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 soil density-relations group (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 develop the soil density-relations. For example, when moisture-density relationships as determined by T 99 – Method C are used to form the soil density-relations group 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.

Sample

Sample size determined according to the FOP for AASHTO T 310. In cases where the existing individual curve or soil density-relations group 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.

1. 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).
2. Thoroughly break up aggregations in a manner that avoids reducing the natural size of individual particles.
3. Pass the material through the appropriate sieve.

Procedure

Use the method matching the individual curve or soil density-relations group. Refer to Table 1 of the FOP for AASHTO T 99 / T 180 for corresponding mold size, number of layers, number of blows, sieve size, and rammer specification for the various test methods.

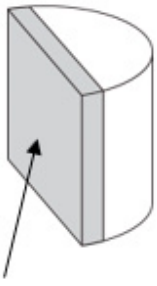
1. Determine the mass of the clean, dry mold. Include the base plate but exclude the extension collar. Record the mass to the nearest 1 g (0.005 lb).
2. Thoroughly mix the sample with sufficient water to adjust moisture content to 80 to 100 percent of the anticipated optimum moisture.

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. 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.
5. Trim the compacted soil even with the top of the mold with the beveled side of the straightedge.
6. Clean soil from exterior of the mold and base plate.
7. Determine the mass of the mold and wet soil to the nearest 1 g (0.005 lb).
8. Determine the wet mass of the sample by subtracting the mass in Step 1 from the mass in Step 7.
9. Calculate the wet density (ρ_w) as indicated below under "Calculations."
10. Extrude the material from the mold. For soils and soil-aggregate mixtures, slice vertically through the center and remove one of the cut faces for a representative moisture content sample. For granular materials, a vertical face will not exist. Take a representative sample ensuring that all layers are represented. This sample must meet the sample size requirements of the test method used to determine moisture content.

Extruded material



Representative moisture content sample

11. Determine the moisture content (w) of the sample in accordance with the FOP for AASHTO T 255 / T 265.

Calculations

Wet Density

$$\rho_w = \frac{M_w}{V_m}\frac{2.0055\ kg}{0.0009469\ m^3} = 2118\ kg/m^3$$

$$\rho_w = \frac{4.42\ lb}{0.0334\ ft^3} = 132.2\ lb/ft^3$$ Where:

ρ_w = wet density, kg/m^3 (lb/ft^3)

M_w = wet mass

V_m = volume of the mold, (FOP for AASHTO T 99/T 180)

Dry Density

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

Where:

ρ_d = dry density, kg/m^3 (lb/ft^3)

w = moisture content, as a percentage

Example for 4-inch mold, Methods A or C

Wet mass, M_w = 2.0055 kg (4.42 lb)

Moisture content, w = 13.5%

Measured volume of the mold, V_m = 0.0009469 m^3 (0.0334 ft^3)

Wet Density

$$\rho_w = \frac{2.0055\ kg}{0.0009469\ m^3} = 2118\ kg/m^3 \quad \rho_w = \frac{4.42\ lb}{0.0334\ ft^3} = 132.2\ lb/ft^3$$

Where:

ρ_w = Wet density, kg/m^3 (lb/ft^3)

Dry Density

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

or

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

ρ_d = Dry density, kg/m^3 (lb/ft^3)

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.

