

## **ONE-POINT METHOD FOR DETERMINING MAXIMUM DRY DENSITY AND OPTIMUM MOISTURE FOP FOR AASHTO T 272**

### **Scope**

This procedure provides for a rapid determination of the maximum dry density and optimum moisture content of a soil sample, using a one-point determination in accordance with AASHTO T 272-18. This procedure is related to the FOPs for AASHTO T 99/T 180 and R 75.

One-point determinations are made by compacting the soil in a mold of a given size with a specified rammer dropped from a specified height and then compared to an individual moisture/density curve (FOP for AASHTO T 99 or T 180) or a family of curves (FOP for AASHTO R 75). Four alternate methods – A, B, C, and D – are used and correspond to the methods described in the FOP for AASHTO T 99/T 180. The method used in AASHTO T 272 must match the method used for the reference curve or to establish the family of curves. For example, when moisture-density relationships as determined by T 99 - Method C are used to form the family of curves or an individual moisture density curve, then T 99 - Method C must be used to for the one-point determination.

### **Apparatus**

See the FOP for AASHTO T 99/T 180. Use the method matching the individual curve or Family of Curves. Refer to Table 1 of the FOP for AASHTO T 99 / T 180 for corresponding mold size, number of layers, number of blows, and rammer specification for the various test methods.

### **Sample**

Sample size determined according to the FOP for AASHTO T 310. In cases where the existing individual curve or family cannot be used a completely new curve will need to be developed and the sample size will be determined by the FOP for AASHTO T 99/T 180.

If the sample is damp, dry it until it becomes friable under a trowel. Drying may be in air or by use of a drying apparatus maintained at a temperature not exceeding 60°C (140°F). Thoroughly break up aggregations in a manner that avoids reducing the natural size of individual particles.

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## Procedure

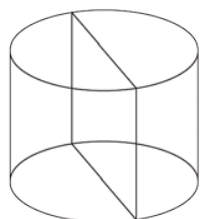
1. Determine the mass of the clean, dry mold. Include the base plate but exclude the extension collar. Record the mass to the nearest 1 g (0.005 lb).
  2. Thoroughly mix the sample with sufficient water to adjust moisture content to 80 to 100 percent of the anticipated optimum moisture.
  3. Form a specimen by compacting the prepared soil in the mold (with collar attached) in approximately equal layers. For each layer:
    - a. Spread the loose material uniformly in the mold.
- Note 1:** It is recommended to cover the remaining material with a non-absorbent sheet or damp cloth to minimize loss of moisture.
- b. Lightly tamp the loose material with the manual rammer or other similar device, this establishes a firm surface.
    - c. Compact each layer with uniformly distributed blows from the rammer.
    - d. Trim down material that has not been compacted and remains adjacent to the walls of the mold and extends above the compacted surface.
  4. Clean soil from exterior of the mold and base plate.
  5. Remove the extension collar. Avoid shearing off the sample below the top of the mold. The material compacted in the mold should not be over 6 mm (¼ in.) above the top of the mold once the collar has been removed.
  6. Trim the compacted soil even with the top of the mold with the beveled side of the straightedge.
  7. Clean soil from exterior of the mold and base plate.
  8. Determine the mass of the mold and wet soil to the nearest 1 g (0.005 lb) or better.
  9. Determine the wet mass of the sample by subtracting the mass in Step 1 from the mass in Step 6.
  10. Calculate the wet density as indicated below under “Calculations.”

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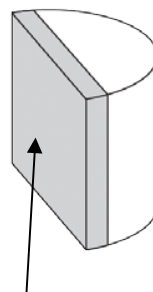
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11. Extrude the material from the mold. For soils and soil-aggregate mixtures, slice vertically through the center and take a representative moisture content sample from one of the cut faces, ensuring that all layers are represented. For granular materials, a vertical face will not exist. Take a representative sample. This sample must meet the sample size requirements of the test method used to determine moisture content.



Extruded material



Representative moisture  
content sample

12. Determine the moisture content of the sample in accordance with the FOP for AASHTO T 255 / T 265.

### Calculations

1. Calculate the wet density, in  $\text{kg/m}^3$  ( $\text{lb/ft}^3$ ), by dividing the wet mass by the measured volume of the mold (T 19).

