

Method of Test for Determining the In-Place Density of Low Slump Dense Concrete Using the Nuclear Gauge

1. Scope:

This test is for determining the in-place density of freshly mixed low slump dense concrete using the nuclear gauge.

Definitions:

Adjusted Unit Weight Determination: Field determination of unit weight using the calibrated bucket of an air meter and adjusting the results to an air content of 6% (Or otherwise specified air content).

In-Place Density Measurement: A specific individual measurement of in-place nuclear gauge wet density (One of three measurements made for a lot).

Lot: A quantity of material from the same source, using the same mix, placed the same day, representing a specific segment of construction.

Percent of Standard Density: Relationship of the in-place density measurement to the standard density.

Standard Density: Average of the three most recent adjusted unit weight determinations.

2. Apparatus:

- 2.1 Nuclear density-moisture gauge capable of determining densities by the direct transmission method and conforming to the requirements of AASHTO T 310.
- 2.2 2" snap-on source rod protection plate.
- 2.3 A reference standard block for taking standard counts.
- 2.4 A manufacturer's instruction manual for the nuclear gauge.
- 2.5 A nuclear gauge information book, transportation documents book, and nuclear badge.
- 2.6 A supply of rags, a can of WD-40 for cleaning the base and a can of spray lubricant containing teflon to keep the gauge base and probe lubricated.

When the gauge base is cleaned with WD-40, all residue must be completely wiped from the base before applying the spray lubricant.

NOTE: Silicone spray will not be used.

- 2.7 Miscellaneous. A measuring tape, chalk or other marking materials (For referencing pre-selected sites), test forms, etc.
- 2.8 An apparatus for determining the percent of air, SD 403.
- 2.9 An apparatus for determining the unit weight, SD 411.

3. Procedure:

- 3.1 Calibration and standardization of the nuclear gauge:
 - A. Calibration and performing the standard count of the nuclear gauge shall be in accordance with SD 114, paragraphs 3.1 and 3.2.

3.2 Selecting density measurement locations.

- A. Record the location of the lot to be tested by indicating the beginning and ending stationing. Record the length, width and quantity represented by the lot in square yards.
- B. During surface preparation operations, pre-selected sites shall be chipped out as required to provide for a 3" minimum depth of overlay at the measurement site at least 18" x 18" in area. Five such sites should be prepared for each lot to provide standby locations in the event a site cannot be measured for density for some reason or in the event additional density measurements are desired. Ordinarily only three of the sites will be used. The center of each site shall be at least 18" from the edge of the lot.
- C. The pre-selected sites shall be referenced by measurements in such a manner that they can easily be located for density measurement after placement of the overlay.

3.3 Adjusted Unit Weight Determination.

- A. The unit weight of the concrete shall be determined by SD 411, with the following exceptions:
 - (1) The bucket of the pressure air meter shall be used as the measure. A cover plate shall be used for strike off on all unit weight determinations for low slump density concrete. Immediately after the unit weight determination has been completed, the top shall be placed on the air meter and the percentage of entrained air determined (SD 403).
 - (2) The unit weight shall then be adjusted for an air content of 6.0%. This adjustment is determined by multiplying the unit weight times 94.0% and dividing that result by 100.0% minus the percent of entrained air in the concrete.

3.4 Standard Density.

- A. The moving average concept shall be employed. A minimum of two adjusted unit weight determinations shall be made on the first pour and then a minimum of one adjusted unit weight determination per pour thereafter. The standard density shall be based on the first two determinations, then on the average of the first three determinations. After the first three tests the average of the three most recent adjusted unit weight determinations shall be used as the standard density. The moving average may include more than one project when the same source, mix and mixing equipment are being used.
- B. The validity of the sample is questionable when the adjusted unit weight determination varies by more than 1.5 lbs./ft³ from the previous adjusted unit weight. Another sample shall be obtained immediately and an adjusted unit weight determination made to verify or replace the sample in question.

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3.5 In-Place Density Measurements.

- A. After the concrete has been placed and struck off, prior to final texturing and tining, locate the pre-selected site, seat the gauge with the 2" snap-on source rod protection plate attached on the plastic concrete. Extend the source rod to the 2" direct transmission position and take a 1 minute density reading. Record the wet density to the nearest 0.1 lbs./ft³ on DOT 56. Remove the gauge from the test site and thoroughly clean all concrete from the bottom of the gauge. After cleaning, lightly coat with the lubricant spray and wipe dry.
- B. Repeat the procedure for the other two selected sites.

4. Report:

4.1 Calculations.

- A. Standard Density determinations.

