Method of Test for Determining Target Dry Density & In-place Density of Salvaged/Recycled Materials Using the Nuclear Gauge (Test Strip)

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1. Scope:

This test is for determining the target dry density of a test strip and determining in-place density of salvaged material or recycled granular material, i.e., subbase, base course, asphalt concrete or any combination of these materials using the nuclear gauge.

2. Apparatus:

2.1 Nuclear moisture-density gauge capable of determining densities by the direct transmission method and conforming to the requirements of AASHTO T 310.

2.2 A reference standard block for taking standard counts.

2.3 A drill rod, extraction tool, and combination guide-scraper plate for preparing the test site and punching the hole for the source rod.

2.4 A manufacturer's instruction manual for the nuclear gauge.

2.5 A nuclear gauge information book, transportation documents book, and nuclear badge.

2.5 A hammer to drive the drill rod, and a shovel and other tools for site preparation.

2.7. Scale or balance having the capacity to weigh any sample which may be tested utilizing this procedure and readable to the nearest 0.1 gram.

2.8 Drying equipment: An oven capable of maintaining a temperature of 230° ± 9°F.

3. Procedure:

3.1 Calibration and standardization of nuclear gauge.

A. Calibration and performing the standard count of the nuclear gauge will be in accordance with SD 114, paragraph 3.1 and 3.2.

3.2 Target density determination (Test strip).

A. Select a test strip a minimum of 500' in length.

B. Select 4 test sites within the test strip for nuclear gauge readings. Select a test site where the nuclear gauge will be at least 2' away from any vertical projection, at least 10' away from any vehicle and at least

30’ away from another nuclear gauge. The first and the last 100’ segment of the test strip will not be used. The test sites must be a minimum of 25’ apart and must be aligned so each is covered by the same pass of the roller.

A roller pass is one application of roller loading by one roller unit. Tandem rollers are considered to be one roller unit.

C. Accurately mark each test site with paint or crayon, in order that the nuclear gauge can be repositioned and oriented the same for each reading.

D. The maximum depressions beneath the gauge will not exceed 1/8”. Use native fines or fine sand to fill voids and level the excess with the scraper plate. The total areas thus filled with fines or sand should not exceed 10% of the bottom area of the gauge.

E. Following the initial “Breakdown” rolling, nuclear gauge readings (1 minute wet density reading) will be taken at each of the 4 test sites.

F. Place the guide-scraper plate on the prepared test site and drive the drill rod with the extraction tool attached through the guide to a depth at least 2” below the depth of material to be tested. Remove the drill rod by pulling straight up and twisting the extraction tool, to avoid disturbing the hole. It is desirable to do the testing as close to the bottom of the lift as possible, but not closer than 1” from the bottom.

Example:

If the lift depth is 4”, subtracting the 1” from the bottom restriction leaves a 3” depth, but since the source rod cannot be locked at 3”, the testing will have to be accomplished at 2”. Each additional lift will be tested as the first lift described above.

G. Place the nuclear gauge over the test site and extend the source rod into the hole to the desired depth. Release the trigger at the desired depth and listen for the “Click” indicating that the source rod is properly locked into position on the index rod. Verify the depth shown on the display of the gauge agrees with the actual depth of the source rod. Slide the gauge so the surface of the source rod nearest the keypad is in contact with the edge of the hole. Take a 1 minute reading to determine the wet density in lbs./ft^3.

H. Record the total number of passes and the wet density in lbs./ft^3 from the gauge for each location on the DOT-28.

I. Continue to take readings at each of the 4 test sites following each series of roller passes. The number of roller passes used per series will have to be determined on the project but 4 per series is a good rule of thumb.

J. Continue the series of roller passes until 4 successive passes fail to increase the average wet density by 1.0 lb./ft^3.

K. Sample the material for moisture from below the 4 nuclear gauge test sites. Take the samples from the top of the lift to the depth of the source rod directly below the nuclear gauge and immediately place in an airtight container for moisture testing.

NOTE: The minimum sample size for this moisture test will be 2000 grams.

