Standard Method of Test for

Field Determination of Maximum Dry Density and Optimum Moisture Content of Soils for Cement Modified Recycled Base

SCDOT Designation: SC-T-27 (07/17)

1. SCOPE

This method covers a procedure for determining the maximum dry density and optimum moisture content of cement modified recycled base (CMRB) in the field. In most instances, it will be possible and advantageous to use the maximum dry density and optimum moisture supplied in the approved CMRB mix design but variations in the existing roadway may require a field maximum dry density and optimum moisture content to be determined. The decision to use the maximum dry density and optimum moisture content of the CMRB approved mix design or re-establish a new maximum dry density and optimum moisture content will be determined based on the results of the Nuclear Density Gauge test results. All failing results (less than 95.0 % compaction when compared to the CMRB approved mix design or moisture contents below optimum moisture when compared to the CMRB mix design) will require a field determination of the maximum dry density and optimum moisture content. Additionally, tests resulting in a percent compaction of 103.0% or greater when compared to the approved CMRB mix design will require field determination of the maximum dry density and optimum moisture content.

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 DOCUMENTS

SC-T-22: Determining Moisture Content of Soils by Carbide Gas Method

SC-T-23: Determining Moisture Content of Construction Materials by 'Pan Drying' Method

SC-T-29: Field Determination of Maximum Dry Density and Optimum Moisture Content of Soils by the One-Point Method

SC-T-33: Field Determination of Density and Moisture Content of Nonstandard Materials by Use of the Nuclear Density Gauge

AASHTO T 224: Correction for Coarse Particles in the Soil Compaction Test

SCDOT Approved CMRB Mix Design

3. SUMMARY OF TEST METHOD

A field determination of the in place wet density will be determined with the in-place CMRB using a nuclear density gauge. Additionally, the in place moisture content will be determined by pan drying. These two results will be compared to the maximum dry density and optimum moisture content provided on the approved CMRB mix design to determine if a field determination of the maximum dry density and optimum moisture will be required. If required, the amount of material retained on the No. 4 sieve is determined by sieving the same sample obtained with SC-T-23 (Determining Moisture Content of Construction Materials by 'Pan Drying' Method). This percentage is then used in combination with the results of the one point proctor test to calculate a corrected maximum dry density and optimum moisture content for the construction material, which can then be used to determine the required dry density and moisture targets.

4. SIGNIFICANCE AND USE

The maximum dry density and optimum moisture content of construction materials for use in roadways is important in field compaction and tests for determining compaction. These values can be obtained in the field for materials containing larger amounts (approximately 10% - 40%) of material which is retained on the No. 4 sieve.

5. APPARATUS

- Balance or Electronic Scale, 12 K capacity, Capable of Reading to Accuracy of 0.1 g
- No. 4 Sieve, 12 inch Diameter

6. TEST PROCEDURE

Determine the density of the in-place CMRB material using SC-T-33. Record the density in pounds per cubic foot (pcf).

Determine the moisture content of the in-place CMRB material using SC-T-23. Record the moisture content as a percentage (%) of the weight of the sample. Do not discard the dry sample, this is the sample for this test procedure.

Compare the moisture content and the density to the optimum moisture content and maximum dry density determined in the SCDOT approved mix design to determine if the maximum dry density and optimum moisture content need to be re-established.

Determining Amount Retained on No. 4 Sieve

Obtain the full representative sample used in SC-T-23 which has been previously dried.

Ensure the sample is cool to the touch prior to handling material. Weigh and record the total dry sample weight to the nearest 0.1 g (a).

Sieve all material over a No. 4 sieve. The material which passes through may be discarded. Take caution to not lose material over the top of the sieve as this will cause this test to become inaccurate. Break up small clumps of material by hand.

Weigh and record the amount of material retained on the No. 4 sieve to the nearest 0.1 g (b).

Use the recorded weight values in *Equation 1* below to determine the percentage of material retained on the No. 4 sieve (c). Round to the nearest 0.1%.

Calculating Corrected Maximum Dry Density

Using *Equation 2*, determine the percentage of material passing the No. 4 sieve (d). This will require the percentage of material retained on the No. 4 sieve as determined in *Equation 1*. Round to the nearest 0.1%.

Using *Equation 3*, determine the total corrected maximum dry density of the composite material, combined fine and coarse particles (e). This will require the maximum dry density of the material passing the No. 4 sieve which can be obtained from SC-T-29 (x) (Field Determination of Maximum Dry Density and Optimum Moisture Content of Soils by the One-Point Method). Round to the nearest 0.1 pcf. (Note: The specific gravity of the material retained on the No. 4 sieve is assumed to be 2.6, per AASHTO T 224.)

Calculating Corrected Optimum Moisture Content

Using *Equation 4*, determine the corrected optimum moisture content of the composite material, combined fine and coarse particles (f). This will require optimum moisture content of the material passing the No. 4 sieve (y) which can be obtained from SC-T-29 (Field Determination of Maximum Dry Density and Optimum Moisture Content of Soils by the One-Point Method). Round to the nearest 0.1%. (Note: The optimum moisture content of the material retained on the No. 4 sieve is assumed to be 2.0%, per AASHTO T 224.)

7. CALCULATIONS

Equation 1 – Determining the Percentage of Material Retained on the No. 4 Sieve

$$c = \% \, Material \, Retained = 100 \, \% * \frac{b \, (Weight \, of \, No \, 4 \, Material \, Retained)}{a \, (Initial \, Dry \, Sample \, Weight \,)}$$

Equation 2 – Determining the Percentage of Material Passing the No. 4 Sieve

$$d = \% \, Material \, Passing = 100 \, \% - c$$

Equation 3 – Determining the Corrected Maximum Dry Density of Composite Material

$$e = Corrected \, Maximum \, Dry \, Density \, (pcf) = \frac{162.24 * x}{(c/100 * x) + (d/100 * 162.24)}$$

Equation 4 – Determining Corrected Optimum Moisture Content of Composite Material

$$f = Corrected \, Optimum \, Moisture \, Content \, (\%) = 0.01 * [(2 * c) + (d * y)]$$

<u>Example;</u>

a - Initial Dry Weight of Sample	2562.4 g
b - Weight of No 4 Material Retained	483.5 g

$$c = \% \, Material \, Retained = 100 * \frac{483.5}{2562.4} = 18.9\%$$

$$d = \% \, Material \, Passing = 100 - 18.9 = 81.1\%$$

x - Maximum Dry Density of the Material Passing the No. 4 Sieve	116.5 pcf

$$e = Corrected \, Maximum \, Dry \, Density \, (pcf) = \frac{162.24 \, pcf * 116.5 \, pcf}{\left(\frac{18.9\%}{100} * 116.5pcf\right) + \left(\frac{81.1\%}{100} * 162.24pcf\right)} = 123.1 \, pcf$$

y - Optimum Moisture Content of Material Passing No. 4 Sieve	12.4%

$$f = Corrected \, Optimum \, Moisture \, Content \, (\%) = 0.01 * [(2 * 18.9) + (81.1 * 12.4)] = 10.4\%$$

8. REPORT

Report the data on SCDOT Form 300.06 – Reclamation Percent Compaction by Nuclear Gauge – Direct Read