(1) The adjusted unit weight shall be calculated as follows:

$$\text{Adjusted Unit Weight} = \frac{\text{Unit Wt.} \times 94.0}{100.0 - \text{Determined Air Content}}$$

Example:

$$\begin{aligned} \text{Obtained Unit Weight} &= 143.6 \text{ lbs./ft}^3 \\ \text{Determined Air Content} &= 5.0\% \\ \text{Adjusted Unit Weight} &= \frac{143.6 \times 94.0}{100.0 - 5.0} \\ &= \frac{143.6 \times 94.0}{95.0} = 142.1 \text{ lbs./ft}^3 \end{aligned}$$

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B. In-Place Density Measurements.

- (1) Determine the wet density in lbs./ft³ with the gauge.
- (2) If a minus correction is required, subtract the correction from the wet density in lbs./ft³.

NOTE: 3.0 lbs./ft³ correction shall be subtracted from the wet density reading when limestone aggregate is used in the mix. There is no correction for quartzite or granite used in the mix.

- (3) The resulting corrected density is the wet density at that site and is the density to be averaged with that of the other two sites to determine the density for the lot. Since the standard density is also a wet density, it is not necessary to determine moisture content or dry density.
- (4) Percent of Standard Density for each density measurement.

% of standard =

$$\frac{(\text{Wet density} - \text{Correction}) \times 100}{\text{Standard Density}}$$

- (5) Percent of Standard Density for the Lot.

% of standard =

$$\frac{\text{Sum of \% of standard for 3 density measurements}}{3}$$

4.2 Report.

- A. Report the standard density to the nearest 0.1 lb./ft³ (DOT-56).
- B. Report the percent of standard density for each site to the nearest 1% (DOT-56).
- C. Report the percent of standard density for the lot to the nearest 1% (DOT-56) Figure 1.
- D. Report the test satisfactory when:
 - (1) The percent of standard density obtained for the lot is equal to or greater than that specified for the project.

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- (2) No more than one of the density measurements is below the specified density.
- (3) None of the density measurements are more than two percentage points below the specified density.

5. References:

AASHTO T 310
SD 114
SD 403
SD 411
DOT-56

Sample ID 2224221
File No.

**Density Report - PC Concrete
(Bridge Deck Overlay)**

DOT - 56
9-16

PROJECT PH 0066(00)15 COUNTY Aurora, Ziebach PCN B015
Structure No. 48-013-210 Tested By Tester, One Checked By Tester, Two
Field No. 01/IA01 Date 06/02/2016 Time 5:00 am Test Mode 2" DIRECT TRANSMISSION
Nuclear Gauge No. MQ 777 Daily Standard Count 2811

Unit Weight Determination

Test Number	01	IA01	02	Test Number	01	IA01	02
A. Weight of Concrete and Measure	44.0	44.7	43.8	G. Slump	0.5	0.5	0.25
B. Weight of Measure	8.2	8.8	8.2	H. Mix. Temp. (°F)	82	83	85
C. Weight of Concrete (A - B)	35.8	35.9	35.6	I. Air Temp. (°F)	73	73	75
D. Factor of Measure	4.01	4.00	4.01	J. % Air	5.0	5.3	5.9
E. Unit Weight PCF (C x D)	143.6	143.6	142.8				
F. Adjusted Unit Weight (E x 94) ÷ (100 - J)	142.1	142.5	142.6				

Standard Density

K. Compute Standard Density - Average of the 3 Adjusted Unit Weights
The Average may be based on 2 tests for the first low slump pour.

	<u>142.1</u>	Line F. from Test No.	<u>01</u>
	<u>142.5</u>	Line F. from Test No.	<u>IA01</u>
	<u>142.6</u>	Line F. from Test No.	<u>02</u>
L. Total	<u>427.2</u>		
M. Standard Density (Average)	<u>142.4</u>		

In-Place Density Measurements

Lot Location: Begin Station 0+00 End Station 2+04.21 RT of Centerline
Length 204 feet; Width 18.00 feet; Quantity 408.4 yd²

Site No.	Distance from Lot Beginning	Distance from Outer Edge	Wet Density PCF	Correction (If Applicable)	Corrected Wet Density PCF	% of Standard
1	0+20	6.5	144.6	3.0	141.6	99
2	0+72	13.8	143.1	3.0	140.1	98
3	1+34	10.5	141.3	3.0	138.3	97
4	1+86	6.2	142.5	3.0	139.5	98
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Percent of Standard Density Required 98.0-108.0 Average Obtained 98

* If the adjusted unit weight for the most current test is not within 1.5 Lbs/Cu. Ft. (24 kg/m³) of the previous test, a check test must be run.

Figure 1