ALDOT-461
COMPRESSIVE STRENGTH OF SOIL-CEMENT CYLINDERS MADE WITH THE PLASTIC MOLD (PM) COMPACTION DEVICE

1. General

1.1. This procedure provides a method to determine the compressive strength of soil cement cylinders made with the plastic mold (PM) compaction device.

1.2. Except otherwise noted herein, follow all the requirements of AASHTO PP 92 and follow Method A (3×6 PM Device).

2. Referenced Documents

2.1. AASHTO PP 92, Standard Practice for Preparation of Test Specimens Using the Plastic Mold Compaction.

2.2. AASHTO T 265, Standard Method of Test for Laboratory Determination of Moisture Content of Soils

2.3. ASTM D1633, Standard Test Method for Compressive Strength of Molded Soil-Cement Cylinders

3. Apparatus

3.1. The Contractor shall supply all necessary equipment to use this procedure. The equipment will be approved by the Materials and Tests Engineer prior to use.

3.2. Only 3 in. by 6 in. cylinders (Method A in AASHTO PP 92) will be used on all ALDOT soil cement projects; therefore, only the Plastic Mold Device Assembly to produce this size cylinder is required for ALDOT projects.

3.3. To facilitate removal from the mold, all plastic molds will be cut on the side prior to molding samples. By using this split plastic mold method, the following apparatus covered in AASHTO PP 92 is not needed on ALDOT projects:

3.3.1. Sample Extruder

3.3.2. Plastic cylinder molds with holes drilled in the bottom.

3.4. Aluminum Foil Tape that is 1¾ in. in width shall be used to seal the cuts made in plastic molds to prevent moisture from escaping during initial curing period.

3.5. A moist room or cabinet capable of maintaining a temperature of 73.4 ± 3°F and a relative humidity of not less than 96 %.

3.6. Compression Testing Machine—This machine shall meet the requirements of ASTM D1633 and provide the rate of loading prescribed in 7.5.

4. Procedure to Sample Material from the Paver

4.1. Soil cement shall be sampled once it has been placed into the paver hopper.

4.2. A composite sample shall be created by taking a shovel-size quantity from three random locations in the hopper and placing all portions into a five-gallon bucket. Place the lid on the bucket after each portion has been obtained in order to prevent moisture loss.

4.3. The composite sample size to be used for strength tests is a minimum of 2/3 cu. ft.

4.4. The elapsed time shall not exceed 15 min. between obtaining the first and final portions of the composite sample.

4.5. Transport the composite sample to the location where test specimens are to be molded. The sampled material shall be mixed with a shovel to ensure that a uniform composite sample is obtained.

4.6. Start molding specimens for strength tests within 15 min. after mixing the composite sample. Expeditiously obtain and use the sample and protect the sample from the sun, wind, and other sources of rapid evaporation, and from contamination.

5. Procedure to Produce Cylinders with the Plastic Mold Compaction Device

5.1. The outside of the bottom of all plastic molds shall be sanded smooth to remove all ridges from the mold casting process as required in AASHTO PP 92.

5.2. All plastic molds shall be vertically pre-cut at one location as shown in Figure 1a. This pre-cut shall be straight and extend from the top to the bottom of the plastic mold, and shall not extend into the bottom part of the mold.