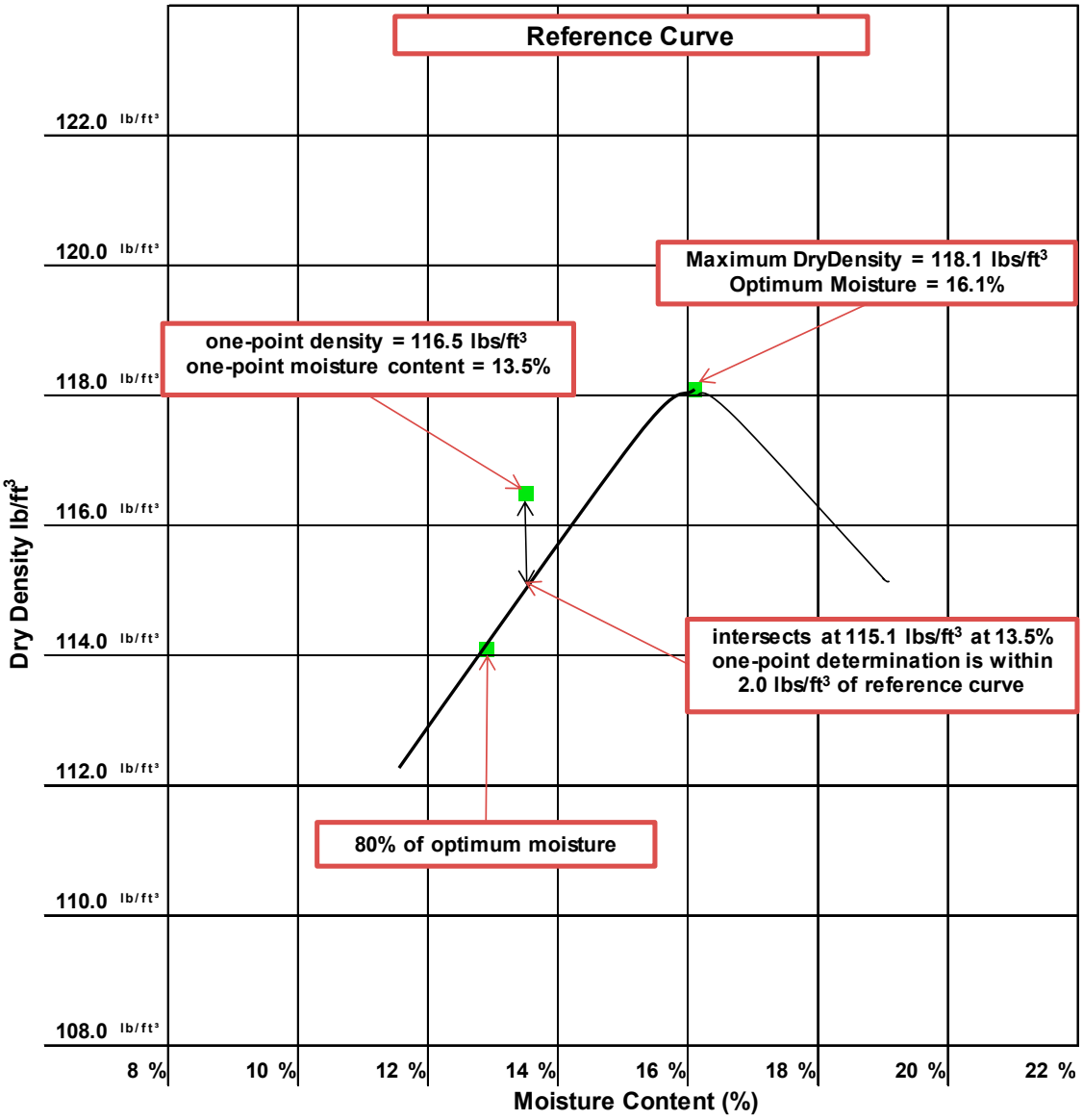
2. Plot the one-point, dry density on the vertical axis and moisture content on the horizontal axis, on the reference curve graph.

3. If the one-point falls on the reference curve or within ±2.0 lbs/ft^3, 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 ±2.0 lbs/ft^3 of the reference curve at 80 to 100 percent optimum moisture.

Example



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

Maximum Dry Density and Optimum Moisture Content Determination Using Soil Moisture-Density Relations

1. Plot the one-point, dry density on the vertical axis and moisture content on the horizontal axis, on the reference soil density-relations graph.

2. If the moisture-density one-point falls on one of the curves in the soil density-relations, use the maximum dry density and optimum moisture content defined by that curve.

3. If the moisture-density one-point falls within the soil density-relations 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 soil density-relations. 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. If it does not, then a full curve must be developed.

