Standard Method of Test for

Sampling, Preparing and Testing of Cement Modified Recycled Base Compression Specimens in the Laboratory

SCDOT Designation: SCT-26 (08/2017)

1. SCOPE

1.1. This test method outlines the procedure for preparing and testing of cement modified recycled base specimens for the purpose of designing Cement Modified Recycled Base (CMRB) courses. This test is normally conducted in conjunction with maximum density testing (AASHTO T 99 Method C) on identical material. Samples weighing 7,500 grams are required for each set of 2 cores made.

1.2. Sets of specimens are to be molded with 3.0 percent, 6.0 percent, and 9.0 percent cement (unless otherwise directed by the Chemical Stabilization Engineer [CSE]). The maximum density test is to be conducted on a sample containing 6.0 percent cement.

2. REFERENCED DOCUMENTS

AASHTO Standards:

R 76 Reducing Samples of Aggregate to Testing Size

T 99 Moisture-Density of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop

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

3. LABORATORY

3.1. All laboratory testing activities must be completed at a facility accredited by AASHTO in procedures R 18, T 99, and T 265 at the time of testing. Mix design submittals should be prepared and stamped by a Professional Engineer licensed in South Carolina.

4. APPARATUS

4.1. Drying Ovens – Thermostatically controlled, preferably of the forced-draft type, capable of being heated continuously at a temperature of $140^0 \pm 9^0$F (or $230^0 \pm 9^0$F), as required.

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

4.3. Molds – 4-in. diameter molds meeting the requirements of AASHTO T 99.

4.4. Manually-Operated Rammer- Nominal 5.5-lb circular-faced rammer meeting the requirements of AASHTO T 99.

4.5. Mold Accessories – Sample extruder, straightedge, Mixing Tools, Pans, and Cloths as described in AASHTO T 99.

4.6. Containers – Suitable containers with close fitting lids for determination of moisture content as described in AASHTO T 265. One container is required for each moisture content determination.

4.7. 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.

4.8. 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.

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

4.10. Oven capable of maintaining $257^0 \pm 9^0$F, with inside volume of at least 2.5 ft^3.

4.11. Curing room or curing chamber capable of maintaining $73^0 \pm 4^0$F with a relative humidity of not less than 95%.

5. TEST SPECIMENS

5.1. A set of test specimens consists of 2 cylindrical specimens nominally 4 inch diameter x 4.58 inch height compacted to 100 percent of the maximum dry density as determined by AASHTO T 99 Method C. Sets of specimens are prepared for varying cement contents. To prepare a set of test specimens, a minimum of 16.5 lbs is required.

5.2. *Field Sampling*

5.2.1. Obtain a minimum of 140 lbs of the existing roadway material that contains both asphalt pavement and the base material below for the CMRB design. The sample should be representative of the entire roadway section to be recycled, including any roadway widening which is to occur. This may require more than one design. Sample to a depth equal to the depth to be recycled in as many locations as necessary to obtain the required amount of material. If applicable, ensure the number of samples meets the preliminary investigation recommendations in the contract. Keep the sides of the sampling locations vertical and take care to keep the ratio of asphalt to base representative. Do not sample in locations that have been full depth patched. All sampling locations shall be backfilled with a suitable material after obtaining the

sample. The RCE shall be contacted and notified of sampling for all roadways prior to any work being conducted.

5.3. *Specimen Preparation*

5.3.1. Determine the optimum moisture content (OMC) of the base material by performing AASHTO T 99 Method C at the median rate of cement (6% unless otherwise directed by the CSE).

5.3.2. Dry the bulk sample of base for cement modification at 140 ^{0}F to a constant weight to achieve an air dried condition.

5.3.3. If the asphalt portion of the base material is not sufficiently soft to separate with a spatula or trowel, then separate the asphalt portion of the base material from the rest of the sample. Place the asphalt portion of the base material in a large flat pan and warm it to 257^0 ± 9^{0}F for at least 25 minutes. The sample shall not be heated for more than 1 hour.

5.3.4. Break up the asphalt mixture and sieve the asphalt mixture and the remainder of the bulk sample through a ¾ inch sieve. Discard of the + ¾ inch material and remix the – ¾ inch material until a homogeneous mixture is obtained.

5.3.5. Reduce the bulk sample into samples of appropriate size for molding test specimens according to AASHTO R 76.

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

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

6. PROCEDURE

6.1. Determine the amount of material in grams needed to mold each layer in a 4 inch diameter x 4.58 inch height specimen molded to 100 % of maximum dry density as follows:

Mass in each layer(g) = Max Density(pcf) x (1+ OMC) x 5.04

6.2. Add water to the specimen to bring it to optimum moisture content and mix thoroughly using trowel and hands.

6.3. Tamp the recycled base-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.

6.4. Break up mixture and then remix.

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

6.6. Weigh the amount of material determined in 6.1, place in the mold, and

using the circular faced 5.5 pound rammer, compact the material using 25 blows with a 12 inch drop.

6.7. Repeat step 6.6 for each of the 3 layers.

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

6.9. Repeat steps 6.2 through 6.9 to mold one more specimen.

6.10. All specimens should be kept covered with a damp cloth on a slotted tray until all work is completed on this material.

6.11. Place all moisture specimens in a drying oven ($230^0 \pm 9^0$F) for 12 hours or until a constant mass is obtained. Average the moisture contents and determine the dry density of the material as follows:

$$\gamma_{Dry}(pcf) = \frac{\gamma_{Wet}(pcf) * 100}{100 + \%_{Moisture}}$$

6.12. The dry density should be within 2 pcf of the maximum value determined by AASHTO T 99 and the average moisture content should be within 1% of optimum.