Example – Methods A or C mold:

Wet mass = 2.0055 kg (4.42 lb)

Measured volume of the mold =  $0.0009469 \text{ m}^3$  ( $0.03344 \text{ ft}^3$ )

$$\text{Wet Density} = \frac{2.0055 \text{ kg}}{0.0009469 \text{ m}^3} = 2118 \text{ kg/m}^3$$

$$\text{Wet Density} = \frac{4.42 \text{ lb}}{0.03344 \text{ ft}^3} = 132.2 \text{ lb/ft}^3$$

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2. Calculate the dry density as follows.

$$\rho_d = \left( \frac{\rho_w}{w + 100} \right) \times 100 \quad \text{or} \quad \rho_d = \frac{\rho_w}{\left( \frac{w}{100} \right) + 1}$$

Where:

$\rho_d$  = Dry density, kg/m<sup>3</sup> (lb/ft<sup>3</sup>)  
 $\rho_w$  = Wet density, kg/m<sup>3</sup> (lb/ft<sup>3</sup>)  
 $w$  = Moisture content, as a percentage

Example:

$\rho_w = 2118 \text{ kg/m}^3$  (132.2 lb/ft<sup>3</sup>)  
 $w = 13.5\%$

$$\rho_d = \left( \frac{2118 \text{ kg/m}^3}{13.5 + 100} \right) \times 100 = 1866 \text{ kg/m}^3 \quad \rho_d = \left( \frac{132.2 \text{ lb/ft}^3}{13.5 + 100} \right) \times 100 = 116.5 \text{ lb/ft}^3$$

or

$$\rho_d = \left( \frac{2118 \text{ kg/m}^3}{\frac{13.5}{100} + 1} \right) = 1866 \text{ kg/m}^3 \quad \rho_d = \left( \frac{132.2 \text{ lb/ft}^3}{\frac{13.5}{100} + 1} \right) = 116.5 \text{ lb/ft}^3$$

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### Maximum Dry Density and Optimum Moisture Content Determination Using an Individual Moisture / Density Curve

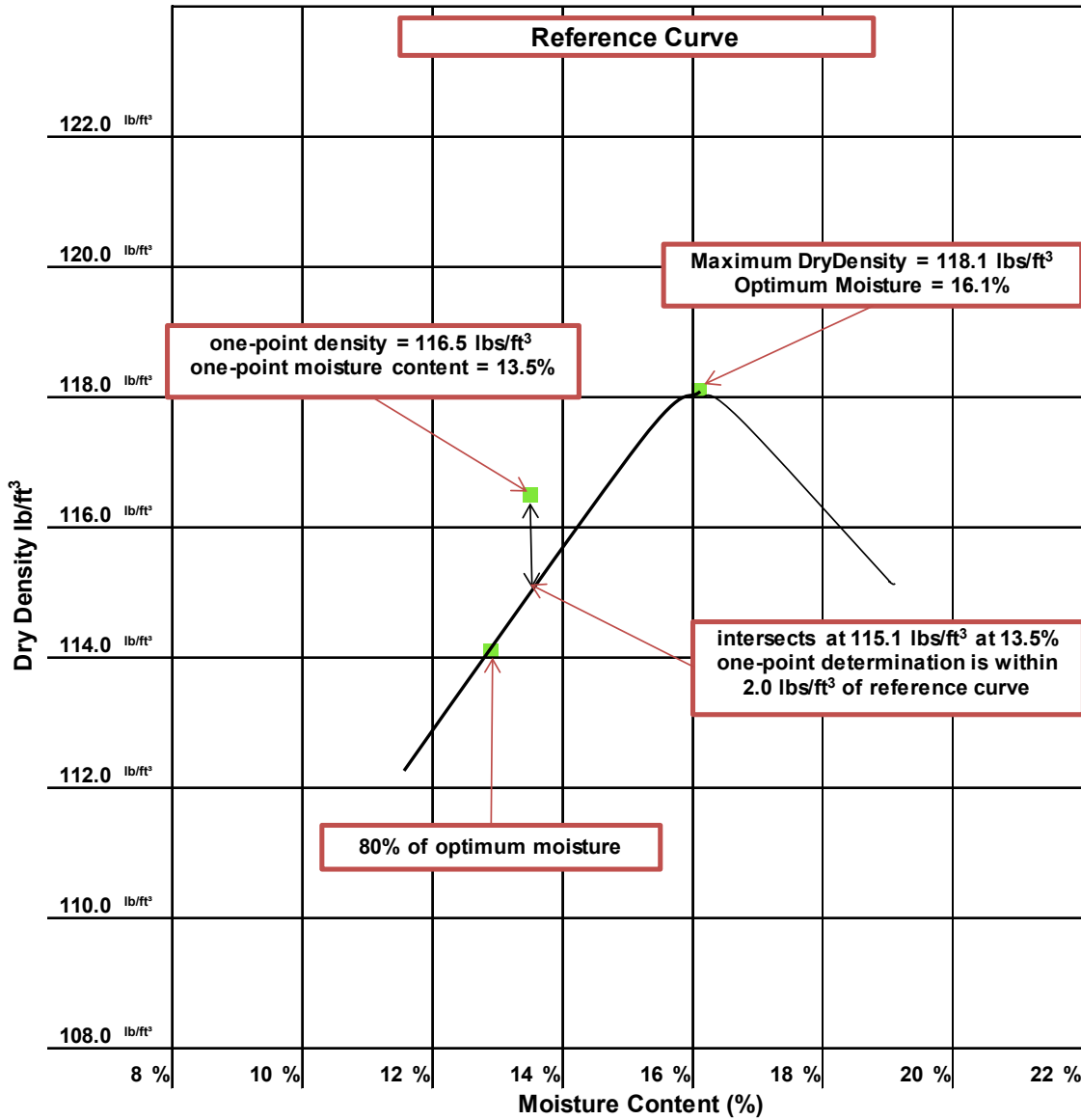
1. The moisture content must be within 80 to 100 percent of optimum moisture of the reference curve. Compact another specimen, using the same material, at an adjusted moisture content if the one-point does not fall in the 80 to 100 percent of optimum moisture range.
2. Plot the one-point, dry density on the vertical axis and moisture content on the horizontal axis, on the reference curve graph.
3. If the one-point falls on the reference curve or within  $\pm 2.0$  lbs/ft<sup>3</sup>, use the maximum dry density and optimum moisture content determined by the curve.
4. Use the FOP for AASHTO T 99/T 180 Annex A to determine corrected maximum dry density and optimum moisture content if oversize particles have been removed.
5. Perform a full moisture-density relationship if the one-point does not fall on or within  $\pm 2.0$  lbs/ft<sup>3</sup> of the reference curve at 80 to 100 percent optimum moisture.

