INDIANA DEPARTMENT OF TRANSPORTATION
DIVISION OF MATERIALS AND TESTS

FIELD DETERMINATION OF MAXIMUM DRY DENSITY AND OPTIMUM MOISTURE CONTENT OF SOIL
ITM No. 512-19

1.0 SCOPE.

1.1 This test method is used for field determination of the maximum dry density and optimum moisture content of a soil.

1.2 The procedure consists of compacting a soil specimen in accordance with the charts in Appendix A to determine the adjusted maximum wet density, adjusted maximum dry density, and the adjusted optimum moisture content.

1.3 This test method shall be used for clay, silty, or sandy soils. This test shall not be used for soils having 35% or less passing the No. 200 sieve.

1.4 This ITM may involve hazardous materials, operation, 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 regularity limitations prior to use.

2.0 REFERENCES.

2.1 AASHTO Standards

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 ITM Standards

506 Field Determination of Moisture Content of Soils

3.0 TERMINOLOGY.

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

3.1 Clay Soil. Soil with a maximum dry density of 114 lb/ft^3 or less

3.2 Silty Soil. Soil with a maximum dry density greater than 114 lb/ft^3 and less than or equal to120 lb/ft^3

3.3 Sandy Soil. Soil with a maximum dry density greater than 120 lb/ft^3

3.4 **Granular Soil.** Soil that is non-cohesive with 35% or less passing the No. 200 sieve.

4.0 SIGNIFICANCE AND USE.

4.1 This ITM shall be used to determine the maximum dry density and optimum moisture content of clay soils, sandy soils, and silty soils in the field. These procedures are not applicable for granular soils, b borrow, structure backfill, coarse or fine aggregates, or chemical modified soils.

5.0 APPARATUS.

5.1 Balance, Class G 2, in accordance with AASHTO M 231

5.2 Balance, Class G 20, in accordance with AASHTO M 231

5.3 Compaction base, in accordance with AASHTO T 99

5.4 Drying apparatus, in accordance with ITM 506

5.5 Mixing tools, mixing pan, spoon, trowel, spatula, etc.

5.6 4 in. mold, with detachable collar and base plate, in accordance with AASHTO T 99

5.7 Rammer, with a weight of 5.5 lb having a circular face of 2 in. diameter, in accordance with AASHTO T 99

5.8 Sample extruder

5.9 Sieve, No.4

5.10 Straightedge, at least 10 in. in length

6.0 SAMPLE PREPARATION.

6.1 Obtain approximately 2500 g of soil

6.2 Break up the soil and sieve through a No. 4 sieve

6.3 Discard the soil retained on the No. 4 sieve.

6.4 Measure the moisture content in accordance with ITM 506.

7.0. PROCEDURE.

7.1 Weigh the mold with base plate

7.2 Place the mold, with base plate and collar attached, on a hard and stable surface

7.3 Thoroughly mix 2500 g of the sample so that the moisture is uniform

7.4 Place approximately one-third of the sample in the mold

7.5 Compact the first layer of the specimen with the 5.5 lb hammer using 25 uniformly distributed blows dropped from a height of 12 in.

7.6 Repeat Step 7.4 and Step 7.5 for the second and third layers of the specimen

7.7 Following compaction of the third layer, remove the collar and carefully trim the specimen at the top of the mold with the straightedge

7.8 Weigh the mold, base plate and specimen

7.9 Remove the specimen from the mold and take a representative sample of the specimen. Determine the moisture content in accordance with ITM 506.

7.10 Determine the weight of the specimen by subtracting the weight of the mold and base plate from the weight of the mold, base plate and specimen

7.11 Determine the wet density of the specimen by multiplying the mold constant value of 30 (Proctor mold volume of 1/30 cubic foot) by the weight of the specimen

7.12 Using the moisture content and wet density of the specimen, determine the maximum dry density and optimum moisture content in accordance with 8.0

8.0 MAXIMUM DRY DENSITY AND OPTIMUM MOISTURE CONTENT.

8.1 Using the charts in Appendix A, plot a point on the Maximum Wet Density vs. Moisture Content chart determined from the wet density and moisture content obtained (Figure 1). If the point is between two curves on the chart, project the point, using the same curvature as the nearest line, to the maximum wet density/moisture content solid line. The intersecting point on the solid line is the adjusted maximum wet density of the soil.

8.2 Draw a horizontal line from the point on the maximum wet density/moisture content solid line to intersect the Maximum Wet Density vs. Maximum Dry Density line (Figure 2).

8.3 Verify that the moisture content is within -3 % and +1 % of the optimum moisture content. If the moisture content is greater than +1 % of the optimum moisture content, the material shall be dried. If the moisture content is less than -3% of the optimum moisture content, water shall be added to the sample.

8.4 Draw a vertical line from the intersection point on the line in Figure 2 to the Optimum Moisture Content vs. Maximum Dry Density line (Figure 3). The intersecting point on the horizontal axis of the Maximum Wet Density vs. Maximum Dry Density chart (Figure 2) is the adjusted maximum dry density of the soil.

