FIELD DENSITY & MOISTURE TESTING OF SOILS

Reminders & Updates

General Info

- Testing Modes
- Changed from NDR T238 to AASHTO T310
- Basics
- Problem Solving
- New Site Manager Templates

- Required to have Earthwork Level I Certification to perform Embankment Inspection and Testing
- If you were certified last year – you need to have a IA performed on you. Call your QA if you haven't been IA'd.

- Earthwork Level II – Soils Lab Testing (Proctor, PI, LL, Dry Prep. Direct Shear)

Nu

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- Form

NEBRASKA DEPARTMENT OF ROADS
NDR STANDARD METHOD T 238

STANDARD TEST METHODS FOR IN-PLACE MOISTURE DENSITY OF SOILS BY NUCLEAR METHODS

SCOPE

1.1 Follow AASHTO T 310 to determine moisture density of soils.

AASHTO T310 Now the Standard NDOR Uses

Standard Method of Test for

In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

AASHTO Designation: T 310-10

1. SCOPE

1.1. This test method describes the procedure for determining the in-place density and moisture of soil and soil-aggregate by use of nuclear gauge. The density of the material may be determined by either direct transmission, backscatter, or backscatter/air-gap ratio method. The moisture of the material is determined only from measurements taken at the surface of the soil (i.e., backscatter).

1.2. *Density*—The total or wet density of soil and soil-rock mixtures is determined by the attenuation of gamma radiation where the source or detector is placed at a known depth up to 300 mm (12 in.) while the detector(s) or source remains on the surface (Direct Transmission Method) or the source and detector(s) remain on the surface (Backscatter Method).

1.2.1. The density in mass per unit volume of the material under test is determined by comparing the detected rate of gamma radiation with previously established calibration data.

1.3. *Moisture*—The moisture content of the soil and soil-rock mixtures is determined by thermalization or slowing of fast neutrons where the neutron source and the thermal neutron detector both remain at the surface.

1.3.1. The water content in mass per unit volume of the material under test is determined by comparing the detection rate of thermalized or slow neutrons with previously established calibration data.

1.4. *SI Units*—The values stated in SI units are to be regarded as the standard. The inch-pound equivalents may be approximate. It is common practice in the engineering profession to concurrently use pounds to represent both a unit of mass (lbm) and of force (lbf). This implicitly combines two systems of units, that is, the absolute system and the gravitational system.

1.4.1. This standard has been written using the absolute system for water content (kilograms per cubic meter) in SI units. Conversion to the gravitational system of unit weight in lbf/ft^3 may be made. The recording of water content in pound-force per cubic foot should not be regarded as nonconformance with this standard, although the use is scientifically incorrect.

1.4.2. In the English system, the pound (lbf) represents a unit of force (weight). However, the use of balances or scales recording pounds of mass (lbm) or recording of density (lbm/ft^3) should not be regarded as nonconformance with this standard.

1.5. *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and*

Important Notes

- Density Interference:
  - Chemical Composition of Soil - effect density measurement
  - Direct Transmission the preferred method
  - Be aware of voids, rocks, or foreign materials

Important Notes

- Moisture Content Interferences:
  - Chemical Composition – Significant effect on moisture measurement
  - Gauge is more sensitive to water content near the surface.
  - Need to correlate with moisture content from actual soil.

Important Notes

Standard Counts

- Be at least 30′ from any other radioactive sources (gauges)
- Keep permanent record of standard counts.
- Make sure standard counts are within limits for Moisture and Density.
  - Acceptable limit for density is 1%
  - Acceptable limit for moisture is 2%
  - Both compared to average of the previous 4 standard counts.

Important Notes

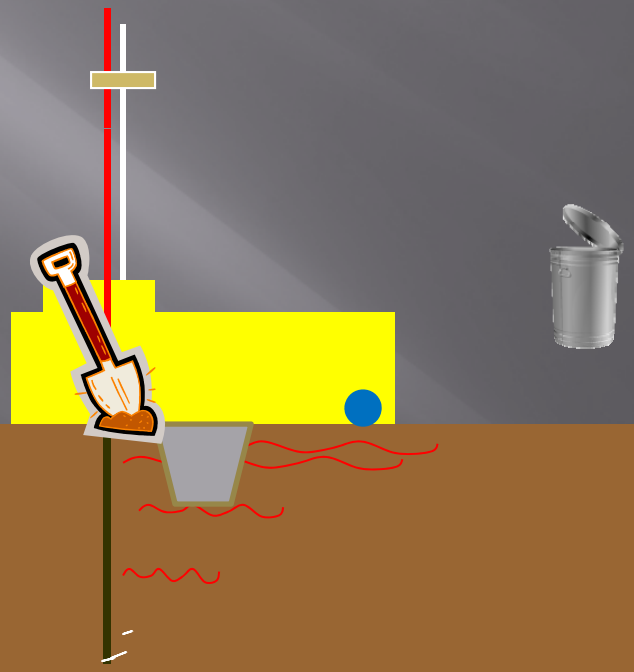
Standard Counts (cont.):

- If Standard Count fails, check gauge, reference block for cleanliness.
- Move location if near over-head power lines or underground utilities.
- Re-run Standard Count a total of 4 times (Save).
- If fails again, take into lab for evaluation/ possible repairs.

