**INDIANA DEPARTMENT OF TRANSPORTATION**
*Driving Indiana's Economic Growth*

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**Michael R. Pence, Governor**
**Michael B. Cline, Commissioner**

May 29, 2013

**CONSTRUCTION MEMORANDUM**
**13-06**

TO: District Deputy Commissioners
District Construction Directors
District Technical Service Directors
District Testing Engineers
District Area Engineers
District LPA Coordinators
Field Engineers
Project Engineers/Supervisors
Office of Materials Management

FROM: Mark A. Miller, Director
Division of Construction Management

SUBJECT: Update Notice for Field Testing of Soils and One Point Proctors

The purpose of this memorandum is to give notice to all personnel that the information concerning the field testing of soils and One Point Proctors have been updated. A "Field Testing of Soils and Aggregate" (rev. 3/1/13) manual and new ITM 512 has been recently added to reflect the changes to field testing methods for clay, silty, and sandy soils.

As soils may have a wide variation in properties on a given contract, determination of the correct Dynamic Cone Penetrometer, DCP, criteria or the maximum dry density and optimum moisture content in a laboratory for every possible soil combination is difficult. The new field procedure utilizes AASHTO T 272, One Point Proctor, to determine the adjusted maximum wet density, adjusted maximum dry density, and the adjusted optimum moisture content in the field.

This field testing procedure is a quick process for determining the required DCP blow counts for multiple soil types on a given contract. Establishing the maximum dry density and optimum moisture content through compaction of the soil in accordance with AASHTO T 272 and the use of the charts in the "Field Testing of Soils and Aggregate" manual, the target DCP blow count for a particular soil can then be determined in the field.

Attached to this memorandum you will find the "Field Testing of Soils and Aggregate" manual and new ITM 512. Also below, you will find the hyperlinks for portable reference. Please take time to review the new documents and to also take note of any changes in numeric values or procedures.

**Field Testing of Soils and Aggregate**
Internet:

- Located in Materials Management Information under Publications & Manuals (http://www.in.gov/indot/2736.htm)

Intranet:

- Located in INDOT Office of Materials Management under Geotechnical Materials (http://intranet.indot.state.in.us/materialtests/)

**ITM 512**
Internet:

- Located in Materials Management Information under Indiana Test Methods or Procedures Index (http://www.in.gov/indot/div/mt/itm/itm.htm)

If you should have any questions relating to the memo, please do not hesitate to contact the Office of Materials Management for further information.

MAM/ddh

# INDIANA DEPARTMENT OF TRANSPORTATION
# OFFICE OF MATERIALS MANAGEMENT

# FIELD DETERMINATION OF MAXIMUM DRY DENSITY AND OPTIMUM MOISTURE CONTENT OF SOIL
# ITM No. 512-13T

## 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 AASHTO T 272, Method A and using 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.

**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

T 272 Family of Curves-One Point Method

### 2.2 ITM Standards

506 Field Determination of Moisture Content of Soils

**3.0 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 112 lb/ft$^3$ or less

**3.2 Silty Soil.** Soil with a maximum dry density greater than 112 lb/ft$^3$ and less than or equal to 120 lb/ft$^3$

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

## 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** 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 to 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.

## 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 by means of the sample extruder and slice the specimen vertically through the center. Take a representative sample of the specimen from one of the cut faces and 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** 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.

