ALDOT-140-84
METHOD OF TEST FOR DETERMINING THE LABORATORY VIBRATED DENSITY BY THE STANDARD VIBRATORY TEST ON GRAVEL AND CRUSHED AGGREGATE MATERIALS

1. Scope

1.1. This method of test is for determining the maximum density and optimum moisture on a given gradation of base material.

2. Applicable Documents

2.1. AASHTO T-2
AASHTO T-19 For Mold Calibration
AASHTO T-27
AASHTO T-100
AASHTO T-248

3. Apparatus

3.1. Mold - The mold shall be a solid wall, metal cylinder manufactured with dimensions and capacity shown in 3.1.1 below.

3.1.1. An 8 in. (200 mm) mold having a capacity of 0.25 ft^3 ± 0.015 ft^3 (0.0071 m^3 ± 0.0004 m^3) with an internal diameter of 8 in ± 0.10 in. (200 mm ± 3 mm) and a height of approximately 8 in ± 0.5 in.(200 mm ± 10 mm) equipped with a detachable metal collar, 4 in. (100 mm) in height.

Note: Molds currently in use which exceed the Volume shown in 3.1.1 may be continued in use provided the results obtained on a comparison sample fall within the precision limits acceptable for multi-laboratory results.

3.2. Base Plate - A steel plate, 0.24 in. (6 mm) in thickness, with an external vibrator riveted or bolted to the underside. This plate shall be equipped with a threaded collar, or other means for attaching the mold.

3.3. Support Rods - The support rods shall be of steel, adequate in size, to support the mold and plate assembly during the test. The ends of these rods are embedded in a heavy concrete cast base. These rods may carry large rubber stoppers above and below the base plate that is attached to the top of these rods for added resilience.

3.4. Pedestal for LVD Machine - See page 5.

3.5. Vibrator Motor - The vibrator motor shall be set to produce 500 lbs (2500 N.)

3.6. Balances or Scales - The balances or scales shall have a capacity of 30,000 g, graduated to 9 g.

3.7. Ovens - An oven with sufficient capacity to hold moisture samples capable of maintaining a temperature of 230 ± 9°F (110°C ± 5°C).

3.8. Steel Straight Edge - A steel straight edge at least 12 in. (300 mm) long and 0.10 in. (3 mm) thick.

3.9. Moisture Sample Containers - Moisture sample containers capable of holding a minimum of 5 lbs (2.3 kg).

3.10. Mixing pans 36 in x 36 in x 6 in (900 mm x 900 mm x 150 mm) trowels, scoop, etc.

4. Sample

4.1. A blended mixture of gravel and soil, or a graded crushed aggregate meeting the specification requirements.

5. Procedure

5.1. Determine the gradation of the sample submitted.

5.2. The gradation of the material submitted will be used to establish a job mix formula. From this same material, the Laboratory Vibrated Density will be determined. This LVD will be used to control the field densities for all material whose gradation falls within plus or minus five (5) percent for each sieve shown on the job mix formula.

5.2.1. Samples for the LVD test shall be air or oven dried with oven temperatures not exceeding 140°F (60°C) until less than one (1) percent moisture remains.

5.3. Two (2) percent water, by weight, will be mixed thoroughly and uniformly with a dried sample weighing approximately 60 lbs (27 kg).

5.4. A representative portion of the sample shall be taken from the pan of mixed material to determine the water content (minimum of 6 lbs (3 kg)).

5.5. With the collar attached to the mold, sufficient material is then placed in the mold to produce a slightly overflowing condition, and vibrated for three (3) minutes. The mold is then removed from the base plate and the collar detached. The material shall be struck off level with the top of the mold and the weight of the material established. (mold + sample - mold weight)

5.6. Successive increments of water in sufficient amount to increase the moisture content of the sample by approximately two (2) percent (usually 2.0 to 3 lb (0.9 to1.4 kg)) shall be added and the procedure in 5.4 and 5.5 repeated for each increment of water added, until there is a substantial decrease in the wet weight of the vibrated sample.

6. Calculations

6.1. The optimum moisture content and dry weight per yd^3 (m^3) of the material vibrated shall be calculated as follows:

$$W = \frac{w_1 - w_2 \times 100}{w_2} \qquad D = \frac{D_1 \times 100}{W + 100}$$

Where:
W = Optimum moisture content in percent based on the weight of oven dry material.
w_1 = Weight of wet material.
w_2 = Weight of oven dry material.
D = Dry weight/yd^3 (m^3) of vibrated material.
D_1 = Wet weight/yd^3 (m^3) of vibrated material.

7. Plotting And Determining The Moisture-Density Relationship

7.1. The calculations in 6.1 are made to determine the moisture content and corresponding oven-dry weight/yd^3 (m^3) of the compacted material for each determination made.

7.2. The moisture content is plotted as abscissas and the dry weight/yd^3 (m^3) as ordinates. A smooth line will be drawn through these points to establish a curve.

7.3. The moisture content corresponding to the peak of the curve shall be the Optimum Moisture Content for the compaction specified herein.

7.4. The oven-dry weight in grams/g^3 (m^3) of the soil at optimum moisture shall be termed Laboratory Vibrated Density for the compaction specified herein.

8. Reporting

8.1. Report the following item for each test on form BMT-16.

8.1.1. Optimum Moisture Content to nearest 0.1%.

8.1.2. Lab Vibrated Density (LVD) to nearest lb (kg.)

8.1.3. Gradation

1. If the material is 100 percent crushed stone, gravel or slag, the gradation will be reported, based on the sample as a whole.

2. If the material is a blend of stone and soil binder, it will be reported in the currently used method based on splitting the sample on the No. 8 (2.36 mm) sieve.

8.1.4. Specific Gravity (AASHTO T-100).

8.1.5. Percent Voids or Porosity

8.1.6. Calculate the Voids as follows:

$$\frac{(A \times W) - C}{A \times W} \times 100$$

Where:
A = Specific gravity of material.
W = Wt. /yd^3 (m^3) of water.
C = Plotted dry wt. / yd^3 (m^3) of material.

9. Precision Statement

9.1. Reproducibility (multi-laboratory) - Two results obtained from the same material by different operators in different laboratories should be considered suspect if they differ by more than fifteen (15) percent of their mean for Optimum Moisture and 3lb/ft^3 (46.8 kg/m^3) for Maximum Density.

Pedestal for L.V.D. Machine

The 0.5 in. (13 mm) steel rods are 12 in. (300 mm) long. The bottom 6 in. (150 mm) will be cast in the concrete, leaving a 6 in. (150 mm) stub above the concrete. A 6 in. (150 mm) piece will be threaded to fit the base plate of the machine and will be furnished. The center to center location of the rods is very important since they will be connected to the ones on machine base with rubber tubing. The #10 rubber stoppers are to be cast 0.2 in. (6 mm) deep in the bottom block. A 3-phase, 220 volt line will be necessary to install the starter box.

Dimensions shall be sufficient to produce a block weighing a minimum of 200 lbs (92 kg).
See Materials and Tests Soils Laboratory for design of L.V.D. Machine.