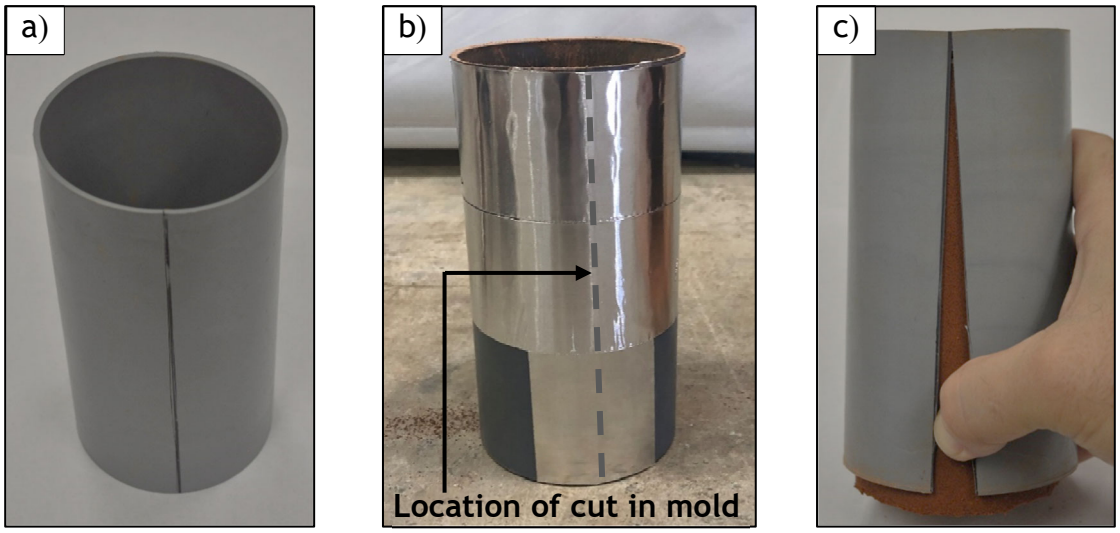

Figure 1: Example of pre-cut plastic mold preparation and demolding: a) vertical cut on side of mold, b) aluminum foil tape applied to mold, and c) demolding of the soil cement sample

5.3. The vertical cut in the plastic mold shall be taped with aluminum foil tape at

the following locations as shown in Figure 1b:

5.3.1. One, continuous piece of tape vertically applied from the top to the bottom of the mold. No tape is allowed around the bottom of the plastic mold.

5.3.2. One, piece of tape at the top along the circumference of the mold extending at least 3 inches past on each side of the vertical cut.

5.3.3. One, piece of tape at mid-height along the circumference of the mold extending at least 3 inches past on each side of the vertical cut.

5.4. Plastic molds will be positioned with the sealed vertical cut facing the hinge of the steel split-mold. All plastic molds will fit tightly in the steel split-mold of the Plastic Mold Device Assembly.

5.5. As required by AASHTO PP 92, a 2.984-inch diameter aluminum plate with a thickness of one-sixteenths of an inch will be inserted in the bottom of all plastic molds.

5.6. Specimens are formed by compacting the sampled soil into the plastic mold assembly in three approximately equal layers. Each layer is compact by a number of uniformly distributed blows from the rammer. Determine the number of blows required per lift to achieve a compaction of 98% of the maximum dry density, or greater, in the plastic molded cylinders as defined in Appendix X2 of AASHTO PP 92.

5.6.1. As guidance, past ALDOT projects in Coffee County used 7 blows per layer to yield specimen densities equal to greater than 98% of the maximum dry density.

5.7. Demold each sample by removing the tape along the sides, turning the sample upside down, and carefully pulling the edges of the mold apart as shown in Figure 1c. Once the sample is demolded, remove the aluminum plate from the bottom of the specimen.

6. Curing of Cylinders

6.1. Initial Curing: All cylinders shall be initially cured while sealed with plastic caps under field conditions for 24 to 48 hours. During initial curing, cylinders shall be exposed to ambient temperatures, no direct sun light or wind, while in a vibration-free environment. During cold weather, all cylinders shall be protected from freezing with suitable insulation material.

6.2. After the initial 24 hours but no later than 48 hours, the cylinders shall be transported to the facility at which final curing will occur.

6.3. During transporting, all cylinders shall be protected with suitable cushioning material to prevent damage.

6.4. After transportation to the final curing location, all specimens shall be demolded. All specimens shall be placed in sealable plastic bags, and sealed

after removing all excess air as shown in Figure 2.

Figure 2: Cylinders in sealable plastic bags

6.5. Final Curing: Final curing shall start within 30 minutes from demolding the specimen. Unless otherwise specified all specimens shall be cured in sealed plastic bags in a moist curing room or cabinet at 73.4 ± 3°F from the time of de-molding until testing.

6.6. The specimens shall be tested in the moist condition following removal from the sealed plastic bags.

7. Moisture Content and Density of Cylinders

7.1. After removal from the plastic mold, take measurements of the diameter and length. A caliper shall be used to read the values of the diameter and length of the soil cement cylinder to the nearest 0.01 in. as shown in Figure 3.

7.1.1. The diameter shall be measured once at the top, middle, and bottom of the cylinder. The average of these three diameters shall be determined to find the average diameter of the soil cement cylinder.

7.1.2. The length of the cylinder shall be measured at three locations approximately 120 degrees apart. The average of these three measurements shall be determined to find the average length of the soil cement cylinder.