8.5 Draw a horizontal line from the intersection point on the line in Figure 3 to the vertical axis of the Optimum Moisture Content vs. Maximum Dry Density chart (Figure 3). The intersecting value on the vertical axis of the Optimum Moisture Content vs. Maximum Dry Density chart (Figure 3) is the adjusted optimum moisture content of the soil.

Note 1: Appendix B has three examples of the procedure indicated in 8.1 through 8.4 to determine the adjusted maximum wet density, adjusted maximum dry density, and the adjusted optimum moisture content.

9.0. CALCULATIONS. The following equations are used for the determination of the moisture content, wet density, and dry density of a soil sample.

9.1 Moisture Content.

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

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

9.2 Wet Density.

Wet Density, lb/ft^3 = Wet Wt. of Soil in Mold (lb) x Mold Factor

where: Mold Factor = 30

9.3 Dry Density.

$$\text{Dry Density, lb/ft}^3 = \frac{\text{Wet Density, lb/ft}^3}{\text{Moisture Content,\%} + 100} \times 100$$

10.0. REPORT. The optimum moisture content is reported to the nearest 0.1 percent and the maximum dry density is reported to the nearest 1 lb/ft^3.

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Appendix A

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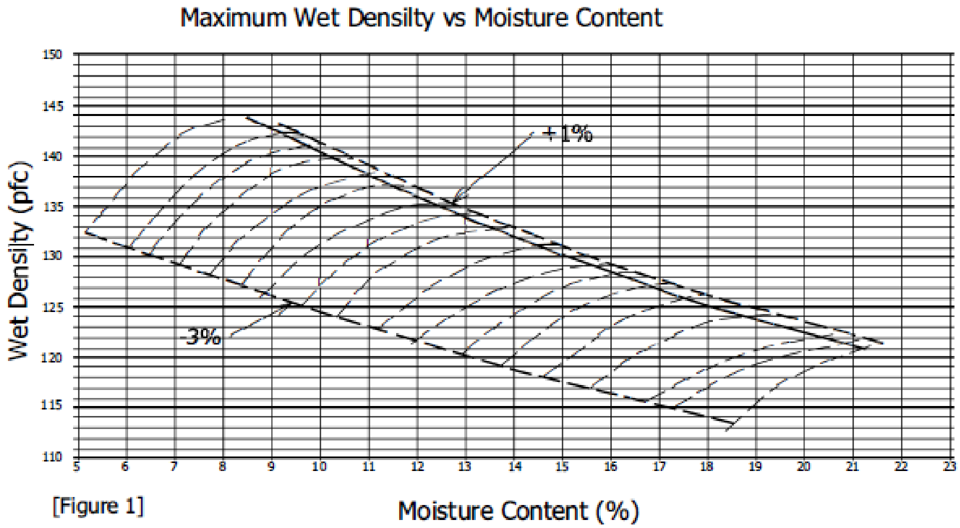
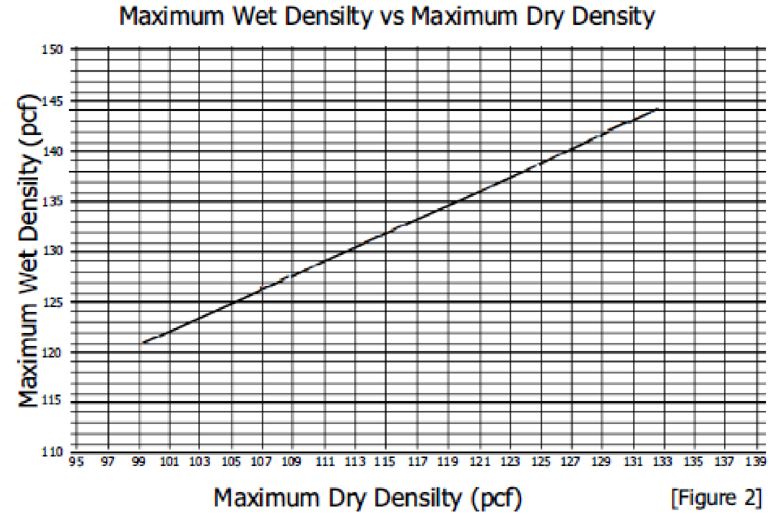
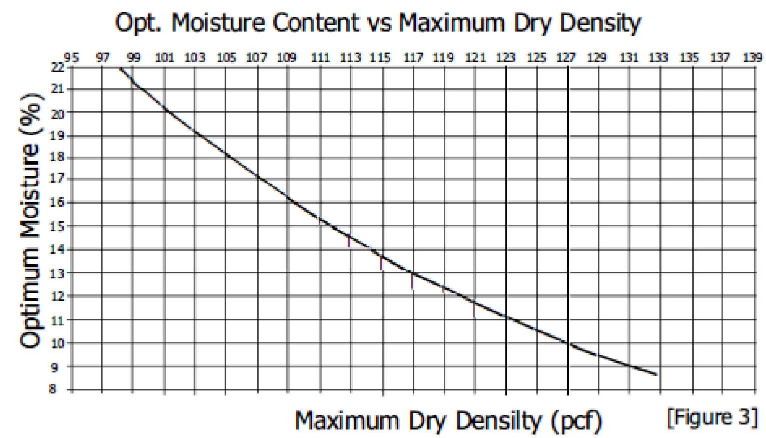
One Point Proctor, ITM 512 - 19T