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Example



The results of a one-point determination were 116.5 lb/ft<sup>3</sup> at 13.5 percent moisture. The point was plotted on the reference curve graph. The one-point determination is within 2.0 lb/ft<sup>3</sup> of the point on the curve that corresponds with the moisture content.

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### Maximum Dry Density and Optimum Moisture Content Determination Using a Family of Curves

1. Plot the one-point, dry density on the vertical axis and moisture content on the horizontal axis, on the reference family of curves graph.
- 1.2.If the moisture-density one-point falls on one of the curves in the family of curves, use the maximum dry density and optimum moisture content defined by that curve.
- 2.3.If the moisture-density one-point falls within the family of curves but not on an existing curve, draw a new curve through the plotted single point, parallel and in character with the nearest existing curve in the family of curves. Use the maximum dry density and optimum moisture content as defined by the new curve.
  - a. The one-point must fall either between or on the highest or lowest curves in the family. If it does not, then a full curve must be developed.
  - b. If the one-point plotted within or on the family of curves does not fall in the 80 to 100 percent of optimum moisture content, compact another specimen, using the same material, at an adjusted moisture content that will place the one point within this range.
4. Use the FOP for AASHTO T 99/T 180 Annex A to determine corrected maximum dry density and optimum moisture content if oversize particles have been removed.
- 3.5.If the new curve through a one-point is not well defined or is in any way questionable, perform a full moisture-density relationship to correctly define the new curve and verify the applicability of the family of curves.

