Recommend Approval: Team Leader 03/05/12 Date Division Chief 3/05/2012 Date Approved: Director 05/03/12 Date	Maryland Department of Transportation State Highway Administration Office of Materials Technology MARYLAND STANDARD METHOD OF TESTS	
	FIELD DETERMINATION OF MOISTURE DENSITY RELATIONS OF SOILS	**MSMT 351**

SCOPE:

This procedure is used to determine the wet density and moisture content of soils and soil aggregate mixtures.

REFERENCE DOCUMENTS:

MSMT 251	Determination of the Amount of Stabilization Agent in Bases and Subbases
MSMT 350	In-Place Density of Embankment, Subbase, Base, Surface and Shoulder Materials
T 99	Moisture-Density Relations of Soils Using a 2.5-kg (5.5 lb) Rammer and a 3.5-mm (12-in.) Drop.
T 180	Moisture-Density Relations of Soils Using a 4.54-(10 lb) Rammer and a 457 mm (18-in.) Drop.

MATERIALS AND EQUIPMENT:

Refer to MSMT 350.

TEST PROCEDURES:

A. METHOD 1 (*MODIFIED T 180, METHOD C*)

1. Select a representative sample of at least 12 lbs from the test site.

2. Obtain a representative moisture sample as specified in MSMT 251.

3. Weigh the sample and sieve through the 2 in., ¾ in. and No. 4 sieves into the pan. Discard all material retained on the 2 in. sieve.

4. Weigh and discard all material retained on the ¾ in. sieve. Weigh the material retained on the No. 4 sieve. If more than 35 percent of the material is retained on the No. 4 sieve, refer to METHOD 2.

5. Thoroughly mix the sample and compact the soil into the assembled 4 in. diameter mold with extension collar in five approximately equal layers. Compact each layer with 25 uniformly distributed blows with the 10 lb rammer to get a specimen height of approximately 5 in. Place the mold on a dense, uniform, rigid, and stable foundation during compaction.

6. Following compaction, remove the extension collar, carefully trim the compacted soil even with the top of the mold using the straightedge, and then weigh to the nearest 0.01 lb.

7. Determine the wet density of the compacted soil as shown in **CALCULATIONS**.

8. Plot the wet density obtained in the one step test at the percent moisture on the Typical Curve Chart.

9. Should this point fall directly on one of the curves, determine the maximum density of that curve.

10. Should this point fall between two curves and to the left of the maximum density optimum moisture line, interpolate the maximum dry density as follows:

(a) Project the point upwards and to the right, keeping it proportionately the same distance between the two guide curves.

(b) Continue this projection until it intersects the maximum dry density-optimum moisture line on the chart.

(c) This point of intersection represents the maximum dry density and optimum moisture content for the particular soil.

If the plotted point falls above or to the right of the maximum dry density-optimum moisture line, dry the material to lower the moisture content and perform another one step moisture density. Plot the new results as detailed in Steps 9, 10 and 11.

If the plotted point falls outside the range covered by the group of curves, that is, above the highest curve on the chart or below the lowest curve on the chart, it will be necessary to run a completely new curve.

B. METHOD 2 (*MODIFIED T 180, METHOD D***)**

For compaction of soils having more than 35 percent retained on the No. 4 sieve using a 10 lb rammer with an 18 in. drop

1. Replace the material retained on the ¾ in. sieve with material of equal weight passing the ¾ in. sieve and retained on the No. 4 sieve.

2. Thoroughly mix the sample and compact the soil into the assembled 6 in. diameter mold with extension collar in five approximately equal layers. Compact each layer with 56 uniformly distributed blows from the 10 lb rammer to get a specimen height of approximately 5 in. Place the mold on a dense, uniform, rigid, and stable foundation during compaction.

3. Follow the procedure outlined in METHOD 1, Steps 7 through 11.

C. METHOD 3 (*MODIFIED T 99, METHOD C***)**

1. Use a 5.5 lb rammer with a 12 in. drop and follow the procedure outlined in METHOD 1, Steps 1 through 11.

D. METHOD 4 (*MODIFIED T 99, METHOD D***)**

1. Use a 5.5 lb rammer with a 12 in. drop and follow the procedure outlined in METHOD 2.

DETERMINATION OF THE MOISTURE - DENSITY CURVE

1. Refer to test procedures of METHOD 1, Steps 1, 3, 4, and 5.

2. Dry the sample to a slightly moist condition.

3. Compact the sample in accordance with the appropriate method.

4. Remove the specimen from the mold and vertically cut through the center. Obtain a sample from one of the cut faces to determine the moisture content as specified in MSMT 251.

5. Thoroughly break up the remainder of the specimen and add the remaining portion of the 12 lb test sample.

6. Add water to increase the moisture content by 1 or 2 percent and repeat Steps 3 through 5. Continue these procedures until there is no change or decrease in the wet weight per ft^3.

7. Connect the plotted points with a line, forming a parabolic shape curve.

8. Draw a line parallel to the diagonal dry density lines of the chart on a tangent to the upper most part of the new curve. By extrapolating this line to the dry density side of the typical curve chart, obtain the maximum dry density of the soil. At the contact point of the tangent line and the new curve, drop vertically to obtain the optimum moisture content.

CALCULATIONS:

Calculate the wet density in lb/ft^3 as follows:

$$W = \frac{A - B}{C}$$

where:

W = wet density in lb/ft^3,
A = weight of compacted specimen and mold,
B = weight of mold, and
C = volume of mold.

REPORT:

Report the wet density to the nearest 1.0 lb/ft^3.