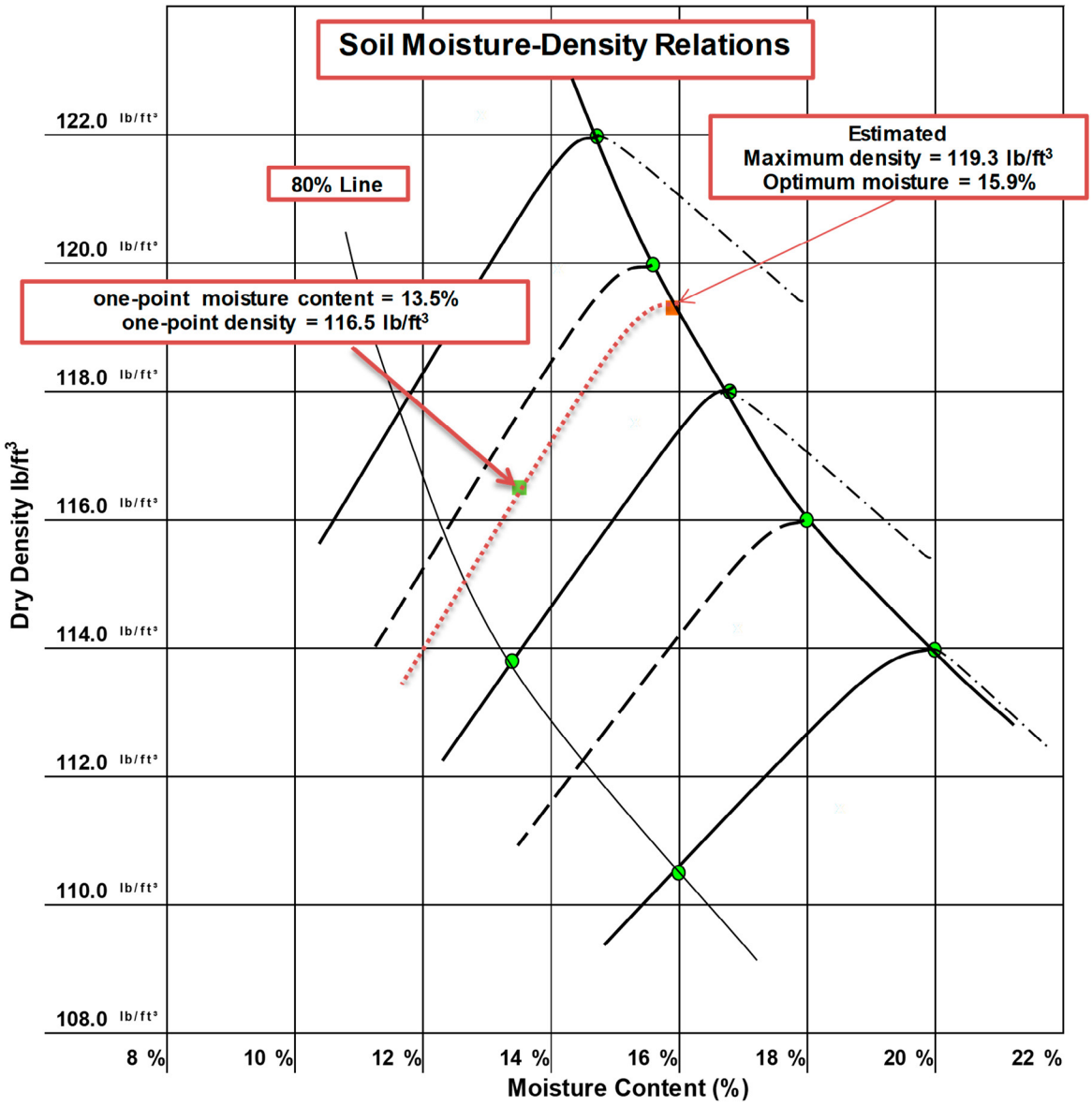
    b. If the one-point plotted within or on the soil density-relations group does not fall in the 80 to 100 percent of optimum moisture content, compact another specimen, using the same material, at an adjusted moisture content that will place the one point within this range.

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.

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 soil density-relations.

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

Example



The results of a one-point determination were 116.5 lb/ft^3 at 13.5 percent moisture. The point was plotted on the reference curve graph. The point was plotted on the appropriate group 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^3 and a corresponding optimum moisture content of 15.9 percent were estimated.