7.2. Determine the weight of the cylinder with moist soil cement in pounds to the nearest 0.01 pounds.

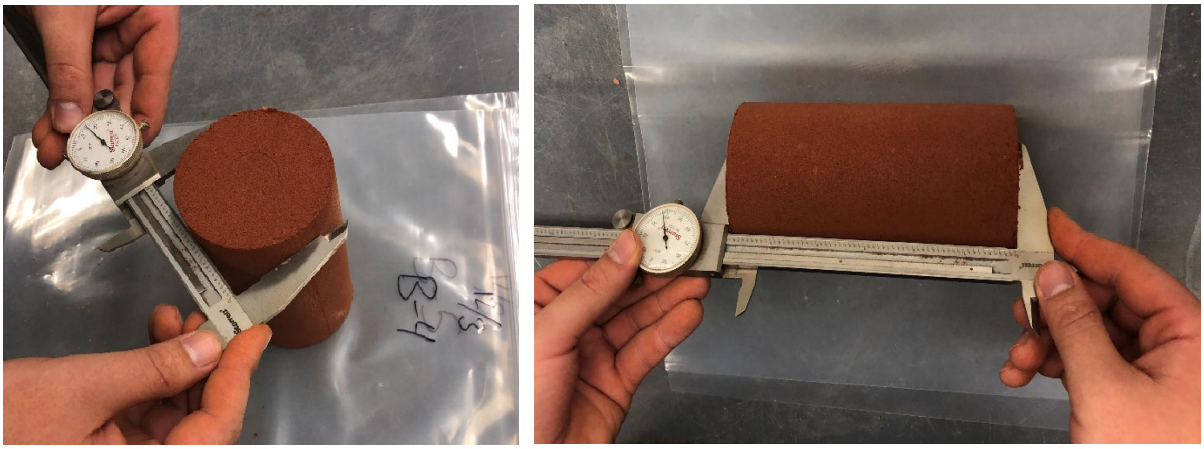

Figure 3: Measurements of the soil cement cylinder using a caliper

7.3. After the compressive strength testing has been completed as described in Section 8, recover a sample of the soil cement from the tested cylinder. Determine the moisture content of this sample in accordance with AASHTO T 265.

7.4. Calculate the volume of the cylinder by using Equation 1.

$$V_{cyl} = 0.7854(LD^2) \qquad \text{(Equation 1)}$$

Where,

V_{cyl} = volume of cylinder (in.^{3}),
D = average diameter of cylinder (inch), and
L = average length of cylinder (inch).

7.5. Calculate the dry density of the sample by using Equation 2.

$$D_{dry} = \frac{W_{cyl}}{V_{cyl}(1+w/100)} \times 1728\ in^3/ft^3 \qquad \text{(Equation 2)}$$

Where,

D_{dry} = dry density (lb/ft^3),
W_{cyl} = weight of cylinder (lb),
V_{cyl} = volume of cylinder (in.^{3}), and
w = moisture content (percent).

7.6. Determine the average cylinder dry density of all cylinders at a section.

7.7. Compare the average cylinder dry density to the maximum dry density to ensure the percent compaction is 96% or more.

8. Compressive Strength Testing of Cylinders

8.1. Test the compressive strength of each cylinder as per ASTM D1633, except where other requirements are prescribed in this procedure.

8.2. Do not cap the specimens.

8.3. The diameter used for calculating the cross-sectional area of the test specimen shall be that determined in Section 7.1.1.

8.4. Apply a constant rate of deformation without shock to produce an approximate rate of strain of 0.05 in./min. Alternatively, the load may be applied at a constant rate within the limits of 5 to 15 psi/sec. Apply the load until it decreases steadily, indicating failure. Record the maximum load carried by the specimen during the test to the nearest 10 lbf.

8.5. Calculate the compressive strength of the specimen by dividing the maximum load by the cross-sectional area.

8.6. When three cylinder strengths are available in a set, the data from one cylinder shall be discarded if its individual result is different by more than ±23 percent of the average of the other two cylinders.

8.7. When only two cylinder strengths remain in a set, the difference in their results, expressed as a percent of their average, shall not exceed ±20 percent.

8.8. When the two remaining cylinders in a set do not meet the criteria in Section 8.7, then the results from this batch are invalid unless additional cylinders cast from the same batch are available for testing at this age.

9. Report

9.1. The following minimum data shall be reported:

- Technician name,
- Soil-cement testing laboratory name,
- Number of blows user per lift to mold the cylinders,
- Date and time when the specimens were made,
- Date and time when the specimens were tested,
- Age of the specimens,
- Average diameter, height, and volume of all cylinders,
- Water content of all cylinders,
- Average dry density of the soil cement cylinders, and
- Compressive strength to the nearest 10 psi of all cylinders.