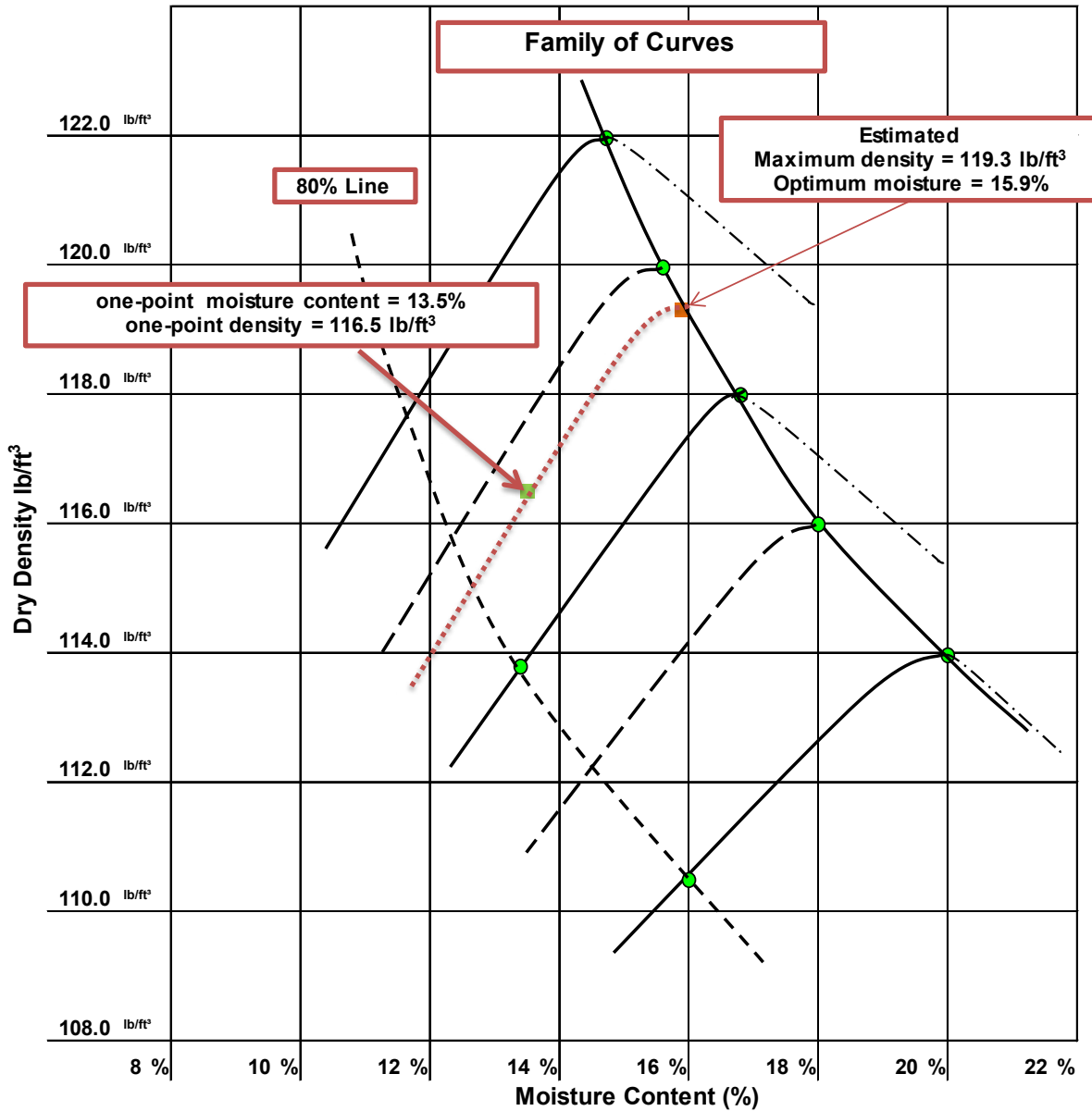
**Note 2:** New curves drawn through plotted single point determinations shall not become a permanent part of the family of curves until verified by a full moisture-density procedure following the FOP for AASHTO T 99/T 180.

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EXAMPLE



The results of a one-point determination were 116.5 lb/ft<sup>3</sup> at 13.5 percent moisture. The point was plotted on the reference curve graph. The point was plotted on the appropriate family between two previously developed curves near and intermediate curve.

The “dotted” curve through the moisture-density one-point was sketched between the existing curves. A maximum dry density of 119.3 lb/ft<sup>3</sup> and a corresponding optimum moisture content of 15.9 percent were estimated.



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## Report

- Results on forms approved by the agency
- Sample ID
- Maximum dry density to the closest  $1 \text{ kg/m}^3$  ( $0.1 \text{ lb/ft}^3$ )
- Corrected maximum dry density (if applicable)
- Optimum moisture content to the closest 0.1 percent
- Corrected optimum moisture content (if applicable)
- Reference curve or Family of Curves used

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**PERFORMANCE EXAM CHECKLIST**

**ONE-POINT METHOD  
FOP FOR AASHTO T 272 (T 99)**

Participant Name \_\_\_\_\_ Exam Date \_\_\_\_\_

Record the symbols “P” for passing or “F” for failing on each step of the checklist.

