DETERMINATION OF CEMENTITIOUS MATERIAL CONTENT FOR CEMENTITIOUSLY TREATED MIXTURES

1. SCOPE

1.1 This procedure is used to determine the cementitious material content of a cement treated mixture.

1.2 This test method may involve hazardous materials, operations, and equipment. This test method does not purport to address all of the safety problems associated with its use. It is the responsibility of whoever uses this test method to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. APPARATUS

2.1 Requirements for the frequency of equipment calibration and verification are found in Appendix A3 of the Materials Testing Manual.

2.2 4 inch proctor mold having a capacity of approximately 1/30 cubic foot, with an internal diameter of 4.000 plus 0.024 or minus 0.016 inches and a height of 4.584 plus 0.005 or minus 0.008 inches. The mold shall have a nominal wall thickness of 1/4 inch. It shall be equipped with an extension collar approximately 2-3/8 inches high.

2.3 A hand or mechanical rammer weighing 5.50 $\pm$ 0.02 pounds, having a flat face, and equipped with a suitable arrangement to control the height of drop to a free fall of 12 $\pm$ 0.06 (1/16) inches above the elevation of the soil. The rammer face shall be circular with a diameter of 2.000 plus 0.010 or minus 0.015 inches.

2.4 Hard steel straightedge, at least 10 inches in length. It shall have one beveled edge, and at least one longitudinal surface (used for final trimming) shall be plane within 0.01 inch per 10 inches (0.1 percent) of length with the portion used for trimming the soil.

2.5 A circular sample follower with a diameter slightly less than the inner diameter of the proctor mold to aid in the removal of the mold collar.

2.6 Scale or balance capable of measuring the maximum weight to be determined, accurate to at least 0.1 g.

2.7 Oven capable of maintaining a temperature of 230 $\pm$ 9 °F

2.8 Sieves of sizes as required for screening conforming to the requirements of ASTM E11.

2.9 Miscellaneous mixing tools and pans.

2.10 Equipment as required for ARIZ 241, "Compressive Strength of Molded Cement Treated Base or Soil-Cement Specimens".

2.11 Non-absorptive glass or plexiglass plates larger than the diameter of the 4 inch proctor mold.

3. SAMPLE

3.1 Approximately 75 kg of material will be required. The amount required for the sieve analysis will be as determined in ARIZ 201, approximately 20000 g will be required for the optimum moisture determination, and approximately 40000 g will be required to develop the five separate 7500 g test samples.

3.2 If the sample is damp when received, it shall be dried until it becomes friable under a trowel. Drying may be accomplished by air drying or by the use of a drying apparatus such that the temperature of the sample does not exceed 140 °F. Prepare the sample for testing by separating the Plus No. 4 Material and breaking up the remaining soil aggregations to pass the No. 4 sieve in such a manner to avoid reducing the natural size of individual particles.

3.3 Select and prepare five separate test samples of approximately 7500 g and one 20000 g sample for optimum moisture content determination, corresponding to the sieve analysis of the total sample, in accordance with the following procedure.

Determine the gradation of the sample in accordance with ARIZ 201. For samples containing Plus 3/4 Inch Material, the material retained on the 1/2 inch, 3/8 inch, 1/4 inch, and No. 4 sieves shall be stored separately. Aggregate retained on the 3/4 inch sieve shall not be used, but its percentage shall be distributed proportionately among the aforementioned sieves.

NOTE: No change is made in the Percent Pass No.4 Material. See Subsection 3.3 of ARIZ 221 for further information regarding the proportional redistribution of the Plus 3/4 Inch Material.

3.4 Determine the optimum moisture content of the 20000 g sample in accordance with ARIZ 221 with the anticipated required cement content included in the material during the performance of the procedure.

3.5 The moisture content to be added to each of the five 7500 g test samples prior to compaction is the optimum moisture content obtained in Subsection 3.4.