**8.4** 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.**

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

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

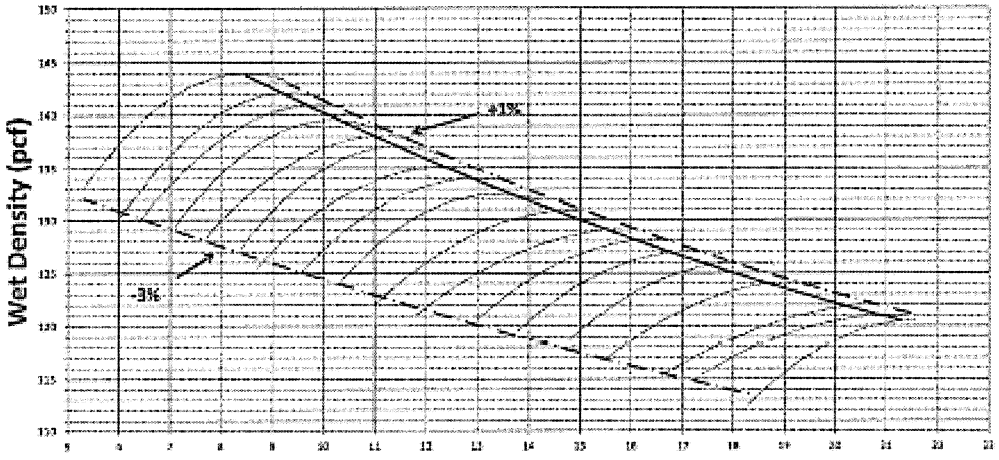
**9.3 Dry Density.**

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

**10.0. REPORT.** The optimum moisture content is reported to the nearest whole number and the maximum dry density is reported to the nearest 1 $lb/ft^3$.

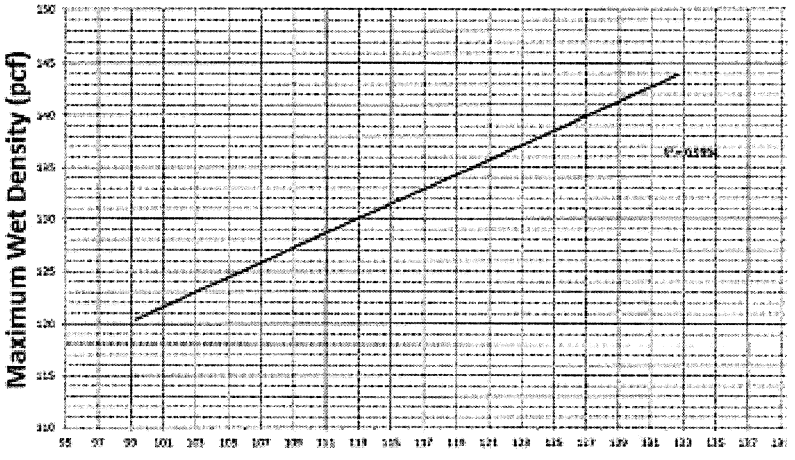
# One Point Proctor, AASHTO T 272

Maximum Wet Density vs Moisture Content




[Figure 1]

Maximum Wet Density vs Maximum Dry Density



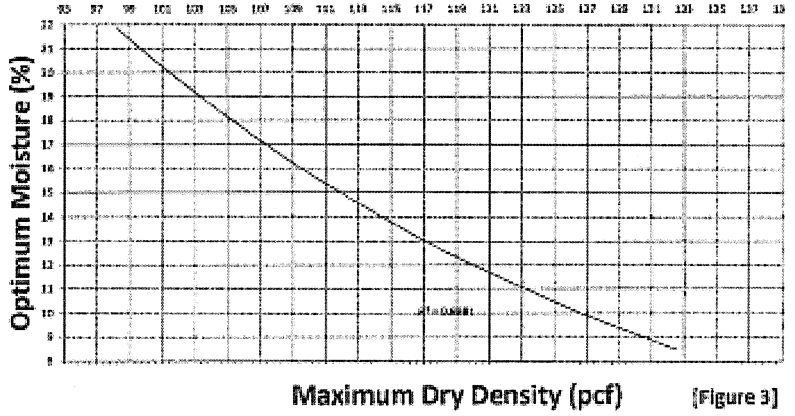

[Figure 2]

- Charts to be used for Clay, Silty, or Sandy soils only.

-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 used in accordance with AASHTO T 272.

