

## DETERMINATION OF CEMENT CONTENT REQUIRED FOR CEMENT TREATED MIXTURES

(A Modification of AASHO Designation T 144)

### Scope

1. These methods of test are intended for determining the percentage of Portland Cement required for cement treatment of a cement treated mixture. The determination of the compressive strength of molded specimens at varying cement contents and the effect of cement content on the Atterburg Limits constitute the test information required for determining the required cement of cement treated mixtures, ARIZ 223.

### Apparatus

2. (a) Mold. — A cylindrical metal mold having a capacity of 1/30 cubic foot with an internal diameter of  $4.0 \pm 0.005$  in. and a height of  $4.584 \pm 0.005$  in. It shall also be equipped with a detachable collar approximately 2½ in. in height.

(b) Rammer. — A metal rammer having a 2-in. diameter circular face and weighing 5.5 lbs. The rammer shall be equipped with a suitable arrangement to control the height of drop to a free fall of 12 in. above the elevation of the cement treated mixture.

(c) Balance. — A balance or scale of at least 4 kg. capacity, sensitive to 0.5 g.

(d) Drying Oven. — A thermostatically controlled drying oven capable of maintaining a temperature of  $230^\circ \pm 9^\circ$  F ( $110^\circ \pm 5^\circ$  C).

(e) Straightedge. — A rigid steel straightedge 12 in. in length having one beveled edge.

(f) Sieves. — 3 in., ¾ in., and No. 4 sieves conforming to the requirements of the Specifications for Sieves for Testing Purposes (AASHO M 92).

(g) Miscellaneous mixing tools and pans.

(h) Speedy Moisture Tester (optional).

(i) Equipment required for determining the Liquid Limit and the Plastic Limit of Soils, ARIZ 206 and ARIZ 207, respectively.

(j) Equipment required as stated for Preparation of Specimens for Compression Test (ARIZ 300) and Compression Testing of Molded Concrete Cylinders (ARIZ 301).

### Sample

3. (a) 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 drying apparatus such that the temperature of the sample does not exceed  $140^\circ$  F ( $60^\circ$  C). Prepare the sample for testing by separating the aggregate retained on a No. 4 sieve and breaking up the remaining soil aggregations to pass the No. 4 sieve in a manner which will avoid reducing the natural size of individual particles.

(b) Select and prepare five separate test charges of approximately 4500 g., corresponding to the sieve analysis of the total sample, in accordance with the following procedure:

The material retained on the ½", ¾", ¼", and No. 4

TABLE 1

Sieve No.	% Ret.	Adjusted % Ret.	Weight in g. (4500-g. charge)	Accumulative Total
2"	0			
2½"	2			
1"	3			
¾"	4	0		
½"	7	9 (7+2)	405	405
⅜"	6	8 (6+2)	360	765
¼"	9	12 (9+3)	540	1305
#4	6	8 (6+2)	360	1665
Pass #4	63	63	2835	4500
TOTAL	100	100	4500	

NOTE: No change is made in the percentage of Pass No. 4 material (See ARIZ 226 the test for Moisture-Density Relations of Soils, Methods C & D, for explanation).

sieves shall be stored separately. Aggregate retained on the 3/4" sieve shall not be used, but its percentage shall be distributed proportionately among the sieves mentioned. An example of a coarse sieve analysis which requires adjusting to prepare test charges of 4500 g. is shown in Table I.

(c) Add the first of the cement contents to be used and mix thoroughly together.

(d) The moisture content to be added to each test charge is determined by making a maximum density-optimum moisture determination (ARIZ 226) with the anticipated required cement content and using this developed optimum-moisture thereafter for all specimens prepared.

**Compaction**

4. (a) Form a specimen by compacting the prepared mixture in the mold, with the collar attached, in three equal layers to give a total compacted depth of 5 in. Compact each layer by 25 uniformly distributed blows from the rammer dropping free from a height of 12 in. Following compaction, remove the extension collar, carefully trim the compacted mixture even with the top of the mold by means of the knife or straightedge, and weigh. Multiply the weight of the specimen (in g.) by 0.06614 to obtain the wet weight per cubic foot. The factor 0.06614 is valid only if the volume of the mold is 1/30 cubic foot. If calibration shows any change in volume, a new factor shall be calculated.

NOTE: Assuming the mold has a volume of 1/30 (0.0333) cu. ft., the factor is derived as follows:

$$.06614 = \frac{1}{0.0333 \text{ cu. ft.} \times 453.6 \text{ g./lb.}}$$

In the case of a change in volume, 0.0333 cu. ft. shall be replaced by the decimal fraction for the new volume.

(b) Compact a duplicate specimen in the same manner as 4.(a).

(c) Extrude both samples from their respective molds, place on glass plates, and store for curing in a moist condition.

(d) Determine the moisture content of the prepared sample from the residue in accordance with ARIZ 209, Moisture Content of Soil and Aggregates.

(e) Determine the dry weight per cu. ft. (see ARIZ. 225, Sec. 5 for details).

(f) Repeat the procedures in paragraph 4.(a), (b), (c), and (d) to additional samples with increased cement content in approximately 1% increments or in 2% increments if so desired, until a complete bracketing of the specification requirements is met.

**Procedure**

5. (a) All specimens must be cured in a moist condition for six days and then immersed for a period of 24 hours in water.

(b) Specimens shall then be prepared for the compression test by following ARIZ 300.

(c) Test the cylinders for compressive strength according to ARIZ 301.

(d) Remove the capping material from the broken cylinders and combine duplicate cylinders. Break up the material and allow to dry in air.

(e) Screen the dried material through a No. 4 sieve, making sure that all of the cement and fines are dislodged from the surface of the rock.

(f) Prepare a sample for a Plasticity Index determination, according to ARIZ 204.

**Report**

6. (a) Report the results in the following format (Table II):

Standard Specifications require that Class A Cement Treated Base shall have a compressive strength between 300 and 500 pounds per square inch at seven days. The test information indicates that in order to meet this requirement six percent cement by weight should be used.

NOTE: If the intent of cement treatment was to reduce the Plasticity Index of the mixture (Class B, Cement Treated Base), then tests ARIZ 206 and ARIZ 207 should be performed on the original mixtures before the addition of cement and on the treated mixtures after the incorporation of cement.

TABLE II

Cyl. No.	Dry Density lb. per cu. ft.	Cement %	Water %	Comp. Str. psi	Avg. psi	P.I.
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Example:

Assume the test information as shown in Table III was obtained:

**RESULTS OF CEMENT TREATED SPECIMENS PREPARED AT OPTIMUM MOISTURE**

Cyl. No.	Density lbs. per cu. ft.	Cement %	H <sub>2</sub> O %	7 Day Strength lbs. per sq. inch	Average lbs. per sq. inch
1	117	2	9.4	131	
2	117	2	9.5	135	133
3	118	4	9.5	235	
4	118	4	9.6	247	241
5	119	6	9.3	412	
6	119	6	9.5	394	403
7	120	8	9.5	613	
8	120	8	9.4	605	609