Method of Making, Curing and Testing of Soil-Cement Compression Specimens in the Laboratory

SC T 38

1. Scope

This test method outlines the procedure for preparing and testing of soil-cement specimens for the purpose of designing cement-modified soils. This test is normally conducted in conjunction with maximum density testing (AASHTO T 134) on identical material. The curing and testing procedures are also performed on specimens molded in the field to monitor the construction process.

Dry preparation (AASHTO T 87) should be performed on the remainder of original samples if not done during dry preparation for density testing (AASHTO T 134). Samples weighing 2000 grams are required for each set of 3 cores made.

2. Referenced Documents

2.1 AASHTO Standards
- T 87 Dry Preparation of Disturbed Soil and Soil Aggregate Samples for Test
- T 134 Moisture-Density Relations of Soil-Cement Mixtures
- T 265 Laboratory Determination of Moisture Content of Soils

3. Apparatus

3.1 2-inch x 2-inch cylindrical molds with drop tamper and accessories
3.2 Trowel
3.3 Scoop
3.4 Moisture cups
3.5 Cloth
3.6 250-ml graduated cylinder
3.7 100-ml graduated cylinder
3.8 Oven (air dry) 60°C
3.9 Oven (drying) 110°C
3.10 Electronic scales or balance (440-gram capacity)
3.11 Slotted pan

4. Test Specimens

A set of test specimens consists of either three (3) laboratory-prepared 2-inch x 2-inch cylindrical specimens compacted to 95% of the maximum dry density as determined by AASHTO T 134 or two (2) field-prepared 4 inch x 4 inch cylindrical specimens. Sets of laboratory-prepared specimens are prepared for varying cement

contents. 2000 grams of soil are required to prepare a set of three specimens.

4.1 Select a cement content for each sample and determine the amount of cement required in grams. Determine the amount of water required based on the optimum water content of the soil cement mixture as determined by AASHTO T 134 including the amount of cement in the weight of the soil. Place oven-dried sample on a non-absorbent surface, add cement, and mix dry until thoroughly blended.

5. Procedure

5.1. Determine the amount of material needed to mold a 2-inch diameter x 2-inch height specimen molded to 95 % of maximum dry density as follows:

$$0.95\ \gamma_{DRY\ Max} \times \frac{100 + OMC}{100} = \gamma_{WET}$$

$$\frac{\gamma_{WET} \times 103}{\gamma_{WATER}} = \text{amount of material required to mold 1 specimen.}$$

Add an additional gram for material lost during molding.

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

5.3 Tamp the soil-cement mixture, cover, and allow to stand for 5 to 10 minutes to aid in dispersion of the moisture and permit absorption by the soil-cement mixture.

5.4 Break up mixture until it passes a No. 4 sieve and then remix.

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

5.6 Weigh the amount of material determined in 5.1, place in the mold, and using the hand tamper, compact the material to produce a 2-inch high specimen (usually 3-6 blows).

5.7 Remove the specimen from the mold and determine the height. If the height is below 2 inches, mold another specimen reducing the number of blows. If the height is above 2 inches, mold another specimen increasing the number of blows. Continue until the required height is obtained.

5.8 Once the specimen meets the size requirement, weigh the specimen and record the height and weight. Calculate γ_{WET} for the specimen as follows:

$$\gamma_{WET} = \frac{\text{weight of specimen (grams)}}{\text{height of specimen (in.)}} \times 1.212$$

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

5.10 Repeat steps 5.2 through 5.9 to mold two more specimens.

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

5.12 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:

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

The dry density should be within 2 lb/ft^3 of the maximum value determined by AASHTO T 134 and the average moisture content should be within 1% of optimum.

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

5.14 Curing: Soil-cement specimens should be stored in a moist curing room undisturbed for seven (7) days. Upon removing from the curing room, the specimens are soaked overnight in water.

5.15 Testing: After the over night water soak, test the specimens for unconfined compressive strength. Specimens molded from fine-grained sandy soils should be capped with a sulfur compound prior to compressive strength testing due to non-uniform stresses near the surface of the specimen.

5.16 Plot the average 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. The corresponding spread rate for cement application in the field can be determined by:

$$\% \text{ cement} \times \gamma_{DRY} \times \% \text{ compaction required in field} \times \text{depth (feet)} \times 9$$

6. Calculations

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

From AASHTO T 134, $\gamma_{DRY\ MAX}$ = 104.0 pcf, OMC = 19.6%

Therefore, $\gamma_{WET} = \frac{0.95\ (104.0 pcf)\ 100+19.6}{100} = 118.2$ pcf

Amount of material required to mold one sample =

$$\frac{118.2 pcf\ (103)}{62.4\ pcf} + 1 \text{ gram} = 196 \text{ grams of material per core.}$$

6.2 After molding specimen to the required dimensions, compute the wet density of each specimen as follows:

$$\gamma_{WET} = \frac{\text{weight of specimen (grams) x 1.212}}{\text{height of specimen (inches)}} = \frac{195\ g(1.212)}{2\ \text{inches}} = 118.2\ \text{pcf.}$$

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

$$\text{Compressive strength} = \frac{\text{Load (lbs.)}}{\text{Area (in}^2\text{)}} = \frac{776\ \text{lb.}}{3.1416\ \text{in}^2} = 246\ \text{psi.}$$

6.4 For laboratory-prepared specimens, plot the average compressive strength of the set of cores versus the cement content at which they were molded. The recommended cement content is determined from the plot based on the desired compressive strength of the material. The corresponding spread rate in pounds per square yard for use in the field is computed as follows:

Recommended cement content = 7%

Spread Rate = % cement x γ_{DRY} x % compaction required x 9 ft^2/yd^2 x depth (ft)
= 7% (109.0 pcf) (95%) (9) (0.5 ft) = 33 psy.

7. Report

For laboratory-prepared specimens, report the recommended cement content to the nearest 0.5 percentage. If a spread rate for use in the field is to be recommended, report the rate to the nearest 0.1 pound per square yard. For field prepared specimens, report the individual compressive strengths of the specimens to the nearest pound per square inch. Report test results and recommended spread rates for laboratory-prepared specimens on Lab Form SO127. Report test results for field-molded specimens on Lab Form SO112.