3.6 Add the first of the cement contents to be used, to the first sample, and mix together thoroughly.

4. COMPACTION

4.1 Form a specimen by compacting the prepared mixture in the four inch mold (with the extension collar attached) in three equal layers to give a total compacted depth of about 5 inches. Compact each layer with 25 uniformly distributed blows from the rammer, dropping free from a height of 12 inches. While each layer is being compacted, the remainder of material shall be in a pan covered by a damp cloth. During compaction, the mold shall rest firmly on a dense, uniform, rigid and stable foundation.

4.2 Following compaction, carefully remove the extension collar. It may be necessary to use a follower to retain the soil in the mold while removing the collar to prevent damage or disturbance of the soil below the top of the mold. Carefully trim the compacted soil even with the top of the mold by means of the straightedge. If any voids are created during trimming, these shall be filled with fine material and smoothed off. Determine the wet density, "WD", of the compacted soil by the following:

$$WD = \frac{M1 - M2}{VM \times 453.6 \text{ (grams/lb)}}$$

Where:
WD = Wet density of compacted soil, lb./cu. ft.
M1 = Weight of compacted specimen and mold, grams
M2 = Weight of the mold, grams

VM = Volume of the mold, cu. ft., determined in accordance with ARIZ 225, Appendix A

4.3 Compact the other two specimens from the first sample, at the same cementitious material contents, in the same manner as Subsection 4.1.

4.4 Extrude all three specimens from their respective molds, place on glass or plexiglass plates, and store for curing in a moist condition.

4.5 Determine the moisture content of the specimens from the left over material from the first sample in accordance with AASHTO T 265, "Laboratory Determination of Moisture Content of Soils". Calculate percent moisture and record to the nearest 0.1 percent by the following:

$$\% \text{ Moisture} = \frac{WW - DW}{DW} \times 100$$

Where: WW = Weight of wet soil, grams
DW = Weight of dry soil, grams

4.6 Calculate the dry density and record to the nearest 0.1 lb./cu. ft. by the following:

$$DD = \frac{WD}{\% \text{ Moisture} \times 100} \times 100$$

Where: DD = Dry density of compacted soil, lb./cu. ft.
WD = Wet density of compacted soil, lb./cu. ft.

4.7 Repeat the procedures in Subsections 4.1 to 4.6 to the additional samples with increased cementitious material contents of 2% increments, until a complete bracketing of the specification requirements is met.

5. PROCEDURE

5.1 All specimens must be cured in a moist condition for six days and then immersed for a period of 24 hours in saturated lime water at 65 to 80 °F for 24 hours.

5.2 Specimens shall then be prepared and tested for compressive strength in accordance with ARIZ 241.

6. REPORT

6.1 Report the cylinder number, dry density, cementitious material content, moisture content, and 7-day compressive strength of all specimens tested, and the average 7-day compressive strength for the specimens tested at each of the cementitious material contents.

