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**DIVISION OF ENGINEERING SERVICES**  
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## METHOD OF DETERMINING MOISTURE CONTENT OF BITUMINOUS MIXTURES OR GRADED MINERAL AGGREGATES USING MICROWAVE OVENS

**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 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 conforming to California Test 201.

5. Sample splitters for bituminous mixtures; rotating pan type (California Test 304, Figure 1) or riffle type splitter conforming to 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 minutes 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. For production control (moisture content).

(1) Split the material within 15 minutes of sampling (to avoid reheating) and place in suitable containers.

(2) If a delay of 15 minutes or more is anticipated before testing, split samples must be placed into, and kept in, sealed metal containers. Seal container lids with tape.

(3) For reliable results, all samples should be tested within 1-hour of sampling.

b. 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 (see Note 1).

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 minutes (see Note 2), and then start the oven.

6. After heating for the predetermined time, remove the samples from the microwave oven. Cool the samples at ambient temperature for 15 minutes.

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 (see Note 3).

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

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

10. Record Moisture Contents to the nearest 0.1 g. If the Moisture Contents of the two samples 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,  $MoistureContent_{TEST}$ .

12. Discard the sample material upon completion of this test method. Do not use the material for other tests.

## **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 ( $Mass_{ORIGINAL}$ ) by subtracting the mass of sample container from the total mass. Record  $Mass_{ORIGINAL}$  to the nearest 0.1g (see Note 1).

**NOTES:**

1. Original split sample mass ( $Mass_{ORIGINAL}$ ) must be determined at the same time the initial mass of test specimens for California Test 379 and 382, for example, are determined.
2. 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) or 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.
3. 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 two minutes. Note the times and power levels on the test report form (see Note 2).

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

**F. PRECAUTIONS**

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

**G. SAFETY AND HEALTH**

Personnel should use heat resistant gloves when working with hot materials. Reasonable care should be exercised to avoid being burned by hot bituminous mixtures, aggregate, or equipment. Use proper lifting techniques when handling heavy field samples.

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.

End of Text  
(California Test 370 contains 4 pages)

**MOISTURE CONTENT WORK SHEET**

Sample I.D. \_\_\_\_\_ Project I.D. \_\_\_\_\_ Resident Engineer \_\_\_\_\_  
 Location of Sample \_\_\_\_\_  
 Oven Make and Model \_\_\_\_\_ Serial No. \_\_\_\_\_  
 Testing Laboratory \_\_\_\_\_ Mobile Lab Unit I.D. \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Technician Name \_\_\_\_\_  
 Date of Test \_\_\_\_\_  
 Aggregate Source \_\_\_\_\_ 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:

<u>Sample A</u>	<u>Sample B</u>	<u>Time</u>	<u>Power Level</u>
_____	_____ = Mass of sample container.		
_____	_____ = Total mass (mass of sample container + split sample).		
_____	_____ = Mass <sub>ORIGINAL</sub> , the original sample mass.	_____	_____
_____	_____ = Mass <sub>1</sub> , the mass after the 1 <sup>st</sup> drying cycle.	_____	_____
_____	_____ = Mass <sub>2</sub> , the mass after the 2 <sup>nd</sup> drying cycle.	_____	_____
_____	_____ = Mass <sub>3</sub> , the mass after the 3 <sup>rd</sup> drying cycle.	_____	_____
_____	_____ = Mass <sub>4</sub> , the mass after the 4 <sup>th</sup> drying cycle.	_____	_____
_____	_____ = Mass <sub>5</sub> , the mass after the 5 <sup>th</sup> drying cycle	_____	_____

(Note power levels and times for testing consistency, and be wary of sample damage.)

\_\_\_\_\_ = Mass<sub>FINAL</sub>, the mass after the final drying cycle in the Microwave oven.  
 \_\_\_\_\_ = Moisture Content<sub>SAMPLE</sub> (%), 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<sub>TEST</sub> (%), as determined by the averaging formula below.

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

**FIGURE 1**