Soil Density

2026

Proficiency Pack

Date: _____

Name: _____

Employer: _____

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Notes if Needed

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

Applicant: _____

Employer: _____

Trial #	1	2
Procedure		
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. (**Wet Weight**) **Note:** Soils containing organic material can be air dried or oven-dried at approximately 140°F (60°~~C)~~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. (**Dry Weight**)		
8. Percent moisture calculated to the nearest 0.1% by: $$w = \left[\frac{(W_1 - W_2)}{(W_2 - W_c)}\right] \times 100$$		
	PASS	PASS
	FAIL	FAIL

Examiner:_____Date:_____

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Notes if Needed

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

Applicant: _____

Employer: _____

Updated for 2025

Method A Trial #	1	2
SAMPLE PREPARATION		
1. Sample air dried or dried in oven not exceeding 140°F (60°C).		
2. Sample broken up and an adequate amount sieved over the #4 sieve		
3. Material retained on No. 4 sieve, • Less than 5.0% - discard • Over 5.0% - see Annex A1 for over size particles		
4. Material passing No. 4 sieve, reduced to 7lb. (3,000g) for testing. (Method A)		
5. **If soil is degradable**: • Multiple samples mixed with water varying moisture content by 1 to 2 %, bracketing the optimum moisture content. **If soil is clayey – or – organic soil**: • Multiple samples mixed with water varying moisture content by 2 to 4%, bracketing the optimum moisture content. • Samples placed in airtight containers for at least 12 hrs.		
6. Sample mixed with water to approximately 4 to 8% below optimum moisture.		
PROCEDURE – Method A		
1. Determine mass of clean, dry 4" mold and base plate (without collar) to nearest 0.005 lb. (1g).		
2. Attached collar to the mold and placed on a stable foundation.		
3. Place loose soil in mold distributed evenly to yield approximately 1/3 full (then 2/3, then 3/3 full)		
4. Lightly tamp the surface with a 2-inch face tamper		
5. Applied 25 blows with a 5.5 lb. rammer, 12 inch drop (move the blows across the surface)		
6. Trim excess soil from mold walls, distribute on top surface		
7. Repeat steps 3 – 6, for 3 equal layers, last lift is slightly above the top of the mold.		
8. Remove the collar and trim soil to top of mold with straightedge, fill holes as needed		
9. Remove all soil from exterior surface of mold and base plate.		
10. Weigh the mold, base, and contents, and record to nearest 0.005 lb. (1g).		
11. Extract the sample from the mold.		
12. Slice vertically through the center to collect a 100g moisture content sample.		
13. Place the 100g in a pre-weighed sample container for moisture testing, weigh & record to 0.1g		
14. Sample dried and % moisture determined according to AASHTO T 265, reported *w* to 0.1%.		
15. Material left over, broken up, pass #4 size sieve and add to the remainder of original sample.		
16. Samples mixed with water varying by 1-2% (2.5% max) increments of moisture and mix well. - Repeat steps 2 – 15 for each increment of water added. - Minimum of 2 determinations pass optimum density.		

AASHTO T 99: Moisture-Density Relations of Soils
PROFICIENCY CHECKLIST
(cont.)

	Trial #	1	2
CALCULATIONS AND REPORTING			
CALCULATE: Wet Density, Dry density and Percent Moisture calculated for each sample. $W_1 = (M_{ms} - M_m) \times \text{Constant}$ Wet Density $W = \frac{W_1}{w + 100} \times 100$ Dry Density $w = \left[\frac{(W_1 - W_2)}{(W_2 - W_c)}\right] \times 100$ Moisture Content			
- Dry density plotted on vertical axis.			
- Percent moisture content plotted on horizontal axis			
- Points connected with a smooth curve			
REPORT: *__Percent Moisture__ At peak of curve taken as Optimum Moisture reported to nearest 0.1%. *__Dry Density__ Mass at Optimum percent moisture reported as maximum dry density to the nearest 0.1 lb./ft^3. *__Method Used__ A, B, C, D. *Information on oversized particles and adjusted Max DD, Corrected Optimum MC and Gsb to 0.001.			

PASS PASS

FAIL FAIL

Examiner: _____ **Date:** _____

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Notes if Needed

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

PROFICIENCY CHECKLIST

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^3 (1 kg/m^3).		
	PASS	PASS
	FAIL	FAIL

Examiner:_____ Date:_____

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

Applicant: _____

Employer: _____

Trial#	1	2
Make sure gauge is calibrated, charged, lab data, or offsets entered if any.		
Standardization		
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 – AASHTO Equation 1 used to determine standardization.		
Preparing the test site		
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).		

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

Trial#	1	2
Direct Transmission Procedure		
1. Gauge turned on allowed to warm up.		
2. Drilling the Hole.		
a. Placed scraper plate on prepared test site.		
b. Attached extraction tool and inserted drill rod.		
c. Stepped firmly on center of plate and hammered drill rod perpendicular to the surface 2" deeper than test depth.		
d. Removed drill rod with upward and twisting motion.		
e. After drill rod removed, marked around the scraper plate.		
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.		
7. One or more 1-minute readings secured and % Compaction, Dry Density, % Moisture recorded by the gauge.		
8. Returned source rod to safe position.		
Backscatter Procedure		
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:_____

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

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. ($\%M_{gauge}$).		
5. At each test site obtain sample for moisture, retrieving material between source and detectors 2.2 lb. (1,000 g) for ≤ ¼", 3.3 lb. (1,500 g) > ¼".		
6. Dry sample per AASHTO T 265.		
7. Record and Avg. ($\%M_{lab}$).		
8. Calculate "K" factor: $$K = \frac{\left(\%M_{lab} - \%M_{gauge}\right)}{\left(100 + \%M_{gauge}\right)} \times 1{,}000$$		
	PASS	PASS
	FAIL	FAIL

Examiner:_____Date:_____