| Procedure Element   | Trial 1 | Trial 2 |
|---|---------|---------|
| 1. One-point determination of dry density and corresponding moisture content made in accordance with the FOP for AASHTO T 99?   | _____   | _____   |
| a. Correct size (4.75 mm / No. 4 or 19.0 mm / 3/4 in.) material used?   | _____   | _____   |
| 2. If necessary, sample dried until friable in air or drying apparatus, not exceeding 60°C (140°F)?   | _____   | _____   |
| 3. Sample broken up and an adequate amount sieved over the appropriate sieve (4.75 mm / No. 4 or 19.0 mm / 3/4 in.) to determine oversize (coarse particle) percentage? | _____   | _____   |
| 4. Sample passing the sieve has appropriate mass?   | _____   | _____   |
| 5. Moisture content adjusted if needed?   | _____   | _____   |
| 6. Determine mass of clean, dry mold without collar to nearest 1 g?   | _____   | _____   |
| 7. Mold placed on rigid and stable foundation?  | _____   | _____   |
| 8. Layer of soil (approximately one third compacted depth) placed in mold with collar attached, loose material lightly tamped?  | _____   | _____   |
| 9. Soil compacted with appropriate number of blows (25 or 56)?  | _____   | _____   |
| 10. Material adhering to the inside of the mold trimmed?  | _____   | _____   |
| 11. Layer of soil (approximately two thirds compacted depth) placed in mold with collar attached, loose material lightly tamped?  | _____   | _____   |
| 12. Soil compacted with appropriate number of blows (25 or 56)?   | _____   | _____   |
| 13. Material adhering to the inside of the mold trimmed?  | _____   | _____   |
| 14. Mold filled with soil such that compacted soil will be above the mold, loose material lightly tamped?   | _____   | _____   |
| 15. Soil compacted with appropriate number of blows (25 or 56)?   | _____   | _____   |
| 16. Collar removed without shearing off sample?   | _____   | _____   |
| 17. Approximately 6 mm (1/4 in.) of compacted material above the top of the mold (without the collar)?  | _____   | _____   |
| 18. Soil trimmed to top of mold with the beveled side of the straightedge?  | _____   | _____   |
| 19. Remove soil from exterior surface of mold and base plate?   | _____   | _____   |
| 20. Mass of mold and contents determined to appropriate precision?  | _____   | _____   |

**OVER**



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FOP AASHTO T 272 (18)

**PERFORMANCE EXAM CHECKLIST**

**ONE-POINT METHOD  
FOP FOR AASHTO T 272 (T 180)**

Participant Name \_\_\_\_\_ Exam Date \_\_\_\_\_

Record the symbols “P” for passing or “F” for failing on each step of the checklist.

| <b>Procedure Element</b>  | <b>Trial 1</b> | <b>Trial 2</b> |
|---|----------------|----------------|
| 1. One-point determination of dry density and corresponding moisture content made in accordance with the FOP for AASHTO T 180?  | _____          | _____          |
| a. Correct size (4.75 mm / No. 4 or 19.0 mm / 3/4 in.) material used?   | _____          | _____          |
| 2. If necessary, sample dried until friable in air or drying apparatus, not exceeding 60°C (140°F)?   | _____          | _____          |
| 3. Sample broken up and an adequate amount sieved over the appropriate sieve (4.75 mm / No. 4 or 19.0 mm / 3/4 in.) to determine oversize (coarse particle) percentage? | _____          | _____          |
| 4. Sample passing the sieve has appropriate mass?   | _____          | _____          |
| 5. Moisture content adjusted if needed?   | _____          | _____          |
| 6. Determine mass of clean, dry mold without collar to nearest 1 g?   | _____          | _____          |
| 7. Mold placed on rigid and stable foundation?  | _____          | _____          |
| 8. Layer of soil (approximately one fifth compacted depth) placed in mold with collar attached, loose material lightly tamped?  | _____          | _____          |
| 9. Soil compacted with appropriate number of blows (25 or 56)?  | _____          | _____          |
| 10. Material adhering to the inside of the mold trimmed?  | _____          | _____          |
| 11. Layer of soil (approximately two fifths compacted depth) placed in mold with collar attached, loose material lightly tamped?  | _____          | _____          |
| 12. Soil compacted with appropriate number of blows (25 or 56)?   | _____          | _____          |
| 13. Material adhering to the inside of the mold trimmed?  | _____          | _____          |
| 14. Layer of soil (approximately three fifths compacted depth) placed in mold with collar attached, loose material lightly tamped?                                      | _____          | _____          |
| 15. Soil compacted with appropriate number of blows (25 or 56)?   | _____          | _____          |
| 16. Material adhering to the inside of the mold trimmed?  | _____          | _____          |
| 17. Layer of soil (approximately four fifths compacted depth) placed in mold with collar attached, loose material lightly tamped?                                       | _____          | _____          |
| 18. Soil compacted with appropriate number of blows (25 or 56)?   | _____          | _____          |
| 19. Material adhering to the inside of the mold trimmed?  | _____          | _____          |

**OVER**