Factors That Effect Nuke Tests

- Moisture Content Correlation
  - Most Important
  - Why?
    - Affected by the type of soil
    - Chemistry of Soil
    - Other hydrocarbons (organics, wood, oil)
    - Test result not representative of entire depth being tested.
    - Makes Dry Density test result inaccurate if off.

Moisture Correction



Moisture Correction

- Take Nuclear test
- Record Dry Density and Moisture Content.
- Take a sample of soil from directly beneath the gauge test spot
- Dig deep enough, representative of test.
- Place in sealed container/ bag.
- Take back to Lab.
- Compare Lab Moisture versus Gauge Moisture.
  - If difference by more than 1.5%, correct using Troxler Instructions.

Factors That Effect Nuke Tests

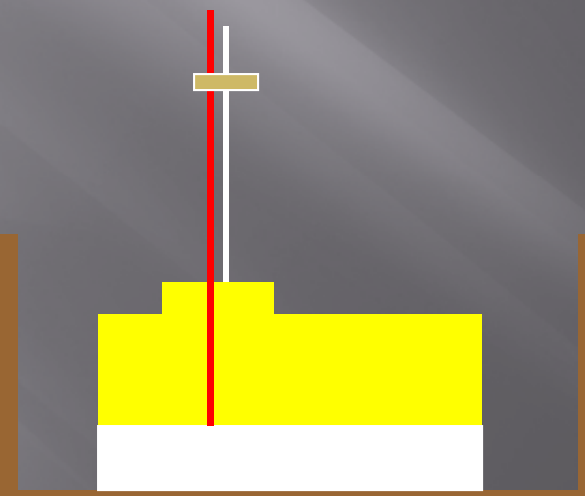
	Results with Gauge Moisture	Results with Lab Moisture
Moisture Content	17.5	21.5
Wet Density	120 pcf	120.0 pcf
Dry Density	102.1 pcf	98.8 pcf
Max. DD	105.0 pcf	105.0 pcf
% Compaction	97.2%	94.00%

Factors That Effect Nuke Tests

- **It's a good idea to check test spot with a spade to verify:**
  - **Material actually fits the proctor you are using.**
  - **No foreign objects.**
  - **Material is indeed firm, moist, and uniform (well compacted).**
  - **<u>Take a sample to run a moisture content in the lab.</u>**

Factors That Effect Nuke Tests

- Are you testing backfill in a trench?
  - **If so, have you trench-corrected your gauge before testing?**



Factors That Effect Nuke Tests

- Other Checks:
- If the test results don't make sense, verify with a volumetric test.
- When correlating Nuclear Tests with volumetric test:
- Do a moisture correction first.
- Be sure Nuclear gauge depth is same as volumetric test depth.

Judgment Calls

- The Nuclear Gauge is accurate to 0.5 pcf.
- If you get 94.8% compaction, should it still fail?
- Is the tested material firm with proper moisture content? Check it with a spade, dig it up, look at it, take a sample back to the lab.
- If you're not sure about something, ask your PM or another tech with more experience, give us a call.

Nuclear Density Tests for Soils

Field Performed Tests

NDOR M&R
Omar Qudus, Geotechnical Engineer

Template ID: SLF002001
Version: 20110215

Nuclear Density Gauge

Make	Model	Serial Number	Calibration Date
			/ /

Method of Compaction

Class	Type	Test Depth

Test Number					
Curve Number					
Optimum Moisture Percentage					
Maximum Dry Density (pcf)					
Moisture Limits					
Required Percentage of Maximum Density	min	min	min	min	min
Station	+	+	+	+	+
Offset (ft)	'	'	'	'	'
Direction of Offset					
Depth Below Final Grade (ft)					
Density Standard Count					
Percent of Proctor 1					
Percent of Proctor 2					
Average Percentage Density					
Moisture Standard Count					
% Moisture 1					
% Moisture 2					
Average Moisture Percentage					
Density Correction Factor Used					
Moisture Correction Factor Used					

Note: A moisture correction is required if lab moisture and nuclear moisture test results differ by more than 1.5%. Refer to the Moisture Calculation template for moisture correction. If a volumetric test is performed and the volumetric and nuclear density test results differ by more than 2.5 pcf, a density correction factor is required. Refer to the Volumetric Balloon Test template for density correction.