[Figure 1]



[Figure 2]



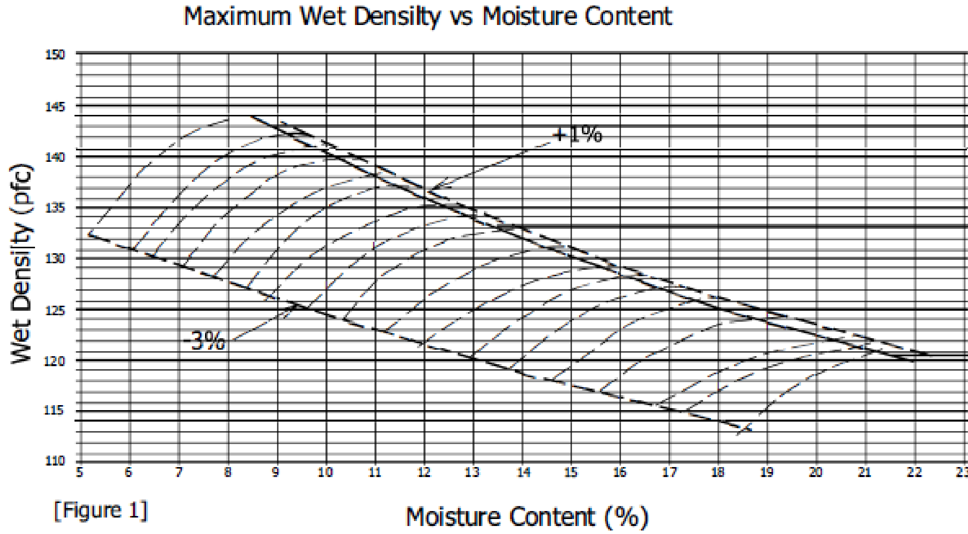
[Figure 3]

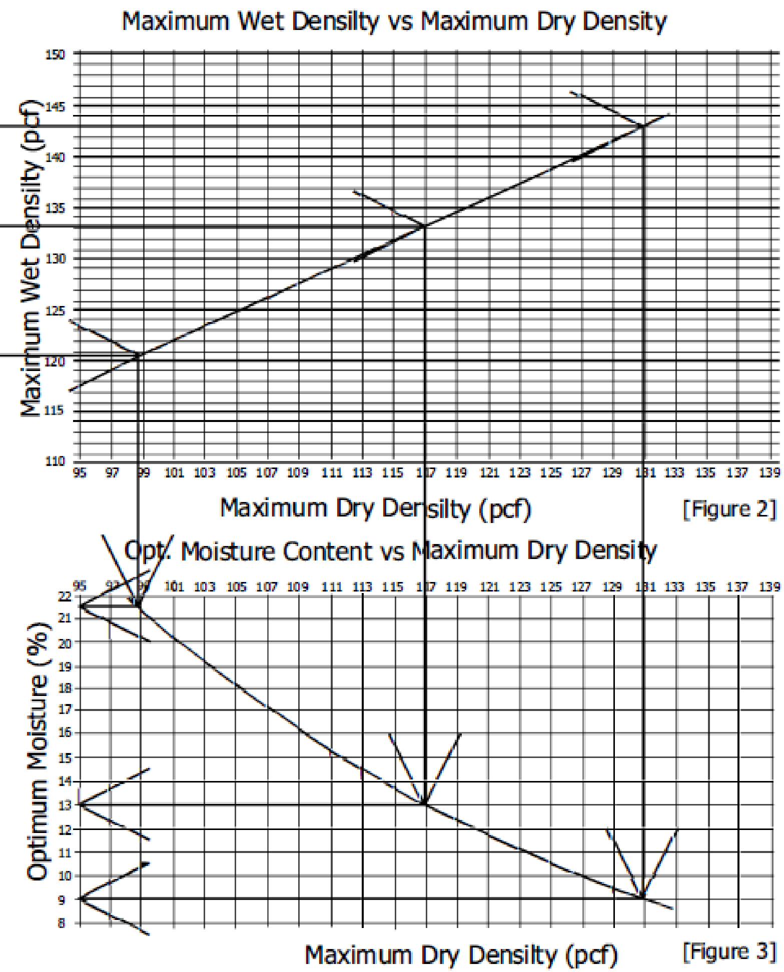
- Charts to be used for Clay, Silty, or Sandy soils only. This test shall not be used for soil having less than 35% passing No. 200 sieve

- Moisture is required to be between -3% and +1% for a valid Maximum Wet Density.

- These charts are an alternative to the family of Curves and may be use in accordance with ITM 512

One Point Proctor, ITM 512 - 19T
Example





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