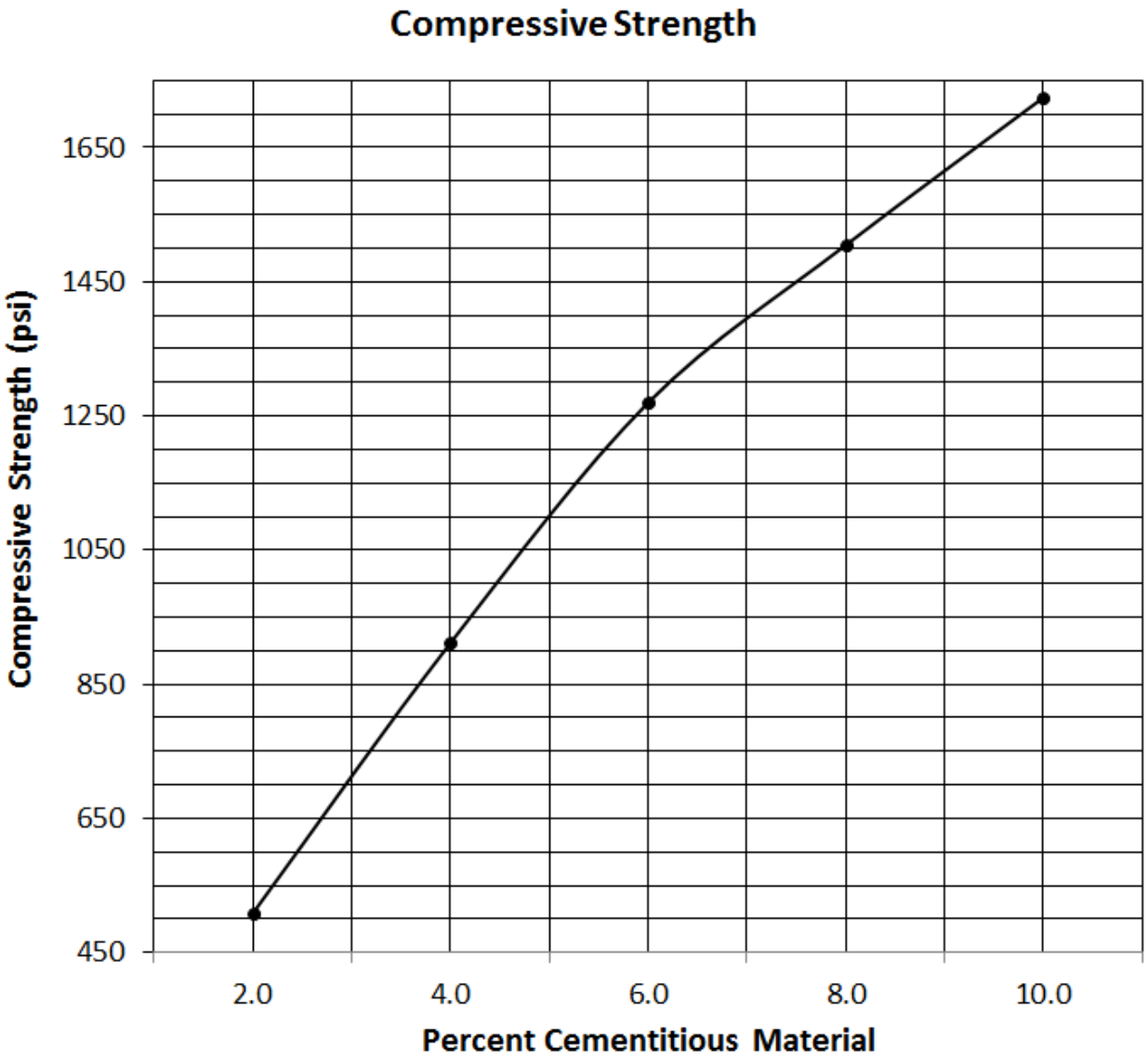
6.2 Following is an example of testing information obtained and how the information would be compared to the Special Provisions of a project for the purpose of determining the appropriate cementitious material content:

Assume the test information as shown in the following table was obtained:

RESULTS OF CEMENTITIOUSLY TREATED SPECIMENS PREPARED AT OPTIMUM MOISTURE CONTENT

Sample Number	Specimen Number	Density (lbs./cu. ft.)	Cementitious Material Content	Moisture Content	7-Day Strength (PSI)	Average 7-Day Strength (PSI)
	1	117.1	2.0	9.4	506	
1	2	117.2	2.0	9.5	509	509
	3	117.3	2.0	9.5	512	
	4	118.7	4.0	9.5	909	
2	5	118.8	4.0	9.6	912	912
	6	118.9	4.0	9.5	915	
	7	119.5	6.0	9.3	1268	
3	8	119.4	6.0	9.5	1270	1270
	9	119.3	6.0	9.4	1272	
	10	120.2	8.0	9.5	1502	
4	11	120.3	8.0	9.4	1505	1505
	12	120.4	8.0	9.4	1508	
	13	121.1	10.0	9.5	1725	
5	14	121.2	10.0	9.3	1728	1725
	15	121.3	10.0	9.4	1722	

A graphical presentation of the test information above would appear as follows:



If the Special Provisions required that a soil-cement mixture shall have a design compressive strength of at least 1250 pounds per square inch at seven days, this test information would indicate that in order to meet this requirement, 5.9 percent cementitious material by total weight should be used.