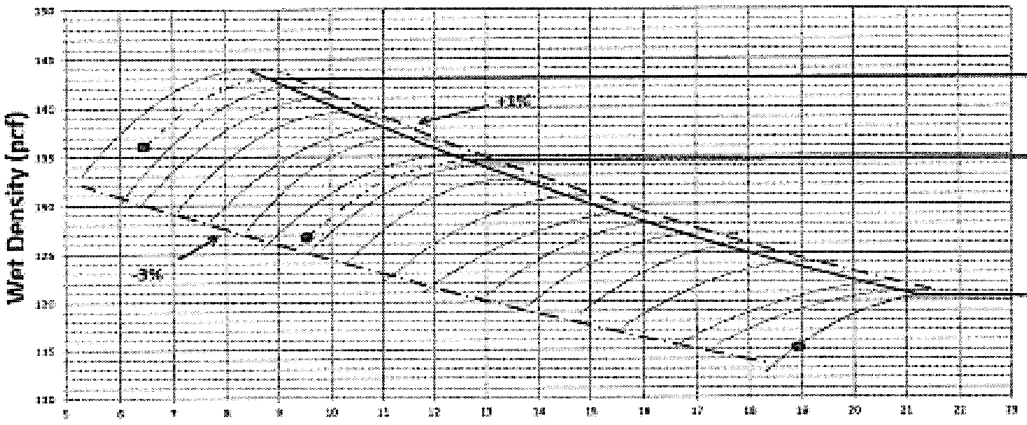
Opt. Moisture Content vs Maximum Dry Density




[Figure 3]

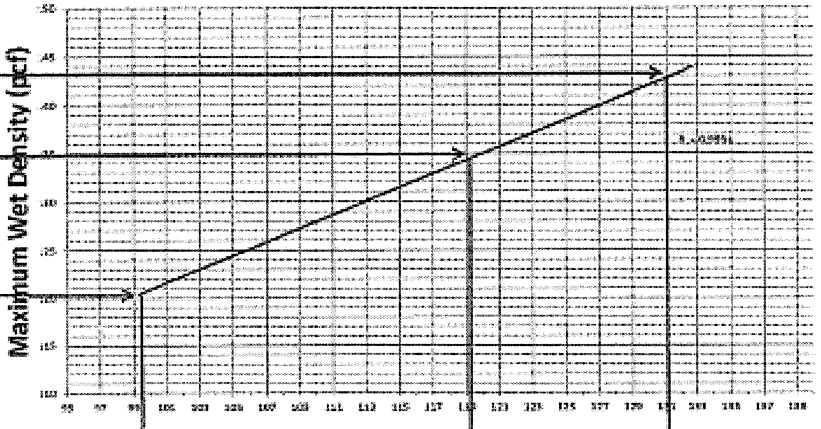
# One Point Proctor, AASHTO T 272
# Example

**Maximum Wet Density vs Moisture Content**



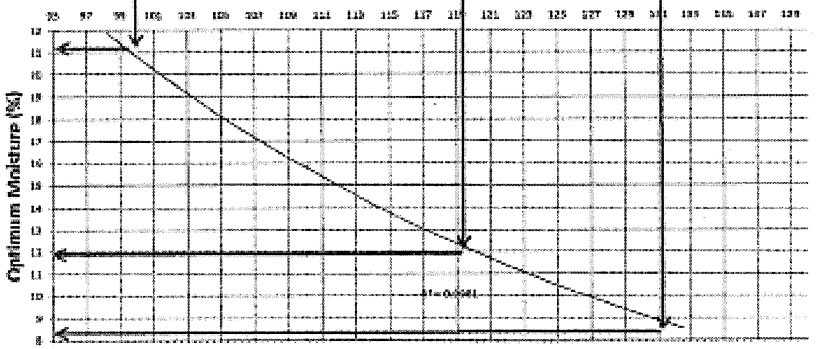

[Figure 1]

**Maximum Wet Density vs Maximum Dry Density**




[Figure 2]

**Opt. Moisture Content vs Maximum Dry Density**




[Figure 3]

**- Charts to be used for Clay, Silty, or Sandy soils only.**

**-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 used in accordance with AASHTO T 272.**