

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

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 $230^{\circ} \pm 9^{\circ}\text{F}$.

3. Procedure:

- 3.1 Calibration and standardization of nuclear gauge.
 - A. Calibration and performing the standard count of the nuclear gauge shall 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 shall 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) shall 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 shall 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 one minute reading to determine the wet density in lbs./ft³.
- H. Record the total number of passes and the wet density in lbs./ft³ 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./ft³.
- 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 shall 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./ft³ as the 1-point maximum density on the DOT-41. This value is used to compute the percent of density.
- O. A test strip shall 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/ft³ 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 shall 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 shall 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.

$$\text{Dry density} = (A \times 100) / (100 + G)$$

A = Wet density from nuclear gauge

G = Moisture content (% moisture)

- D. Report the average test strip dry density to the nearest 0.1 lb./ft³ on a DOT-28.

4.2 In-place density:

- A. The nuclear gauge wet density and field moisture shall 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
File No.

Test Strip Worksheet

DOT - 28
9-14

PROJECT PH 0066(00)15 COUNTY Aurora, Ziebach PCN B015
 Test No. 02 Test Date 04/29/2016 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 lb/ft³

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

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 (A x 100) / (100 + G)	125.3	127.8	127.0	125.1

Average Dry Density 126.3

Figure 1

Sample ID 2205560
File No.

Density Report

DOT - 41
9-16

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) (Hole - Gravel) Field # 07
Tested By Tester (TEST), One Checked By Tester (TEST), Two Date 05/01/2015

WORK AREA REPRESENTED (Circle what applies)

EMBANKMENT STA. TO STA. _____ (per half mile, for each roadbed)
Zone 1(0-1ft.) Zone 2(1-3 ft.) Zone 3(3-5 ft.) Zone 4(5 ft. to base, 1 per 5 ft.)
BRIDGE END STA. TO STA. _____
EMBANKMENT 1 per zone within plan limits 3 equal zones when backwall is less than 7 ft. 4 equal zones when backwall is 7 ft. or greater
Zone 1 Zone 2 Zone 3 Zone 4
BERM STA. TO STA. _____ (100 ft. from Bridge End)
Zone 1(0-1ft.) Zone 2(1-3 ft.) Zone 3(3-5 ft.) Zone 4(5 ft. to base, 1 per 5 ft.)
CROSS 24" or Smaller undercut (1/2 way up) (0-2 ft. Above)
PIPE 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		Granular Material 4-Point Range	SPECIFICATION	
Curve Used	Maximum Density U.		Optimum Moisture %	% Obtained
	126.3		95	97
			100 X (G/U)	

Balloon Method		Sand Density		Nuclear Method	
B. Wt. Undried Mat. from Hole	_____	A. Std. Sand PCF	_____	Meter No.	<u>MQ 778</u>
C. Volumeter Reading in Hole	_____	B. Wt. Undried Mat. from Hole	_____	Test Mode	<u>2" DIRECT TRANSMISSION</u>
D. Initial Volumeter Reading	_____	C. Initial Wt. Sand	_____	A. Wet Density from Gauge	<u>128.70</u>
E. Volume of Test Hole (C - D)	_____	D. Final Wt. Sand Plus Cone Sand	_____	± Corr. *	<u>128.7</u>
F. Wet Density (B / E)	_____	E. Volume of Test Hole (C - D) / A	_____	B. Dry Density	<u>122.0</u>
G. Dry Density F / (100 + M) x 100	_____	F. Wet Density (B / E)	_____	A / (100 + M-Field) x 100	_____
		G. Dry Density F / (100 + M) x 100	_____		

1-Point Density Determination		Moisture Determinations		Rock Determination		
		1-Point	Field			
O. Weight of Mold & Specimen	_____		H. Wt. of Wet Mat. and Container	<u>3120.4</u>	A. Total Sample Weight	_____
P. Weight of Mold	_____		I. Wt. of Dry Mat. and Container	<u>3009.9</u>	B. Weight of Material Retained on 3/4" Sieve	_____
Q. Wet Wt. of Molded Specimen (O - P)	_____		J. Wt. of Moisture (H - I)	<u>110.5</u>	C. Percent Retained On 3/4" Sieve (B x 100)/A	_____
R. Factor of Mold No. Used in Test	_____		K. Wt. of Container	<u>990.2</u>		
S. Wet Density (Q x R)	_____		L. Wt. of Dry Mat. (I - K)	<u>2019.7</u>		
T. Dry Density S / (100 + M [1-PT]) x 100	_____		M. Percent Moisture Field (J x 100) / L	<u>5.5</u>		

* Correction from DOT-39. If there is no correction or, if the correction has been applied to the meter show "NA".

1-Point Not Made this Test, Refer to Test Strip Maximum Density: 126.30

Figure 2