Standard Method of Test for

Making, Curing and Testing of Cement Stabilized Aggregate Base Compression Specimens in the Laboratory

SCDOT Designation: SC-T-142 (09/15)

1. SCOPE

This test method outlines the procedure for preparing and testing of cement treated graded aggregate base specimens for the purpose of designing Cement Stabilized Aggregate Base (CSAB) courses. This test is normally conducted in conjunction with maximum density testing (SC-T-140) on identical material. Samples weighing approximately 20,000 grams are required for each cylinder or approximately 60,000 grams for each set of 3 cylinders made.

SCDOT specifications require that the cement content of CSAB mixes be between 2.5 percent and 5 percent by Saturated Surface Dry (SSD) weight. Therefore, sets of specimens are normally molded with 2.5 percent, 3.5 percent and 5 percent cement. The maximum density test is normally conducted on a sample containing 3.5 percent cement.

2. REFERENCED DOCUMENTS

2.1 AASHTO Standards:

T 180 Moisture Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18 In.) Drop

T 248 Reducing Samples of Aggregate to Testing Size

T 265 Laboratory Determination of Moisture Content of Soils

M 92 Wire-Cloth Sieve for Testing Purposes

M 231 Weighing Devices Used in the Testing of Materials

M 201 Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes

2.2 ASTM Standards:

C 1435 Molding Roller Compacted Concrete in Cylinder Molds Using a Vibrating Hammer

C 470 Molds for Forming Concrete Test Cylinders Vertically

D 1633 Compressive Strength of Molded Soil-Cement Cylinders

2.3 SCDOT Standards:

SC-T-140 Moisture Density Relations of Soils or Soil-Aggregate Mixtures Using a 10-lb Rammer and an 18-in. Drop

3. APPARATUS

3.1 Drying Ovens – Thermostatically controlled, preferably of the forced-draft type, capable of being heated continuously at a temperature of 60±5°C (140±9°F) or 110±5°(230±9°F), as required.

3.2 Sieves – No. 4 and 3/4–inch sieves conforming to AASHTO M 92

3.3 Molds -

3.1 6-in. diameter molds meeting the requirements of AASHTO T 180.

3.3.2 A cylindrical mold conforming to the requirements of ASTM C 470 for 6-inch diameter and 12-inch high reusable molds.

3.3.3 A single-use plastic, cylindrical mold conforming to the requirements of ASTM C 470 for 6-inch diameter and 12-inch in height. A cylindrical sleeve meeting the requirements of ASTM C 1435 shall be used with single use molds.

3.4 Manually-Operated Rammer- Nominal 10-lb sector-faced rammer meeting the requirements of AASHTO T 180.

3.5 Vibrating Hammer- A vibrating compaction hammer meeting the requirements of ASTM C 1435.

3.6 Tamping Plate – A circular tamping plate attached to a steel shaft meeting the requirements of ASTM C 1435.

3.7 Mold Accessories – Sample extruder, straightedge, mixing tools, pans, and cloths as described in AASHTO T 180.

3.8 Small Tools - A square ended shovel, a hand scoop, a tamping rod, and a stopwatch as described in ASTM C 1435.

3.8 Containers – Suitable containers with close fitting lids for determination of moisture content. One container is required for each moisture content determination.

3.9 Glass Graduates – One glass graduate of 100 mL to 150 mL capacity and one glass graduate of 200 mL to 300 mL capacity is required. The 100 mL glass graduate shall be subdivided to the nearest 1.0 mL. The 250 mL glass graduate shall be subdivided to the nearest 2.0 mL. The main graduation lines shall extend at least three-quarters of the way around the graduate and shall be numbered.

3.10 Balances and Scales – A balance or scale conforming to the requirements of AASHTO M 231, Class G 20. Also, a balance or scale conforming to AASHTO M 231, Class G 2.

3.11 Disposable Gloves – Latex or other rubber gloves to prevent skin contact with Portland cement.

3.12 Compression Testing Machine – A compression testing machine meeting the requirements of ASTM D 1633.

4. TEST SPECIMENS

4.1 A set of test specimens will consist of 3 cylindrical specimens nominally 6 inches in diameter and 12 inches in height compacted to 100 percent of the maximum dry density as determined by SC-T-140. Sets of specimens are prepared for varying cement contents. To prepare a set of test specimens, a minimum base sample of 40-kg (88-lbs) is required. *Note: Mixing is easier to achieve if the material for each cylinder is mixed separately.*

4.2 Specimen Preparation

4.2.1 Determine the maximum dry density and optimum moisture content of the base material mixed with 3.5 % cement based on the total SSD weight of the bulk sample by performing SC-T-140.

4.2.2 Dry the bulk sample of base for cement modification at 60°C to a constant weight to achieve a saturated surface dry (SSD) condition.

