

## Density of Soils In-place by the Rubber Balloon Method

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### 1. Scope:

This test is for determining the density of soil in-place using a volumeter. This method is restricted to test hole volumes between 0.02500 and 0.05000 ft<sup>3</sup> and to bonded soil masses with a maximum particle size of ½”.

### 2. Apparatus:

2.1 Volumeter conforming to the requirements of ASTM D2167.

**NOTE: New volumeters shall be calibrated and volumeters which have had the jar and scale replaced or pressure gauge repaired or replaced shall be recalibrated, prior to use. Calibration shall be performed by the Region Materials Engineer. Jars and scales are not interchangeable. The serial numbers must be identical.**

2.2 Digging tools: Chisel, hammer, scoop or spoon, prospector's pick.

2.3 Containers. Buckets with lids or plastic bags.

2.4 Scale or balance having the capacity to weigh any sample which may be tested utilizing this procedure and readable to the nearest 0.01 lb. and also one that is readable to the nearest 0.1 gram.

2.5 Drying equipment. An oven capable of maintaining a temperature of 230° ± 9°F or other equipment according to SD 108.

### 3. Procedure:

**NOTE: References to base plate in this procedure apply only when the new type volumeters are being used.**

3.1 Prepare the surface of the test area so that it is reasonably smooth and level (Free from loose material or holes). Place the volumeter and base plate on this surface and mark the outline of the base on the soil surface.

Take an initial reading using the same gauge pressure as was used during the calibration. Read the volume on the scale and record it on the worksheet.

3.2 Remove the volumeter from the test location and dig a hole centered within the scribed outline, or through the hole of the base plate. Exercise care so that soil around the top edge is not disturbed. Carefully place all the soil removed from the test hole in an airtight container for weight and moisture content determinations. Ensure the test hole volume is in accordance with SD 105, table 1.

- 3.3 Place the volumeter over the test hole or base plate in the same position used for the initial reading, and inflate the balloon in the hole. Using the same gauge pressure as was used for calibration, take and record the reading on the volume indicator. Release the pressure to deflate and retract the balloon from the hole. The difference between this reading and the initial reading is the test hole volume in ft.<sup>3</sup>.

**NOTE: The meter should be read to the nearest 0.00025.**

- 3.4 Weigh the soil taken from the hole to the nearest 0.01 lb.
- 3.5 Mix the material thoroughly and select a representative sample for a moisture test, (SD 105, table 1). Weigh the material to the nearest 0.1 gram and dry it to a constant weight as per SD 108.
- 3.6 Standard Density Determination.
  - A. To determine standard density, take material from or adjacent to the test hole for SD 104, method 2 or method 4.

**4. Report:**

- 4.1 Calculations.
  - A. The procedure for calculating the in-place density, standard density, and moisture are shown on the DOT-41, figure 1.

The maximum dry density from the family of curves established by the 1-point determination is used to compute the percent of standard obtained for the test.

- 4.2 Report.
  - A. Report the moisture content to the nearest 0.1 percentage point.
  - B. Report the wet and dry densities for the in-place and standard tests to the nearest 0.1 lb./ft<sup>3</sup>.
  - C. Report the percent of standard density to the nearest whole percentage point.

**5. References:**

- ASTM D2167
- SD 104
- SD 105
- SD 108
- DOT-41

Sample ID 2205173  
File No.

Density Report

DOT - 41  
9-16

County Aurora, Ziebach PCN/PROJECT B015 PH 0066(00)15  
Station 268+50 Dist. From CL 17' R Width (Gravel) \_\_\_\_\_  
Depth 0.5' (from top of Subgrade or Pipe) (Hole - Gravel) Field # E036  
Tested By Tester, One Checked By Tester, Two Date 04/27/2015

WORK AREA REPRESENTED (Circle what applies)

EMBANKMENT	STA. TO STA.	253+00 to 279+00 (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 EMBANKMENT	STA. TO STA.	_____		
	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.)
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 <input type="checkbox"/> 1 per 3 ft. of backfill beginning at 2' above top of pipe		
SUBBASE	STA. TO STA.	LIFT		
BASE COURSE	STA. TO STA.	LIFT		

Curve Used	Standard Density			Granular Material 4-Point Range	SPECIFICATION	
	Maximum Density	Optimum Moisture	%		% Obtained	%
0	U. 107.1	18.1	%	-	95	%
					95	%
					100 X (G/U)	%

Balloon Method		Sand Density		Nuclear Method	
B. Wt. Undried Matl. from Hole	3.56	A. Std. Sand PCF	_____	Meter No.	_____
C. Volumeter Reading in Hole	0.04050	B. Wt. Undried Matl. from Hole	_____	Test Mode	_____
D. Initial Volumeter Reading	0.01025	C. Initial Wt. Sand	_____	A. Wet Density from Gauge	_____
E. Volume of Test Hole (C - D)	0.03025	D. Final Wt. Sand Plus Cone Sand	_____	± Corr. * _____ = _____	
F. Wet Density (B / E)	117.7	E. Volume of Test Hole (C - D) / A	_____	B. Dry Density	_____
G. Dry Density F / (100 + M) x 100	101.3	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	13.32	130.7	H. Wt. of Wet Matl. and Container	109.1	A. Total Sample Weight	_____
P. Weight of Mold	9.23	112.5	I. Wt. of Dry Matl. and Container	93.9	B. Weight of Material Retained on 3/4" Sieve	_____
Q. Wet Wt. of Molded Specimen (O - P)	4.09	18.2	J. Wt. of Moisture (H - I)	15.2	C. Percent Retained On 3/4" Sieve (B x 100)/A	_____
R. Factor of Mold No. Used in Test	2-35	30.01	K. Wt. of Container	_____		
S. Wet Density (Q x R)	122.7	112.5	L. Wt. of Dry Matl. (I - K)	93.9		
T. Dry Density S / (100 + M [1-PT]) x 100	105.6	16.2	M. Percent Moisture Field (J x 100) / L	16.2		

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

Figure 1