

# Soil Density

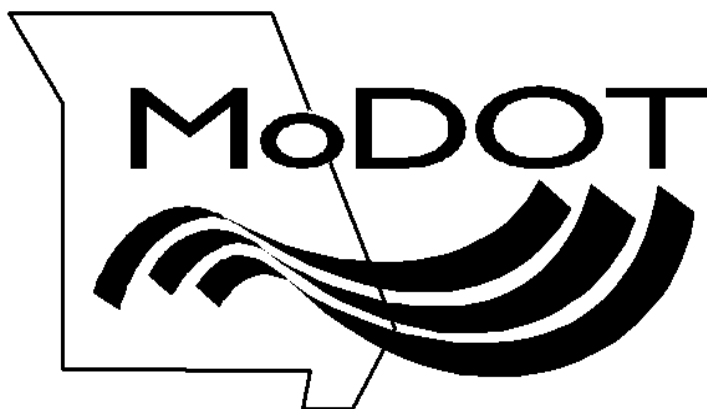
## 2024

### Proficiency Pack

Date: \_\_\_\_\_

Name: \_\_\_\_\_

Employer: \_\_\_\_\_





# AASHTO T 265: Laboratory Determination of Moisture Content of Soils PROFICIENCY CHECKLIST

Rev: 10/22/2019

Applicant: \_\_\_\_\_

Employer: \_\_\_\_\_

| Trial #  | 1 | 2 |
|--|---|---|
| <b>Procedure</b>   |   |   |
| 1. Preheat oven to 230 ± 9°F (110 ± 5°C)   |   |   |
| 2. Mass of clean, dry container plus lid determined  |   |   |
| 3. Sample placed in container, lid immediately placed, and weighed.<br><b>(Wet Weight)</b><br><b>Note:</b> Soils containing organic material can be air dried or oven-dried at approximately 140°F (60°C). |   |   |
| 4. Lid removed and placed container with the moist sample and lid in the drying oven at 230 ± 9°F (110 ± 5°C).   |   |   |
| 5. Dried overnight (15 hours minimum) or until the mass loss of the sample after 1 hour of additional drying is less than 0.1% (Constant Mass).  |   |   |
| 6. Lid replaced immediately and sample cooled to room temperature.   |   |   |
| 7. Container, including lid and dried sample, weighed. <b>(Dry Weight)</b>   |   |   |
| 8. Percent moisture calculated to the nearest 0.1% by:<br><br>$w = \left[ \frac{(W_1 - W_2)}{(W_2 - W_c)} \right] \times 100$  |   |   |

PASS PASS

FAIL FAIL

Examiner: \_\_\_\_\_ Date: \_\_\_\_\_



# AASHTO T 99: Moisture-Density Relations of Soils PROFICIENCY CHECKLIST

Rev: 10/30/2019

Applicant: \_\_\_\_\_

Employer: \_\_\_\_\_

| Trial #  | 1 | 2 |
|--|---|---|
| <b>Sample Preparation</b>  |   |   |
| 1. If damp, sample dried in air or drying apparatus not exceeding 140°F (60°C).  |   |   |
| 2. Thoroughly broke up sample and adequate amount sieved over #4 (4.75mm) sieve (Method A) or ¾" (19.0mm) sieve (Method C).  |   |   |
| 3. Material retained on No. 4 sieve, discarded if less than 5.0% (Method A).<br>If 5.1% or more retained on No. 4, revert to Method C and see Annex A1 for oversize particles.   |   |   |
| 4. Sample passing #4 sieve weighs 7 lb. (3 kg) or more (Method A).   |   |   |
| Sample passing ¾" sieve weighs 11 lb. (5 kg) or more (Method C).   |   |   |
| 5. Sample mixed with water to approximately 4% to 8% below optimum moisture.<br><b>Clayey Soils:</b> Samples mixed with water varying by approx. 2% to 2.5% max 4% for increments of moisture,<br>samples placed in covered containers and allowed to stand for at least 12 hours. |   |   |
| <b>Procedure for Method A (4 inch mold)</b>  |   |   |
| 1. Weighed the mold and base plate (w/o the collar), <u>recorded to the nearest 0.005 lb. (1g)</u>   |   |   |
| 2. Attached collar to the mold and placed on a stable foundation.  |   |   |
| 3. Layer of soil placed in mold distributed evenly to yield approximately 1/3 full after compaction (2/3 or 3/3 full).   |   |   |
| 4. Soil lightly tamped with manual rammer of 2-inch diameter until it is not in a loose state.   |   |   |
| 5. Applied 25 blows for 4 inch mold, with a 5.5 lb. rammer, 12 inch drop.  |   |   |
| 6. Following compaction trimmed away any excess soil on mold walls evenly on top of layer (trimmed soil may be included with additional soil for next layer).  |   |   |
| 7. Repeat steps 3 – 6, for 3 equal layers, last lift is slightly above the top of the mold.  |   |   |
| 8. Removed the collar, soil sample trimmed to top of the mold with a straight edge, filled coarse aggregate holes on surface, patched with smaller sized material.   |   |   |
| 9. Cleaned off the mold and base plate before weighing.  |   |   |
| 10. Weighed the mold, base, and contents, <u>recorded to nearest 0.005 lb. (1g)</u> .  |   |   |
| 11. Sample extracted from the mold.  |   |   |
| 12. Sliced vertically through the center for moisture content sample.  |   |   |
| 13. Moisture content sample removed from the slice, placed in a pre-weighed sample container, and weighed immediately, <u>recorded wet weight to nearest 0.1g</u> .<br>Need approximately: <b>Method A</b> 100g, <b>Method C</b> 500g  |   |   |
| 14. Sample dried and % moisture determined according to AASHTO T 265 , <u>reported w to 0.1%.</u>  |   |   |
| 15. Remainder of material from mold broken up to pass a #4 size sieve and added to the remainder of original test sample. Samples mixed with water varying by 1-2% (2.5% max) increments of moisture and mixed thoroughly.   |   |   |