Test Status					

Comments:

Test Method: AASHTO T310

Nuclear Density Tests for Soils

Field Performed Tests

NDOR M&R
Omar Qudus, Geotechnical Engineer

Template ID: SLF002001
Version: 20110215

Nuclear Density Gauge

Make	Model	Serial Number	Calibration Date
Troxler	3440	1234567	03/08/11

Method of Compaction

Class	Type	Test Depth
CLASS III	Sheep's Foot	8 inches

Test Number	1	1A			
Curve Number	Y-9				
Optimum Moisture Percentage	19.0				
Maximum Dry Density (pcf)	105.5				
Moisture Limits	-3 + 2				
Required Percentage of Maximum Density	95 min	min	min	min	min
Station	110 + 15	+	+	+	+
Offset (ft)	30 '	'	'	'	'
Direction of Offset	Left				
Depth Below Final Grade (ft)	8.0				
Density Standard Count	2473				
Percent of Proctor 1	98.5				
Percent of Proctor 2	97.9				
Average Percentage Density	98.2				

Moisture Standard Count	698				
% Moisture 1	18.4				
% Moisture 2	19.2				
Average Moisture Percentage	18.8				
Density Correction Factor Used	No				
Moisture Correction Factor Used	Yes				

Note: A moisture correction is required if lab moisture and nuclear moisture test results differ by more than 1.5%. Refer to the Moisture Calculation template for moisture correction. If a volumetric test is performed and the volumetric and nuclear density test results differ by more than 2.5 pcf, a density correction factor is required. Refer to the Volumetric Balloon Test template for density correction.

Test Status	Pass				

Comments: Class III embankment to receive concrete.

Test Method: AASHTO T310

Moisture Calculation and Correction for Soils

Field Performed Tests

NDOR M&R
Omar Qudus, Geotechnical Engineer

Template ID: SLF003001
Version: 20110215

Moisture as Determined by AASHTO T265

Curve Number	Y-9			
Wet Weight (g)	300			
Dry Weight (g)	253			
Loss (g)	47			
% Moisture	18.6			

Moisture as Determined by AASHTO T310

Gauge

Make	Model	Serial Number	Calibration Date
Troxler	3440	1234567	03/08/11

Nuclear Gauge % Moisture	21.3			
Moisture Correction %	+2.7			

Note: A moisture correction is required if lab moisture and nuclear moisture test results differ by more than 1.5%. Refer to the Moisture Calculation template for moisture correction. If a volumetric test is performed and the volumetric and nuclear density test results differ by more than 2.5 pcf, a density correction factor is required. Refer to the Volumetric Balloon Test template for density correction.

Comments: Difference in moisture is greater than 1.5%, a moisture correction will be used.

Test Method: AASHTO T265, T310

Volumetric Balloon Test

Field Performed Tests

NDOR M&R
Omar Qudus, Geotechnical Engineer

Template ID: SLF004001
Version: 20110217

Volumetric Balloon Apparatus

Make	Model	Serial Number	Calibration Date
			/ /

Method of Compaction

Class	Type	Test Depth

Test Number					
Curve Number					
Optimum Moisture Percentage					
Maximum Dry Density (pcf)					
Moisture Limits					
Required Percentage of Maximum Density	min	min	min	min	min
Station	+	+	+	+	+
Offset (ft)	'	'	'	'	'
Direction of Offset					
Depth Below Grade (ft)					
Volume					
Initial Reading (cc)					
Final Reading (cc)					
Volume of Sample (cc)					
Mass					
Total Wet Weight (g)					
Moisture					
Sample Wet Weight (g)					
Sample Dry Weight (g)					
Loss (g)					
% Moisture					
Density					
Wet Density (pcf) (g)					
Dry Density (pcf)	.	.	.	.	.
% of Proctor	0.0	0.0	0.0	0.0	0.0

Note: Before performing a density correction a separate moisture correction of the nuclear gauge shall be performed first (Refer to the Moisture Calculation and Correction for Soils template). A density correction is required if the volumetric and nuclear density test results differ by more than 2.5 pcf and should be noted in the comments section below.

Comments:

Test Method: NDR T205

Volumetric Balloon Test

Field Performed Tests

NDOR M&R
Omar Qudus, Geotechnical Engineer

Template ID: SLF004001
Version: 20110217

Volumetric Balloon Apparatus

Make	Model	Serial Number	Calibration Date
Humboldt	Volumetric	123321	05/18/10

Method of Compaction

Class	Type	Test Depth
CLASS III	Sheep's Foot	4 inches

Test Number	1				
Curve Number	Y-9				
Optimum Moisture Percentage	19.0				
Maximum Dry Density (pcf)	105.5				
Moisture Limits	-3 + 2				
Required Percentage of Maximum Density	95 min	min	min	min	min
Station	110 + 15	+	+	+	+
Offset (ft)	30 '	'	'	'	'
Direction of Offset	Left				
Depth Below Grade (ft)	8.0				
Volume					
Initial Reading (cc)	785				
Final Reading (cc)	385				
Volume of Sample (cc)	410				

			Mass		
Total Wet Weight (g)	807.3				
			Moisture		
Sample Wet Weight (g)	300				
Sample Dry Weight (g)	253				
Loss (g)	47				
% Moisture	18.6				
			Density		
Wet Density (pcf) (g)	122.9 1.97				
Dry Density (pcf)	103.6				
% of Proctor	98.2	0.0	0.0	0.0	0.0

Note: Before performing a density correction a separate moisture correction of the nuclear gauge shall be performed first (Refer to the Moisture Calculation and Correction for Soils template). A density correction is required if the volumetric and nuclear density test results differ by more than 2.5 pcf and should be noted in the comments section below.

Comments: Difference in density is less than 2.5 pcf, a density correction is not needed.

Test Method: NDR T205