L. SD 108, oven drying method is to be used to determine the moisture content of the material. Determine the weight of a clean, dry container, and record it on the DOT-28 as “Weight of can”.

M. Determine the target dry density of the test strip by averaging the 4 test site dry density results on the DOT-28.

N. This result is the average test strip dry density and should be recorded on line (U) to the nearest 0.1 lb./ft^3 as the 1-point maximum density on the DOT-41. This value is used to compute the percent of density.

O. A test strip will be completed for each lift of material.

3.3. In-place density determination.

A. Select a location for a test where the nuclear gauge will be at least 2’ away from any vertical projection, at least 10’ away from any vehicle and at least 30’ away from another nuclear gauge.

B. Follow the procedures of Section 3.2, steps F through G to obtain the wet density with the nuclear gauge. It is allowable to take more than one reading at each test site and average the results.

C. Record the wet density in 0.1 lb/ft^3 from the gauge on the DOT- 41.

D. Sample the material for moisture from below the nuclear gauge. Take the samples from the top of the lift to the depth of the source rod directly below the nuclear gauge and immediately place in an airtight container for moisture testing.

NOTE: The minimum sample size for this moisture test will be 2000 grams.

E. SD 108, oven drying method is to be used to determine the moisture content of the material. Determine the weight of a clean, dry container, and record it on the DOT-28 as “Weight of can”.

4. Report:

4.1 Target density (Test strip).

A. The nuclear gauge readings, averages and the number of roller passes will be recorded on a DOT-28 as shown in the example.

B. Calculate the percent moisture at each site as shown on DOT-28.

C. Calculate the dry density at each site.

Dry density = (A x 100) / (100 +G)

A = Wet density from nuclear gauge

G = Moisture content (% moisture)

D. Report the average test strip dry density to the nearest 0.1 lb./ft^3 on a DOT-28.

4.2. In-place density:

A. The nuclear gauge wet density and field moisture will be recorded on a DOT-41 as shown in the example. Record the average test strip dry density on line U of the DOT-41.

B. Calculate the dry density and percent density as shown on the DOT-41.

C. Report the percent density obtained to the nearest whole percent on the DOT-41.

5. References:

SD 108
DOT-28
DOT-41

Sample ID 2205425 **Test Strip Worksheet** **DOT-28**
File No. 3-19

PROJECT PH 0066(00)15 COUNTY Aurora, Ziebach PCN B015
Test No. 02 Test Date 04/29/2019 12:00:00 Lift 2 of 3 Thickness 4"
Tested By Tester, One Checked By Tester, Two
Nuclear Gauge No. MQ 778 Test Mode 2" DIRECT TRANSMISSION

NUCLEAR GAUGE WET DENSITY

	STATION 32+50	STATION 33+50	STATION 34+50	STATION 35+50	AVERAGE
1st Reading Total Passes 4	125.7	131.5	130.9	126.6	128.7
2nd Reading Total Passes 8	128.5	133.8	133.1	130.2	131.4
3rd Reading Total Passes 12	131.4	134.2	133.6	132.0	132.8
4th Reading Total Passes 16	132.4	134.7	134.5	131.9	133.4
5th Reading Total Passes					
6th Reading Total Passes					
7th Reading Total Passes					

MOISTURE AND DRY DENSITY DETERMINATION

A. Final Wet Density	132.4	134.7	134.5	131.9
B. Weight of Can and Wet Material	2643.3	2476.9	2701.7	2519.8
C. Weight of Can and Dry Material	2524.4	2368.4	2584.1	2407.0
D. Weight of Moisture (B - C)	118.9	108.5	117.6	112.8
E. Weight of Can	452.4	344.3	574.8	311.9
F. Weight of Dry Material (C - E)	2072.0	2024.1	2009.3	2095.1
G. % Moisture (D x 100) / F	5.7	5.4	5.9	5.4
H. Dry Density (Ax100) / (100 +G)	125.3	127.8	127.0	125.1