# AASHTO T 99: Moisture-Density Relations of Soils

## PROFICIENCY CHECKLIST

### (cont.)

| Trial #   | 1 | 2 |
|---|---|---|
| 16. Repeat the compaction process: (Steps 2 through 15) for each increment of water added and the process continued until wet density either decreases or stabilizes, need 2 points pass Optimum Density<br><b>Note:</b> Non-cohesive drainable soils, only one additional determination over optimum moisture is sufficient.   |   |   |
| 17. Calculated: Wet Density, Dry Density and Percent Moisture calculated for each sample.<br><br><div style="display: flex; justify-content: space-around; align-items: center;"> <div style="border: 1px solid black; padding: 5px; text-align: center;"> <math display="block">W_1 = (M_{ms} - M_m) \times \text{Constant}</math> <p>Wet Density</p> </div> <div style="border: 1px solid black; padding: 5px; text-align: center;"> <math display="block">W = \frac{W_1}{w + 100} \times 100</math> <p>Dry Density</p> </div> </div> <p style="text-align: center;">Percent Moisture</p> |   |   |
| 18. Dry density mass plotted on y-axis, % Moisture plotted on x-axis and points connected with curve either manually or by computer program.<br><b>Note:</b> (Method C): Calculate adjusted density for oversized particles on each point prior to plotting curve.  |   |   |
| 19. Report:<br>* <b>Percent Moisture</b> at peak of curve taken as Optimum Moisture reported to nearest 0.1%.<br>* <b>Dry Density</b> mass at Optimum percent moisture reported as maximum dry density to the nearest 0.1 lb./ft <sup>3</sup> .<br>* <b>Method Used</b> A, B, C, D.<br>* Information on oversized particles and adjusted Max DD, Corrected Optimum MC and Gsb to 0.001.   |   |   |

PASS    PASS

FAIL    FAIL

Examiner: \_\_\_\_\_ Date: \_\_\_\_\_





# MoDOT TM 40: A One-Point Method for Determining Maximum Dry Density and Optimum Moisture

## PROFICIENCY CHECKLIST

Rev: 12/28/2018

Applicant: \_\_\_\_\_

Employer: \_\_\_\_\_

|   | Trial # | 1 | 2 |
|---|---------|---|---|
| 1. One-point determination of dry density and corresponding moisture content made in accordance with AASHTO T 99 or AASHTO T 180, and moisture content determined in accordance with AASHTO T 265.                    |         |   |   |
| 2. Optimum Moisture and Maximum Dry Density calculated for the one-point.   |         |   |   |
| 3. A Current MoDOT Family of Curves for specific sample on hand.  |         |   |   |
| 4. Used the correct Method A, B, C, or D as described on the Current MoDOT Family of Curves.  |         |   |   |
| 5. A One-Point plotted on the family of curves, was in the OM-4 area of the MoDOT graph, counted as VALID and Maximum Dry Density and Optimum Moisture Content determined.  |         |   |   |
| 6. OR A One-Point plotted on the family of curves, was not in the OM-4 area of the MoDOT graph, was counted as NOT VALID, made another one-point determined with adjusted water content and plotted for a valid test. |         |   |   |
| 7. Report Method used, optimum moisture content as a percentage to the nearest whole number, maximum density to the nearest 0.1 lb./ft <sup>3</sup> (1 kg/m <sup>3</sup> ).   |         |   |   |

