Heat resistant gloves.
8. Suitable containers for sampling bituminous mixtures (cardboard boxes are usually acceptable). Metal containers with lids (e.g., metal concrete cylinder cans or 1 L friction top metal cans) are required if a delay of 15 min or more is anticipated before testing for production control.
9. Tape for sealing metal cans.

C. TEST RECORD FORM

Use the form shown in Figure 1 or an equivalent report form to report the results from this test method.

D. SAMPLE PREPARATION

1. Obtain approximately 2000 g (typical sample size equals one full 1 L metal can) of either the mineral aggregate or the bituminous mixture.

2. Using the sample splitter, split the material to obtain two 500 g minimum samples in accordance with one of the following required procedures.
 - a. Do the following for production control (moisture content):
 - (1) Split the material within 15 min of sampling (to avoid reheating) and place in suitable containers.
 - (2) If a delay of 15 min or more is anticipated before testing, split samples must be placed in sealed metal containers. Seal container lids with tape.
 - (3) All samples should be tested within 1 hr of sampling for reliable results.
 - b. Do the following for correcting mass loss of test specimens due to moisture content (for use in California Test 379 and 382, for example).
 - (1) Split the material for use in this test at the same time the material is split for preparation of test specimens.

NOTE: Original split sample mass (M_{ORIGINAL}) must be determined at the same time the initial mass of test specimens for California Test 379 and 382, for example, are determined.

E. TESTS AND CALCULATIONS

1. Determine the mass of a clean, dry microwave-safe sample container and record.
2. Place the split sample in the container and immediately determine and record the total mass (mass of sample container and split sample).
3. Calculate the original split sample mass (M_{ORIGINAL}) by subtracting the mass of sample container from the total mass. Record M_{ORIGINAL} to the nearest 0.1 g

NOTE: Original split sample mass (M_{ORIGINAL}) must be determined at the same time the initial mass of test specimens for California Test 379 and 382, for example, are determined.

4. Repeat Section E, Steps 1 through 3 for the second split sample.
5. Place the samples in the microwave oven, set the microwave timer for the predetermined amount of time of up to 5 min and then start the oven.

NOTE: Because of the broad range of power output of microwave ovens, appropriate heating time(s) must be predetermined for each microwave oven. If any damage (e.g., burning of the asphalt binder “blue smoke”, paper container, or aggregate shattering) is observed, the heating time(s) must be reduced. The power output may also be adjusted on ovens with the adjustable power capability. Note the time and power adjustments on the test report form so that samples may be tested consistently without the chance of sample damage. Samples tested for the same project should be tested using the same time and power level settings.

6. After heating for the predetermined time, remove the samples from the microwave oven. Cool the samples at ambient temperature for 15 min.
7. Determine the total mass of the samples and calculate the individual sample masses ($Mass_X$, where X is the drying cycle number). Record $Mass_X$ to the nearest 0.1 g.
8. Repeat Section E, Steps 5 through 7 until a constant mass is obtained. Measure and record this final mass as $Mass_{FINAL}$. For this test, a constant mass is obtained when the change in the sample mass between drying cycles does not exceed 0.3 g.

NOTE: Each subsequent drying cycle (each cycle includes the heating and cooling period) may require further adjustment of the heating time and possibly the power level (if it is adjustable). After the second drying cycle, the heating time should not exceed 2 min. Note the times and power levels on the test report form.

9. After the mass has been determined to be constant, calculate the Moisture Contents of the samples as follows:

$$\text{Moisture Content, \%} = \left[\frac{Mass_{ORIGINAL} - Mass_{FINAL}}{Mass_{FINAL}} \right] \times 100$$

NOTE: For cases with Moisture Contents of 1.0 % or less, a 10 to 12 min drying period (about three drying cycles) has been found to produce a constant mass for a 500 g sample.

10. Record Moisture Contents to the nearest 0.1 g of the Moisture Content of the two samples. If they differ by more than 0.4 %, the test is invalid. In this case, new samples must be prepared and the test rerun.
11. Record the Moisture Content for the test as the average of the two samples, $Moisture\ Content_{TEST}$.
12. Discard the sample material upon completion of this test method. Do not use the material for other tests.

F. PRECAUTIONS

Do not use metal containers or place metal tools in microwave ovens at any time or damage to the microwave ovens will occur.

G. HEALTH AND SAFETY

It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Prior to handling, testing or disposing of any materials, testers must be knowledgeable about safe laboratory practices, hazards and exposure, chemical procurement and storage, and personal protective apparel and equipment. Caltrans Laboratory Safety Manual is available at:

http://www.dot.ca.gov/hq/esc/ctms/pdf/lab_safety_manual.pdf

End of Text
(California Test 370 contains 4 pages)

MOISTURE CONTENT WORK SHEET

| | |
|----------------------------|-------------------------------|
| Sample ID: _____ | Aggregate Source: _____ |
| Location of Sample: _____ | Project ID: _____ |
| Oven Make and Model: _____ | Resident Engineer: _____ |
| Testing Laboratory: _____ | Serial No.: _____ |
| Technician Name: _____ | Mobile Lab Unit ID.: _____ |
| Date of Test: _____ | Type of Asphalt Binder: _____ |

Type of AC Mix and Design Asphalt Binder Content (and note if additives are used):

Type _____ : _____ mm Maximum, _____ (Design Asphalt Binder Content = _____ %)

NOTES

| Sample A | Sample B | Time | Power Level |
|----------|----------|-------|-------------|
| _____ | _____ = | | |
| _____ | _____ = | | |
| _____ | _____ = | _____ | _____ |
| _____ | _____ = | _____ | _____ |
| _____ | _____ = | _____ | _____ |
| _____ | _____ = | _____ | _____ |
| _____ | _____ = | _____ | _____ |
| _____ | _____ = | _____ | _____ |

(Note: Power levels and times for testing consistency and be wary of sample damage.)

_____ = Mass_{FINAL}, the mass after the final drying cycle in the Microwave oven.
 _____ = Moisture Content_{SAMPLE} (%), as determined by the formula below:

$$\text{Moisture Content}_{\text{SAMPLE}} (\%) = \left[\frac{(\text{Mass}_{\text{ORIGINAL}} - \text{Mass}_{\text{FINAL}})}{\text{Mass}_{\text{FINAL}}} \right] \times 100$$

Check the difference between the two moisture contents. If the difference is less than or equal to 0.4 %, the test is valid. Otherwise, prepare new samples and rerun the test. If the test is valid, report the average of the moisture contents as shown below.

_____ = Moisture Content_{TEST} (%), as determined by the averaging formula below:

$$\text{Moisture Content}_{\text{TEST}} (\%) = \left[\frac{(\text{Moisture Content}_A + \text{Moisture Content}_B)}{2} \right]$$

FIGURE 1.