Average Dry Density 126.3

Comments

Figure 1

Sample ID 2205560 **Density Report** DOT - 41
File No. 6-21

County: Aurora, Ziebach | PCN/PROJECT: B015 PH 0066(00)15
Station: 47+15 | Dist From CL: 13' L | Width (Gravel): 52.00
Depth: 4" (from top of Subgrade or Pipe) | Field #: 07
Tested By: Tester, One | Checked By: Tester, Two | Date: 06/21/2021

WORK AREA REPRESENTED (Circle what applies)

EMBANKMENT — STA. TO STA. — (per half mile, for each roadbed)
Zone 1 (0-1 ft.) Zone 2 (1-3 ft.) Zone 3 (3-5 ft.) Zone 4 (5 ft. to bottom) 1 per 5 ft.

BRIDGE END EMBANKMENT — STA. TO STA.
1 per zone within plan limits | 3 equal zones when backwall is less than 7ft. | 4 equal zones when backwall is greater than 7ft.
Zone 1 Zone 2 Zone 3 Zone 4 Zone 5

BERM — STA. TO STA. — (100 ft. from Bridge End)
Zone 1 (0-1 ft.) Zone 2 (1-3 ft.) Zone 3 (3-5 ft.) Zone 4 (5 ft. to bottom) 1 per 3 ft.

PIPE
CROSS: 24" or smaller undercut (1/2 way up) (0-2 ft. Above)
STORM: 30" to 72" undercut (Lower 1/2) (Upper 1/2) (0-2 ft. Above)
INTERSECTION: 72" or more undercut (Bottom 1/3) (Middle 1/3) (Top 1/3) (0-2 ft. Above)
After Minimum for size pipe installation ☐ 1 per 3 ft of backfill beginning at 2' above top of pipe

SUBBASE — STA. TO STA. — LIFT
BASE COURSE — STA. TO STA. 36+00 to 67+50 — LIFT 2 of 3

Standard Density
Curve Type: Ohio | Curve Used: | Maximum Density: U. | Optimum Moisture: %
Granular Material 4-Point Range: -
SPECIFICATION: 95%
% Obtained 100X(G/U): 97%

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Balloon Method
B. Wt. Undried Matl. from Hole
C. Volumeter Reading in Hole
D. Initial Volumeter Reading
E. Volume of Test Hole (C-D)
F. Wet Density (B/E)
G. Dry Density F/(100+M{Field}) x 100

Sand Method
A. Std. Sand PCF
B. Wt. Undried Matl. from Hole
C. Initial Wt. Sand
D. Final Wt. Sand Plus Cone Sand
E. Volume of Test Hole (C-D)/A
F. Wet Density (B/E)
G. Dry Density F/(100+M{Field}) x 100

Nuclear Method
Meter No.: MQ 778
Test Mode: 2" DIRECT TRANSMISSION
F. Wet Density from Gauge: 128.70
+/-Corr. *: 0.00 = 128.7
G. Dry Density F/(100+M{Field}) x 100: 122.0

1-Point Density Determination
O. Weight of Mold & Specimen
P. Weight of Mold
Q. Wet Wt. of Molded Specimen (O-P)
R. Factor of Mold No. Used in Test
S. Wet Density (QxR)
T. Dry Density S/(100+M [1-PT])x100

Moisture Determination

	1-Point	Field
H. Wt. of Wet Matl. and Container		3,120.4
I. Wt. of Dry Matl. and Container		3,009.9
J. Wt. of Moisture (H-I)		110.5
K. Wt. of Container		990.20
L. Wt. of Dry Matl. (I-K)		2,019.7
M. Percent Moisture (Jx100)/L		5.5

Rock Determination
A. Total Sample Weight
B. Weight of Material Retained on 3/4" Sieve
C. Percent Retained On 3/4" Sieve (Bx100)/A

* Correction from DOT-39. If there is no correction or, if the correction has been applied to the meter show "NA".
Comments: 1-Point Not Made this Test, Refer to Test Strip Maximum Density : 126.30

Figure 2