ALDOT-223-71A
ESTABLISHING MOISTURE-DENSITY CONTROLS FOR SOILS AND/OR AGGREGATES WITH CHEMICAL ADDITIVES (EXCLUDING BITUMINOUS MATERIALS)

1. Scope

1.1. These methods of test are intended for determining the relation between the moisture content and density of soils compacted in a mold of a given size with a 5.5 lb (2.5 kg) rammer dropped from a height of 12 in (300 mm). Two alternate procedures are provided as follows:

1.1.1. Method A – 4 in. (100 mm mold): For material with 20% or less aggregate retained on the ¾ in. (19 mm sieve).

1.1.2. Method B - 6 in. (150 mm mold): For material with greater than 20% aggregate retained on the ¾ in, (19 mm sieve)

2. Equipment

2.1. Molds - the molds shall be cylindrical in shape, made of metal, and shall have the capacity and dimensions indicated in Method A or B. They shall have a detachable collar assembly approximately 2.5 in.(60 mm)in height, to permit preparation of compacted specimens of soil-water mixtures of the desired height and volume. The molds may be of the "split" type, consisting of two half-round sections, or a section of pipe split along one element, which can be securely locked in place to form a cylinder. The mold and collar assembly shall be so constructed that it can be fastened firmly to a detachable base plate. Capacity and dimensions of the molds shall be as follows:

2.1.1. 4 in. (100 mm) mold having a capacity of 1/30 ± 0.0003 ft^3 (0.000943 m3 ±0.000008 m^3) with an internal diameter of 4 in. (102 mm) ± 0.2 in (0.407 mm) and a height of 4.58 in ± 0.005in (116.43 ± 0.127 mm) (see Note 1).

2.1.2. 6 in (150 mm) mold having a capacity of 1/13.33 ± 0.00075 ft^3 (0.002124 ±0.000021 m^3) with an internal diameter of 150 mm ± 0.6604 mm and a height of 116.43 ± 0.1270 mm (see Note 1).

2.2. Rammer - A rammer of 2.0 ± 0.005 in (50.8 ± 0.127 mm) diameter having a flat circular face and weighing 5.5 ± 0.02 lb (2.495 ± 0.009 kg). The rammer shall be equipped with a suitable arrangement to control the height of drop to a free fall of 12.00 ± 0.06 in (300 ± 2 mm) above the elevation of the soil.

2.3. Sample Extruder (optional) - A jack, lever, frame, or other device adapted for the purpose of extruding compacted specimens from the mold.

2.4. Balances and Scales - A balance or scale of at least 31.75 kg sensitive to 0.009 kg and a balance of at least 2500 g capacity sensitive to 0.1 g.

2.5. Stove or Oven - For drying moisture samples.

2.6. Straightedge - A steel straightedge 12 in (300 mm) in length and having one beveled edge.

2.7. Sieves – ¾ in (19 mm) and No. 4 (4.75 mm) sieves conforming to the requirements of the Specifications for Sieves for Testing Purposes (AASHTO Designation: M-92).

2.8. Mixing Tools - Miscellaneous tools such as mixing pans, spoon, trowel, spatula, etc., or a suitable mechanical device for thoroughly mixing the sample of soil with increments of water.

Note 1: Molds shall comply with dimension requirements set forth in AASHTO T-99. (Figure 1 and 2)

3. Sample Preparation

3.1. From the completed mixture, obtain from the immediate area of the in-place density test the proper weight of material listed below: (Note 2)

3.1.1. Method A - 13.62 kg

3.1.2. Method B - 31.75 kg

Note 2: Sample should be taken immediately after final mixing, or spreading, and before rolling begins.

3.2. Divide material by quartering into approximately four equal samples.

3.3. Place the individual portions into separate pans marked A, B, C, and D.

3.4. Place pans A, C, and D so that they will receive the same atmospheric exposure as the completed mixture on the roadway.

4. Procedure And Preparation Of Samples

4.1. Method A - Three (3) layers in 4 in (100 mm) mold 25 blows per layer with all soil particles passing No. 4 (4.75 mm) sieve and all aggregate particles broken up to pass a ¾ in (19 mm) sieve.

4.2. Method B - Three (3) layers in 6 in (150 mm) mold 56 blows per layer with all soil particles passing No. 4 (4.75 mm) sieve and all aggregate particles broken up to pass a ¾ in (19 mm) sieve.

4.3. From pan B prepare a specimen, using the appropriate method. During compaction, the mold shall rest on a uniform, rigid foundation, such as provided by a cube of concrete weighing not less than 90 kg. Following compaction, remove the extension collar and carefully trim the top and bottom of the compacted soil even with the mold by means of a straightedge. (Note 3)

4.4. Weigh and record the molded weight. (Note 4)

Note 3: During the straightedge operation, high metal content samples will leave voids due to loss of metal. Sieve some of the struck-off material over the 4 in (100 mm) sieve and from the passing 4 in (100 mm) portion fill the void space and lightly tamp with the flat side of the straightedge. Then strike off the material flush with mold again.

Note 4: A tare weigh should be provided for each mold, in order that only the wet weight of the material will be recorded.

4.5. Remove the material from the mold and slice vertically through the center. Take a representative moisture sample from one of the cut faces, weigh immediately and record.

4.6. Place moisture sample in stove or oven for drying. (Note 5)

Note 5: Moisture samples shall be dried until the loss is less than 0.5 of one percent.

4.7. To pan C, add enough water to increase the moisture content by approximately two (2) percent. Mix water and material thoroughly and repeat Steps 4.3 through 4.6.

4.8. To pan D, add enough water to increase the moisture content by approximately four (4) percent. Mix water and material thoroughly and repeat Steps 4.3 through 4.6.

4.9. Thoroughly mix the material in pan A and repeat Steps 4.3 through 4.6. (Note 6)

Note 6: At least 1 1/2 hours should have elapsed since mixing before beginning this point.

5. Calculations

5.1. Calculate the moisture content as percent and the dry weight of the soil as compacted for each trial, as follows:

$$P = \frac{A - B}{B - C} \times 100$$

and

$$W = \frac{w_1}{P + 100} \times 100$$

Where:
P = percentage of moisture in the specimen, based on oven dry weight of soil.
A = weight of container and wet soil in kg.
B = weight of container and dry soil in kg.
C = weight of container in kg.
W = dry weight in kg/m^3 of compacted soil.
w_1 = wet weight, in kg/m^3 of compacted soil.

6. Moisture-Density Relationship

6.1. The calculations in Step 5.1 shall be made to determine the moisture content and corresponding oven-dry weight (density) for each of the compacted soil samples. The oven-dry weights per cubic foot (densities) of the soil shall be plotted as ordinates and corresponding moisture contents as abscissas.

7. Optimum Moisture Content

7.1. When the densities and corresponding moisture contents for the soil have been determined and plotted as indicated in Step 6.1, it will be found that by connecting the plotted points with a smooth line, a curve is produced. The moisture content corresponding to the peak of the curve shall be termed the "optimum moisture content" of the soil under the above compaction.

8. Maximum Density

8.1. The oven-dry weight per kg/m^3 of the soil at optimum moisture content shall be termed "maximum density" under the above compaction.

9. Reporting

9.1. The report shall include the following:

9.1.1. The method used (Method A or B).

9.1.2. The optimum moisture content.

9.1.3. The maximum density.