Report

- On forms approved by the agency
- Sample ID
- Maximum dry density to the nearest 1 kg/m^3 (0.1 lb/ft^3)
- Corrected maximum dry density (if applicable)
- Optimum moisture content to the nearest 0.1 percent
- Corrected optimum moisture content (if applicable)
- Reference curve or Soil Moisture-Density Relations used

EMBANKMENT AND BASE IN-PLACE DENSITY | WAQTC | FOP AASHTO T 272 (24)

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 (0.005 lb.)?	_____	_____
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

EMBANKMENT AND BASE IN-PLACE DENSITY | WAQTC | FOP AASHTO T 272 (24)

Procedure Element	Trial 1	Trial 2
21. Wet density calculated from the wet mass?	_____	_____
22. Soil removed from mold using a sample extruder if needed?	_____	_____
23. Soil sliced vertically through center (non-granular material)?	_____	_____
24. Moisture sample removed ensuring all layers are represented?	_____	_____
25. Moist mass determined immediately to 0.1 g?	_____	_____
26. Moisture sample mass of correct size?	_____	_____
27. Sample dried and water content determined according to the FOP for T 255/T 265?	_____	_____
28. One-point plotted on soils moisture-density relations group supplied?	_____	_____
a. One-point falls within 80 to 100 percent of optimum moisture content in order to be valid?	_____	_____
b. If one-point does not fall within 80 to 100 percent of optimum moisture content, another one-point determination with an adjusted water content is made?	_____	_____
c. Maximum dry density and corresponding optimum moisture content correctly estimated?	_____	_____
29. One-point plotted on a single reference curve?	_____	_____
a. Does one-point plot within 2 lb/ft^3 in order to be valid?	_____	_____
b. Does one-point fall within 80 to 100 percent of optimum moisture content in order to be valid?	_____	_____
c. Maximum dry density and corresponding optimum moisture content determined from single reference curve?	_____	_____

Comments: First attempt: Pass_____Fail_____ Second attempt: Pass_____Fail_____

Examiner Signature _____WAQTC #:_____

EMBANKMENT AND BASE IN-PLACE DENSITY | WAQTC | FOP AASHTO T 272 (24)

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.

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 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 (0.005 lb.)?	_____	_____
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

EMBANKMENT AND BASE IN-PLACE DENSITY | WAQTC | FOP AASHTO T 272 (24)

Procedure Element	Trial 1	Trial 2
20. Mold filled with soil such that compacted soil will be above the mold, loose material lightly tamped?	_____	_____
21. Soil compacted with appropriate number of blows (25 or 56)?	_____	_____
22. Collar removed without shearing off sample?	_____	_____
23. Approximately 6 mm (1/4 in.) of compacted material above the top of the mold (without the collar)?	_____	_____
24. Soil trimmed to top of mold with the beveled side of the straightedge?	_____	_____
25. Remove soil from exterior surface of mold and base plate?	_____	_____
26. Mass of mold and contents determined to appropriate precision?	_____	_____
27. Wet density calculated from the wet mass?	_____	_____
28. Soil removed from mold using a sample extruder if needed?	_____	_____
29. Soil sliced vertically through center (non-granular material)?	_____	_____
30. Moisture sample removed ensuring all layers are represented?	_____	_____
31. Moist mass determined immediately to 0.1 g?	_____	_____
32. Moisture sample mass of correct size?	_____	_____
33. Sample dried and water content determined according to the FOP for T 255/T 265?	_____	_____
34. One-point plotted on soils moisture-density relations group supplied?	_____	_____
a. One-point falls within 80 to 100 percent of optimum moisture content in order to be valid?	_____	_____
b. If one-point does not fall within 80 to 100 percent of optimum moisture content, another one-point determination with an adjusted water content is made?	_____	_____
c. Maximum dry density and corresponding optimum moisture content correctly estimated?	_____	_____
35. One-point plotted on a single reference curve?	_____	_____
a. Does one-point plot within 2 lb/ft^3 in order to be valid?	_____	_____
b. Does one-point fall within 80 to 100 percent of optimum moisture content in order to be valid?	_____	_____
c. Maximum dry density and corresponding optimum moisture content determined from single reference curve?		

Comments: First attempt: Pass_____Fail_____ Second attempt: Pass_____Fail_____

Examiner Signature _____WAQTC #:_____