6.13. Repeat steps 6.1 through 6.12 for each additional set of specimens made at varying cement contents.

6.14. CMRB specimens should be stored in a moist curing room or curing chamber maintaining $73^0 \pm 4^0$F and a relative humidity not less than 95%. The specimens should remain in the curing room undisturbed for seven (7) days. Upon removing from the curing room, the specimens are soaked overnight in water and tested for unconfined compressive strength.

6.15. The unconfined compressive strength shall be determined using the following loading pattern. From 0 lbf to 100 lbf use a rate of 500 lbf/min. After reaching 100lbf then increase the rate to 1000 lbf/min until a force of 6000 lbf is reached. The rate shall be decreased back to the 500/lbf/min after the load is greater than 6000 lbf and should remain at the specified rate until failure is reached.

6.16. Plot the average unconfined compressive strength of the material vs. the cement content of the set of specimens. From this graph, determine the cement content based on the desired compressive strength.

7. CALCULATIONS

7.1. Calculate the amount of material required to mold a specimen as in the following example:

From AASHTO T 99, $\gamma_{DRY\ MAX}$ = 125.0 pcf, OMC = 8.0%

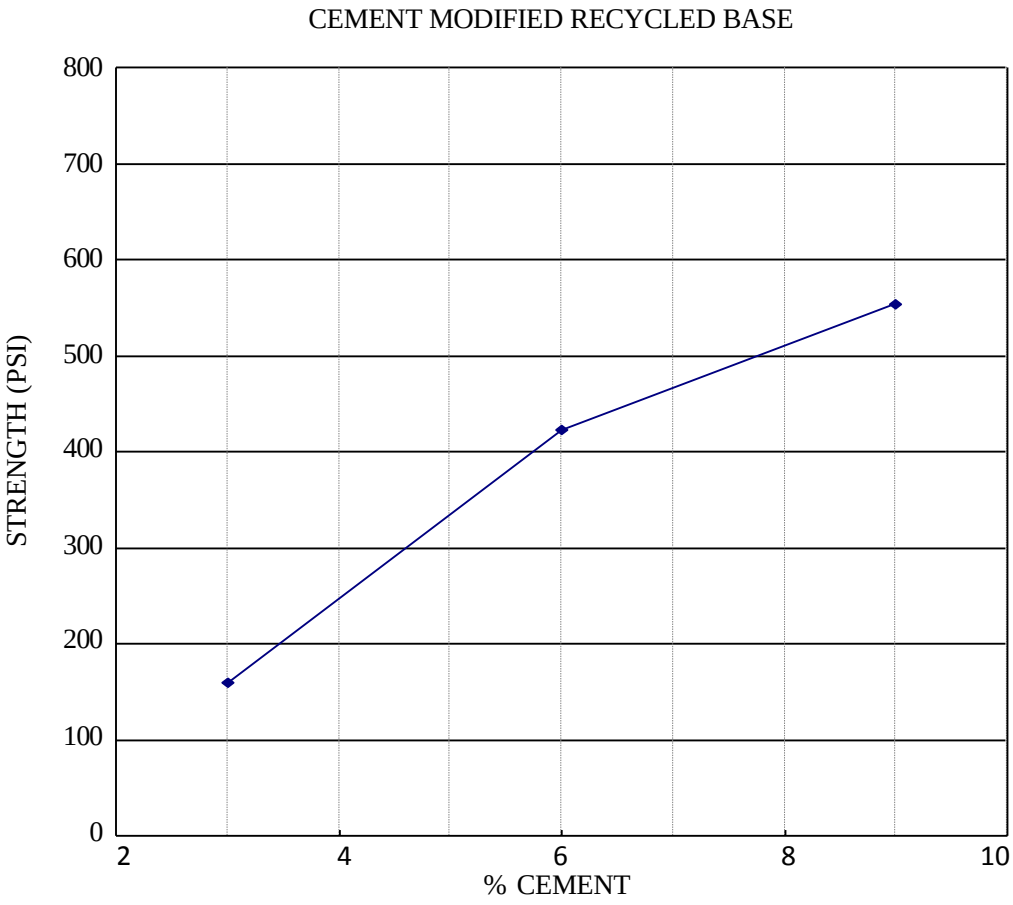
$$Material\ Required\ for\ One\ Layer\ (grams) = \gamma * \big(1 + OMC(\%)\big) * 5.04$$

$$Material\ Required\ (gms) = 125 * (1 + 0.08) * 5.04 = 680.4\ grams$$

After compressive strength testing, the strength of each sample should be computed as follows:

$$Compressive\ Strength = \frac{Load\ (lbs)}{Area\ (in^2)} = \frac{1{,}256\ lbs}{12.57\ (in^2)} = 100\ psi$$

Plot the average unconfined compressive strength of the set of cores versus the cement content at which they were molded. The recommended cement content will be determined by the CSE from the plot based on the desired compressive strength of the material. Below is an example plot to follow.



8. REPORT

8.1. Report, at a minimum, the following information on an appropriate test report;

- 8.1.1. Laboratory and Location which Testing was Performed
- 8.1.2. File Number, Roadway Name, Roadway Number and County
- 8.1.3. Depth of CMRB Treatment and Samples
- 8.1.4. Date and Locations of Samples (Include Map)
- 8.1.5. Description of Sampling Method (4in Cores, 6in Auger, 1ft Saw Cut, Etc.)
- 8.1.6. Section of Roadway Represented and Sample Locations
- 8.1.7. Proctor Information (Maximum Dry Density & Optimum Moisture Content)
- 8.1.8. 7 Day Strength Results with Plot as Described Above

8.2. Submit this information to the CSE for review and acceptance at least two weeks prior to intended date of start of construction.