



**INDIANA DEPARTMENT OF TRANSPORTATION
DIVISION OF MATERIALS AND TESTS**

**FIELD DETERMINATION OF
MOISTURE CONTENT OF SOILS
ITM No. 506-23**

1.0 SCOPE.

- 1.1** This test method covers the procedure for determining the moisture content of soils in the field.
- 1.2** The stove or hot plate may be used for all types of soils. The moisture probe may only be used for granular soils and may not be used in soils with organic material. The microwave oven may be used for most soil types except for soils that contain high organic content, or dissolved soils in the pore water.
- 1.3** This ITM may involve hazardous materials, operations, and equipment and may not address all of the safety problems associated with the use of the test method. The user of the ITM is responsible for establishing appropriate safety and health practices and determining the applicability of regulatory limitations prior to use.

2.0 REFERENCES.

2.1 AASHTO Standards.

- M 231 Weighing Devices Used in the Testing of Materials
- T 99 Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop

2.2 ASTM Standards.

- D4643 Standard Test Method for Determination of Water (Moisture) Content of Soil by Microwave Oven Heating

3.0 TERMINOLOGY. Definitions for terms and abbreviations shall be in accordance with the Department's Standard Specifications, Section 101.

4.0 SIGNIFICANCE AND USE. This ITM shall be used to determine the moisture content of compacted soils in the field. The moisture content may be determined by either the stove or hot plate, microwave oven, or the Hydrosense moisture probe.

5.0 APPARATUS.

- 5.1** Balance, Class G 20, in accordance with AASHTO M 231.
- 5.2** Balance, Class G 2, in accordance with AASHTO M 231.
- 5.3** Gasoline or bottled gas stove, or electric hot plate.
- 5.4** Drying pan, made of material resistant to corrosion and not subject to change in weight or disintegration on repeated heating and cooling.
- 5.5** Microwave oven. Ovens with variable power controls and input power ratings of about 700 W have been found to be adequate for this use.
- 5.6** Microwave oven specimen containers made of a nonmetallic non-absorbent material, resistant to thermal shock, and not subject to changes in mass or shape when subjected to repeated heating, cooling, or cleaning. Porcelain evaporating dishes and standard borosilicate glass dishes perform satisfactorily.
- 5.7** Heat sink. A material or liquid placed in the microwave oven to absorb energy after moisture has been driven from the specimen. Glass beakers filled with water and materials that have a boiling point above water, or moistened bricks may be used.
- 5.8** Campbell Hydrosense moisture probe, CD 620, and the CS 620 probe with 120 mm rods.
- 5.9** Mold and rammer in accordance with AASHTO T 99.
- 5.10** Miscellaneous equipment, such as spoons, brushes, and gloves, as needed.

- 6.0 SAMPLING.** Obtain a sample representative of the soil to be tested. The approximate minimum size sample shall be in accordance with the following:

Apparatus	Minimum Mass of Sample, g
Stove or Hot Plate	200* or 1000
Microwave Oven	100
Moisture Probe	3000

* A G 2 balance is required when a minimum 200g sample is used.

7.0 PROCEDURES.

7.1 Stove or Hot Plate

- 7.1.1 Determine the weight of the drying pan.
- 7.1.2 Place the sample into the drying pan and weigh the drying pan and sample.
- 7.1.3 Dry the sample on the stove or hot plate. Stir the sample while drying and break up any clods. Care should be taken not to burn the sample.
- 7.1.4 Weigh the sample and drying pan when the soil appears dry. Continue drying the sample and reweigh at 5-minute intervals until constant weight is achieved. **Reweigh at 3 minutes intervals when sample size is 200 g.** (Note 1).
- Note 1 - Constant weight is defined as the weight at which further drying does not alter the weight by more than 0.01 lbs for a G 20 balance or 0.5 g for G 2 balance.
- 7.1.5 Determine the moisture content of the soil as follows:

$$\text{Moisture, \%} = \frac{W_1 - W_2}{W_2 - W_3} \times 100$$

where:

W_1 = weight of pan and wet soil, g

W_2 = weight of pan and dry soil, g

W_3 = weight of pan, g

7.2 Microwave Oven

- 7.2.1 Determine the weight of the dish to be placed in the microwave oven on the Class G2 balance.
- 7.2.2 Obtain a minimum of 100 g of crumbled soil by sieving the soil through a No. 4 or smaller sieve.
- 7.2.3 Place the sample onto the dish and weigh the dish and sample.
- 7.2.4 Place the soil, dish, and heat sink in the microwave oven and turn on the oven for 3 minutes at the high setting (Note 2).

Note 2– **Every microwave oven and soil sample are different.** A setting of high and 3 minutes on the microwave is satisfactory for most soils;

however, some soils, such as chemically modified soils, should not need microwave testing. Experience and use of the microwave oven will help to determine the proper settings.

7.2.5 Weigh the sample and dish after the initial drying time. Dry the sample for 1 additional minute and reweigh the sample. Repeat this procedure until constant weight is achieved (Note 1).

7.2.6 Determine the moisture content of the soil as follows:

$$\text{Moisture, \%} = \frac{W_1 - W_2}{W_2 - W_3} \times 100$$

where:

W_1 = weight of pan and wet soil, g

W_2 = weight of pan and dry soil, g

W_3 = weight of pan, g

7.3 Moisture Probe

7.3.1 Fill the mold with the soil to be tested in approximately three equal layers in accordance with AASHTO T 99 and compact the first and second lifts with 5 blows each and the third lift with 6 blows using the rammer.

7.3.2 Fill the mold with the soil and strike off the mold.

7.3.3 Determine the density of the soil in accordance with AASHTO T 99.

7.3.4 Insert the moisture probe rods fully into the soil, taking care not to touch the sides or the bottom of the mold with the rods. Take a reading at three different locations in the mold and average the three readings (θ).

7.3.5 Determine the moisture content of the soil as follows:

$$\text{Moisture, \%} = \theta \left(\frac{62.416}{\gamma_{\text{soil}}} \right)$$

where:

θ = average of moisture probe readings

γ_{soil} = density of soil, lb/ft³

8.0 REPORT. The moisture content is reported to the nearest whole number.