PASS PASS

FAIL FAIL

Examiner: \_\_\_\_\_ Date: \_\_\_\_\_



# AASHTO T 310: In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) PROFICIENCY CHECKLIST

Rev: 12/28/2018

Applicant: \_\_\_\_\_

Employer: \_\_\_\_\_

| Trial#   | 1 | 2 |
|--|---|---|
| Make sure gauge is calibrated, charged, lab data, or offsets entered if any.   |   |   |
| <b>Standardization</b>   |   |   |
| 1. Performed at start of each day's use.   |   |   |
| 2. Permanent records of data retained.   |   |   |
| 3. Performed with equipment at least 10 m (30 ft.) from other radioactive sources, and clear of large masses of water or other items which may affect reference count.                     |   |   |
| 4. Using reference standard, at least four repetitive readings taken at normal measurement period, and mean obtained.  |   |   |
| 5. Procedure recommended by gauge manufacturer used to determine compliance with gauge calibration curves or –<br>AASHTO Equation 1 used to determine standardization.                     |   |   |
| <b>Preparing the test site</b>   |   |   |
| 1. All loose, disturbed and additional material removed as necessary to expose top of material to be tested.   |   |   |
| 2. Prepared a horizontal area sufficient in size to accommodate the gauge, planed the area smooth with plate or suitable tool to obtain maximum contact between gauge and material tested. |   |   |
| 3. Native fines or fine sand used to fill voids as necessary, for surface area less than 10% beneath the gauge.  |   |   |
| 4. The depth of filler does not exceed approximately 1/8" (3 mm).  |   |   |



# AASHTO T 310: Density and Moisture Content of Soils and Soils-Aggregate by Nuclear Methods PROFICIENCY CHECKLIST (CONT.)

|   |  |  |
|---|--|--|
| <b>Direct Transmission Procedure</b>  |  |  |
| 1. Gauge turned on allowed to warm up.  |  |  |
| 2. Drilling the Hole. <ul style="list-style-type: none"> <li>a. Placed scraper plate on prepared test site.</li> <li>b. Attached extraction tool and inserted drill rod.</li> <li>c. Stepped firmly on center of plate and hammered drill rod perpendicular to the surface 2" deeper than test depth.</li> <li>d. Removed drill rod with upward and twisting motion.</li> <li>e. After drill rod removed, marked around the scraper plate.</li> </ul> |  |  |
| 3. Removed all equipment from the test area except the gauge.   |  |  |
| 4. Placed the gauge on marked area, ensuring maximum surface contact.   |  |  |
| 5. Source rod lowered into hole to same depth of the lift being tested.   |  |  |
| 6. Snugged the probe to contact the soil leaving no gap between the probe and soil.   |  |  |
| 6. One or more 1-minute readings secured and % Compaction, Dry Density, % Moisture recorded by the gauge.   |  |  |
| 8. Returned source rod to safe position.  |  |  |
| <b>Backscatter Procedure</b>  |  |  |
| 1. Cleared the area of people and equipment.  |  |  |
| 2. Turned the gauge on, allowed to warm up.   |  |  |
| 3. Set the gauge to backscatter mode.   |  |  |
| 4. Found a smooth location 30 feet (10 m) from other radioactive sources.   |  |  |
| 5. Prepared the site.   |  |  |
| 6. Gauge seated firmly on prepared test site.   |  |  |
| 7. One or more 1-minute readings.   |  |  |
| 8. In-place wet density determined and recorded by the gauge.   |  |  |

PASS      PASS

FAIL      FAIL

Examiner: \_\_\_\_\_ Date: \_\_\_\_\_



# MoDOT TM 35: Moisture Offset Factor for A Nuclear Gauge PROFICIENCY CHECKLIST

12/28/2018

Applicant: \_\_\_\_\_

Employer: \_\_\_\_\_

| Trial#   | 1 | 2 |
|--|---|---|
| 1. Select at least 4 testing sites for each aggregate type.  |   |   |
| 2. Ensure that moisture offset is disabled or turned off in the machine.   |   |   |
| 3. Perform field nuclear wet density and moisture tests.   |   |   |
| 4. Record readings obtained and Avg. (%M <sub>gauge</sub> ).   |   |   |
| 5. At each test site obtain sample for moisture, retrieving material between source and detectors 2.2 lb. (1,000 g) for $\leq \frac{1}{4}$ ", 3.3 lb. (1,500 g) $> \frac{1}{4}$ ". |   |   |
| 6. Dry sample per AASHTO T 265.  |   |   |
| 7. Record and Avg. (%M <sub>lab</sub> ).   |   |   |
| 8. Calculate "K" factor:<br>$K = \frac{(\%M_{lab} - \%M_{gauge})}{(100 + \%M_{gauge})} \times 1,000$   |   |   |

PASS PASS

FAIL FAIL

Examiner: \_\_\_\_\_ Date: \_\_\_\_\_