4.2.3 Reduce the bulk sample into samples of appropriate size for molding test specimens according to AASHTO T 248.

4.2.4 Select the desired cement content for each sample and determine the amount of cement required in grams based on the total SSD weight of the bulk sample. Place the air-dried sample on a non-absorbent surface and mix dry until thoroughly blended, noting the time.

4.2.5 Mold the sample within 2 hours of the time the cement is introduced.

5. PROCEDURE

5.1 Determine the amount of material needed to mold each of the 4 layers in a 6-in diameter by 12-in. height specimen molded to 100 percent of maximum dry density as obtained from SC-T-140 as follows:

$$\textit{Mass in each layer(grams)} = \textit{Max Density(pcf)} \times (1 + \textit{OMC}/100\%) \times 22.2657$$

5.2 Add sufficient water to the specimen to bring it to within +/- 1 percent of optimum moisture content (OMC) and mix thoroughly using trowel and gloved hands. Include

the weight of the cement in the specimen as well as the base material when determining the amount of water required

5.3 Tamp the aggregate-cement mixture, cover with a damp cloth to prevent moisture loss, and allow to stand for 5 to 10 minutes to aid in dispersion of the moisture and permit absorption by the aggregate-cement mixture.

5.4 Break up mixture and then remix.

5.5 Take an initial representative moisture sample from the mixture according to AASHTO T 265.

5.6 Obtain and weigh the amount of material determined in 5.1, place in the mold, and using the vibrating hammer and tamping plate, compact the material per ASTM C 1435 section 8

5.7 Repeat step 5.6 for each of the 4 layers. *Note: Finishing of the 4th and final layer's surface may require the use of minus No.4 material and a straight edge to fill small voids and smooth and level the specimen with the top of the cylinder mold.*

5.8 Take a final representative moisture sample from the mixture according to AASHTO T 265.

5.9 Repeat steps 5.2 through 5.8 to mold the second and third of three specimens for a set.

5.10 Keep all specimens sealed or covered with a damp cloth in the mold until all work is completed on this material.

5.11 Place all moisture specimens in a drying oven (110°C) for 12 hours or until a constant mass is obtained. Average the moisture contents and determine the dry density of the material as follows:

$$\gamma DRY = \frac{\gamma WET \times 100}{100 + \% \text{ moisture}}$$

5.12 The dry density should be within 2 pcf of the maximum value determined by SC-T-140 and the average moisture content should be within 1 percent of optimum.

5.13 Repeat steps 5.1 through 5.12 for each additional set of specimens made at varying cement contents.

5.14 CSAB specimens should be stored in a moist curing room undisturbed for seven (7) days. The specimens should remain in the mold for the first 24 hours of this seven (7) day curing period. Remove the specimens from the molds at 24 hours and return them to the moist curing room for the remaining six (6) days. Upon removing from the curing room, soak the specimens overnight in water and test for unconfined compressive strength on the 8th day.

5.15 Apply the load continuously and without shock. A screw power testing machine, with the moving head operating at approximately 0.05 in. / min when the machine is running idle, may be used. With hydraulic machines, adjust the loading rate to a constant rate within

the limits of 20 +/- 10 psi/s, depending upon the strength of the specimen. Record the total load failure to the nearest 10 lbf.

5.16 Calculate the average compressive strength for each set of specimens. If the measured compressive strength between the first two cylinders of the set varies by more than 10 percent of the stronger cylinder, test the third cylinder and average the results of the three cylinders. Otherwise, average the measured compressive strength of the two cylinders to determine the compressive strength of the set.

6. CALCULATIONS

6.1 Calculate the amount of material required to mold a specimen as follows:

*Amount of material required to mold one layer(grams) = $\gamma_{DRY\ MAX(pcf)}$ *(1+ OMC) * 22.2657*

Example Calculation:
(From SC-T-140, $\gamma_{DRY\ MAX}$ = 131.8 pcf, OMC = 8.3%)

*= 131.8pcf * 1.083 * 22.2657 =3178 grams per layer*

6.2 After compressive strength testing, compute the strength of each sample as follows:

Compressive strength (psi) = [Load (lbs.) / [Area (in^2)] .

Example Calculation:
(From Compressive Strenght Data, Load = 18,378 pounds, Specimen Area = 28.274 in^2)

= [18,378 lb.] / [28.274 in^2] = 650 psi.

6.3 Plot the average unconfined compressive strength of the set of cylinders versus the cement content at which they were molded. Determine the recommended cement content from the plot based on the desired compressive strength of the material.

7. REPORT

7.1 Report the recommended cement content to the nearest one tenth percentage. Density test results and recommended cement content are reported on Lab Form SO129.