MOISTURE-DENSITY RELATIONS OF CEMENT TREATED MIXTURES

(A Modification of AASHO Designation T 134)

Scope

1. This method covers procedures for determining the relationship between moisture content and the density of cement treated mixtures when compacted at varying hydration curing times dependent on and consistent with construction operation procedures.

Apparatus and Procedure

2. (a) Mold. – A cylindrical metal mold having a capacity of 1/30 cu. ft. with an internal diameter of 4.0 ±0.005 in. and a height of 4.584 ±0.005 in. It shall be equipped with a detachable collar approximately 2½ in. high.

(b) Rammer. – A metal rammer having a 2-in. diameter circular face and weighing 5.5 lb. 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) Balances. – 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° ±9° F (110° ± 5° C) for drying moisture samples.

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

(f) Sieve. – No. 4 sieve 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).

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° F (60° 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 such a manner as to avoid reducing the natural size of individual particles.

(b) Select and prepare five separate test specimens with the passing No. 4 fraction.

(c) Add to the prepared samples the required amount of cement as determined in ARIZ 220, Cement Content Required for Cement Treated Mixtures. If this has not yet been determined, an estimate shall be made and this amount added. If the results from ARIZ 220 indicate a cement content required of 6.0% based on total sample (plus and minus No. 4 fractions), use this same cement content, based on total weight, in setting up the specimens of only minus No. 4 material. Mix thoroughly to uniform color. Add sufficient water to dampen the mixture to approximately four to six percentage points below the optimum moisture content obtained from ARIZ 220, and mix thoroughly. Cover and allow to cure 5 minutes to aid dispersion of the moisture.

(d) Form a specimen by compacting the prepared mixture in the mold, with collar attached, in three equal layers to give a total compacted depth of about 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 and 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 cu. ft. If calibration shows any change in volume, a new factor shall be calculated. (Note 1.)

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

$$0.06614 = \frac{1}{0.0333 \text{ cu. ft.} \times 453.6 \text{ g./lb.}}$$

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

(e) Remove the material from the mold and determine its moisture content in a convenient manner, being sure not to use less than 100 g. unless the Speedy Moisture Test is used (ARIZ 224).

(f) Repeat the procedures in paragraphs (c), (d), and (e), to samples increased in moisture content by approximately two percentage points. Continue this series of determinations until there is either a decrease or no change in wet weight per cubic foot of the compacted specimen.

(g) Calculations shall be made to determine the moisture content and corresponding oven-dry weight per cubic foot for each of the compacted samples. (An example of these calculations can be found in ARIZ 225, Maximum Density and Optimum Moisture of Soils – Method A.) The oven-dry weights per cubic foot of the specimens shall be plotted as ordinates and the corresponding moisture contents as abscissas. When the densities and corresponding moisture contents have been determined and plotted, it will be found that by connecting the plotted points with a smooth line a curve is produced. The moisture content corresponding to the peak of the curve shall be termed the "optimum moisture content". The oven-dry weight per cubic foot of the soil at optimum moisture content shall be termed "maximum density" under the above compaction. This curve shall be designated the "zero curing time curve."

(h) Repeat the procedures in paragraphs (c), (d), (e), (f), and (g) on samples allowed to cure prior to compaction for the following curing time periods: one hour, two hours, and four hours. (It will not be necessary to make a four-hour determination for all mixtures. This need should be established on an individual basis.) These separate determinations shall be used for developing a family of curves for use for compaction control with each curve designated according to its respective curing time. If it is determined that the **delay in compaction time** (i.e., the curing time between incorporation of the cement and compaction) will not vary throughout the project construction schedule, then the number of delayed compaction curves can be limited to only those applicable without running the complete family.

(i) The Rock Correction Procedure nomograph can be conveniently used for plotting the results of the maximum density determinations. See ARIZ 222 for Rock Correction Procedure.