

ND D 2167 - DENSITY AND UNIT WEIGHT OF SOIL IN PLACE BY THE RUBBER-BALLOON METHOD

Conduct this procedure according to ND D 2167.

The NDDOT modified the ASTM standard by decreasing the minimum requirement for test hole volume.

Consult the current edition of ASTM for procedure in its entirety and equipment specification details.

SCOPE

This method covers the determination of the in-place soil density of compacted or firmly bonded soil using a rubber-balloon apparatus.

Embankment compaction is controlled by requiring the density of each different soil, after compaction, be a specified minimum percentage of the maximum dry density. The maximum dry density is determined for each different soil on the project. When a particular soil is encountered in the excavation and transferred to and compacted in the embankment, it is tested by the method given in this section to determine its dry density. The in-place dry density is expressed as a percentage of the soils maximum dry density and can be compared to specification requirements.

REFERENCED DOCUMENTS

ND T 217 and AASHTO T 217, Determination of Moisture in Soil by Means of Calcium Carbide Gas Pressure Moisture Tester (Speedy)

ND T 265 and AASHTO T 265, Laboratory Determination of Moisture Content of Soils

ND D 4643 and ASTM D 4643, Determination of Moisture Content of Soil by the Microwave Oven Method

APPARATUS

Rubber-balloon apparatus and base plate
Balance, readable to 0.01 lbs
Pins, shovel, trowel, spoon, hammer, and knife
Auger, 4" diameter
Appropriate size container with lid

PROCEDURE

All information is recorded on SFN 2454. Record the balloon volume readings to 0.00000 cu.ft.

The following chart shows the minimum of test hole volume required.

Maximum Particle Size	NDDOT Minimum Test Hole Volume
1/2"	0.025 cu.ft.
1"	0.03 cu.ft
1½"	0.035 cu.ft.

Select the area of compacted embankment to be tested. Because the surface of a compacted area is generally loose or disturbed due to rolling operations, remove loose material and level off an area slightly larger than the base plate.

Place the base plate over the smoothed area and fasten down with the accompanying pins. Plate must stay in this position and be stable throughout the test.

Place the volume measure on the base plate for the initial reading, noting its position with regard to the base plate. Using the bulb-type pump, and while holding down the volume measure, force the water down into the balloon until resistance is felt. Apply the calibrated pressure and note the reading on the glass cylinder. Record the reading.

Dig a hole with the auger, trowel, or other tools. Hole must be approximately 4" in diameter and 5" deep. Place all of the loosened material from the hole into an aggregate balance pan, or a moisture-tight container if not weighed right away. Clean the sides and bottom of the hole being very careful not to lose any material. Check to be certain that no jagged edges or points remain that may puncture the balloon. Do not disturb the soil around the top edge of the hole.

Place the volume measure on the base plate in the same initial position. Pump the balloon down into the hole and apply the calibrated pressure. Read and record the final reading. The volume of the test hole is determined by the difference between the initial and final reading.

Weigh the soil removed from the hole to the nearest 0.01 lb and record.

Use a representative portion of the soil for moisture determination. Do not use material containing particles large enough to be retained on the No. 4 (4.75 mm) sieve. Moisture can be determined by the use of ND T 217, ND T 265, or ND D 4643.

CALCULATIONS

Complete calculations as follows:

$$\text{Volume of Hole} = \text{Final Reading} - \text{Initial Reading}$$

$$\text{Wet Density} = \text{Wet Weight of Soil} / \text{Volume of Hole}$$

$$\text{Dry Density} = (\text{Wet Density} \times 100) / (100 + \text{Percent Moisture})$$

REPORT

Report dry density to the nearest 0.1 lbs/cu.ft.

CALIBRATION

All new devices should be calibrated prior to being used. A calibration check should be performed annually as a minimum, or whenever damage or repair occurs.