

**Standard Method of Test for**

**Field Determination of Density and Moisture Content of Soils and Aggregate Bases by Use of the Troxler Model 3450 Nuclear Gauge**

**SCDOT Designation: SC-T- 32 (8/08)**

**1. SCOPE**

- 1.1. This method describes procedures for determining the density and moisture content of soils and aggregate bases through the use of the nuclear equipment.
- 1.2. This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

**2. REFERENCED DOCUMENT**

- 2.1. SC-T-22.

**3. SUMMARY OF TEST METHOD**

- 3.1. The total or wet density of the material is determined by placing a gamma source into the material under test. The intensity of radiation detected is dependent upon the density of the material under test. The radiation intensity reading is related to measured wet density by suitable calibration curves or tables. The total water content is determined by placing a neutron source into the material under test. The quantity of fast neutrons is dependent upon the hydrogen content of the water in the material. The quantity of fast neutrons is related to the measured water content by suitable calibration curves or tables.

**4. SIGNIFICANCE AND USE**

- 4.1. The test method described is useful as a rapid, nondestructive method for the in-place determination of the wet density of soils and the wet density and moisture content of aggregate bases.

**5. APPARATUS**

- 5.1. Troxler Model 3450 Nuclear Gauge, reference standard, scraper plate, drill rod, drill rod extraction tool.

**6. TEST SPECIMENS**

- 6.1. This test is conducted on in-place soils or aggregate base material.

## 7. PROCEDURE

- 7.1. Turn the gauge on by pressing the "ON" key and the gauge will go through a short self-test. After the self-test, allow the gauge to warm-up for a minimum of 10 minutes. This will allow the systems critical circuits to stabilize.
- 7.2. Take moisture and density standard counts (at least 10 feet from any large object and at least 30 feet from another gauge).
- 7.3. Place the standard on a dry, solid and flat surface containing not more than 15 percent moisture and at least 100 pounds per cubic foot of density.
- 7.4. Place the gauge on the standard, being sure the scaler end of the gauge is toward the raised end of the standard and seated properly on the recessed surface.
- 7.5. Remove the padlock that locks the source rod in the "SAFE" position.
- 7.6. Press the "STANDARD" key and answer the prompted questions.
- 7.7. The gauge display will show the last standard count and two selections ("1"-take a new count and "2"-view counts). Select "1" (take new count).
- 7.8. The gauge will prompt, "Put Rod In STD Pos. Place Gauge on Standard Block." Press the "ENTER" key. The gauge will display the count progress.
- 7.9. After the count completion, the gauge will display the Density Standard for Systems 1 (DS1), the Density Standard for Systems 2 (DS2) and the Moisture Standard (MS). The "#.#%" and "PASS" or "FAIL" display will indicate whether or not the counts fall within the acceptable limits. The DS1 and DS2 should be within 1 percent and the MS within 2 percent of the average of the previous four counts.
- 7.10. Record both the DS (Density Standard) and MS (Moisture Standard) on the daily log.
- 7.11. The gauge will prompt, "Use New Standard?" If the standard counts pass, press the "YES" key to accept the counts.
- 7.12. After accepting the new standard count, the gauge will prompt, "Calibrate the Depth Strip by Placing the Rod in Backscatter and Pressing Enter."
- 7.13. The gauge will return to the "READY" screen. Return the standard to its case.
- 7.14. If the surface is not relatively smooth, use the scraper plate to smooth and level the test surface (all loose stone should be removed and small voids filled with native fines or sand).
- 7.15. Take moisture and density measurement counts.

- 7.16. Using the drill rod and the scraper plate, put the drill rod through the extractor tool, then through the scraper plate guide. Secure the scraper plate with one foot; drive the test hole at least 2 inches deeper than the desired test depth.
- 7.17. Remove the drill rod by rotating and pulling straight up. Do not loosen the drill rod by tapping from side to side with a hammer.
- 7.18. Before moving the scraper plate, with your foot still securing the plate, take the drill rod and mark around the corners of the scraper plate.
- 7.19. Place the gauge within the scraper plate outline.
- 7.20. Press the "MODE" key and select "1" for the "SOIL" mode.
- 7.21. Press the "TIME" key and select "#2" for the recommended time (1 minute).
- 7.22. This step is only used for Aggregate Bases and Coquina Base Course. To enter Lab Proctor information, press the "TARGET" key and select "1" for "PROCTOR". Enter either "5" for a new "TARGET VALUE" or choose an existing "STORED VALUE" and "LOCATION" from the menu. Press the "ENTER" key to return to the ready screen.
- 7.23. Release the trigger and lower the source rod into the hole to the desired depth of measurement.
- 7.24. Gently slide the gauge to the right (scaler end), placing the source rod in firm contact with the sidewall of the hole.
- 7.25. Press the "START" key to begin the test count. If the gauge is in the automatic depth mode, the correct depth will be displayed. If the gauge is in the manual depth mode, the gauge will prompt you to enter the depth manually. At this time, the gauge will begin the test count.
- 7.26. After the count time is complete, the gauge will display %PR, DD, WD, M and %M. Record the WD (Wet Density) and the actual Density Count only. To obtain the actual Density Count, press the "ARROW UP" key.
- 7.27. Pull the source rod to the top notch, or "SAFE" position, and return the gauge to a safe area.

## **8. CALCULATIONS**

- 8.1. Determine the moisture content and calculate the dry density pounds per cubic foot (pcf).
- 8.2. For Soils:
  - 8.2.1. Determine the percent moisture using SC-T-22.

8.2.2. Calculate the dry density using the following equation:

$$\gamma_{\text{DRY}} = \left( \frac{\gamma_{\text{WET}}}{W + 100} \right) \times 100$$

where:  $\gamma_{\text{DRY}}$  = dry unit weight, in pcf of compacted soil  
 $\gamma_{\text{WET}}$  = wet unit weight, in pcf of compacted soil  
W = percentage of moisture in the specimen

8.3. For Aggregate Base Materials:

8.3.1. Record %PR (% Compaction), DD (Dry Density), WD (Wet Density), M (Moisture) and %M (% Moisture) from the gauge display.

## 9. REPORT

9.1. Report the moisture content of the soil to the nearest 0.1 percent and the moisture content of aggregate base materials to the nearest 0.1 pound per cubic foot. Report the maximum dry density to the nearest 0.1 pound per cubic foot. If running the test on a soil material, report the results on SCDOT Form 200.03 – Percent Compaction by Nuclear Gauge-Direct Read Gauge and SCDOT Form 200.01 – Field Density Test Report (Nuclear Gauge). If running the test on a graded aggregate base material or other material composed of large particles, use SCDOT Form 300.03 – Density Test Report (Nuclear Gauge) Direct Read Gauge.