

METHODS OF SAMPLING AND TESTING
MT 216-13
METHOD OF SAMPLING AND TESTING CEMENT TREATED BASE
(Montana Test Method)

1 Scope:

- 1.1 This method covers procedures for making, curing, and testing cylindrical specimens from representative samples of Cement Treated Base (CTB).

2 Referenced Documents:**2.1 AASHTO:**

T 231 Capping Cylindrical Concrete Specimens

ASTM:

D1633 Standard Test Method for Compressive Strength of Molded Soil-Cement Cylinders

MT Manual:

MT 201 Sampling Roadway Materials

MT 211 Moisture Density Relations of Soil-Cement Mixtures

MT 212 Determination of Moisture and Density of In-Place Materials

MT 601 Materials Sampling, Testing and Acceptance Guide

3 Apparatus:

- 3.1 *Molds* - The molds shall be solid-wall, metal cylinders manufactured with dimensions and capacities shown in 3.1.1. They shall have a detachable collar assembly approximately 2 3/4 in. (60 mm) in height, to permit preparation of compacted specimens of soil-cement mixtures of the desired weight and volume. The mold and collar assembly shall be so constructed that it can be fastened firmly to a detachable base plate made of the same material.

Note 1 - Alternate types of molds with capacities as stipulated herein may be used, provided the test results are correlated with those of the solid-wall mold on several soil types and the same moisture-density results are obtained. Records of such correlations shall be maintained and readily available for inspection when alternate types of molds are used.

- 3.1.1 A 4-inch mold having a capacity of $1/30 \pm 0.0003$ cu. ft. (944 ± 8.5 cm³) with an internal diameter of 4.000 ± 0.016 in. (101.6 ± 0.4 mm) and a height of 4.584 ± 0.005 in. (116.4 ± 0.1 mm).

- 3.1.2 *Molds Out of Tolerance Due to Use* - A mold that fails to meet manufacturing tolerances after continued service may remain in use provided those tolerances are not exceeded by more than 50 percent; and the volume of the mold, calibrated in accordance with Sec 6 (Calibration of Measure) of MT-203, Unit Weight of Aggregate, is used in the calculations:

3.2 Rammer:

- 3.2.1 *Manually Operated* - Metal rammer having a flat circular face of 2.000 ± 0.001 in. (50.8 ± 0.127 mm) diameter, a wear tolerance of 0.005 (0.127 mm) and weighing 5.50 ± 0.02 lb. (2.495 ± 0.009 kg) (Note 2). The rammer shall be equipped with a suitable guide-sleeve to control the height of drop to a free fall of 12.00 ± 0.06 (or 1/16 in.) (304.8 ± 1.524 mm) above the elevation of the soil. The guide-sleeve shall have at least 4 vent holes, no smaller than 3/8 in. (9.5 mm) diameter spaced approximately 90 deg. apart and approximately 3/4 in. (19 mm) from each end, and shall provide sufficient clearance so the free fall of the rammer shaft and head is unrestricted.

- 3.2.2 *Mechanically Operated* - A metal rammer which is equipped with a device to control the height of drop to a free fall of 12.00 ± 0.06 (or 1/16 in.) (304.8 ± 1.524 mm) above the elevation of the soil

Apparatus: (continued)

and uniformly distributes such drops to the soil surface. The rammer shall have a flat circular face 2.000 ± 0.001 in. (50.8 ± 0.127 mm) in diameter, a wear tolerance of 0.005 (0.127 mm) and a manufactured mass of 5.50 ± 0.02 lb. (2.495 ± 0.009 kg) (Note 2).

Note 2 - The rammer apparatus shall be calibrated with several soil-cement mixtures and the mass of the rammer adjusted, if necessary, to give the same moisture-density results as with the manually operated rammer. It may be impractical to adjust the mechanical apparatus so the free fall is 12 in. (305 mm) each time the rammer is dropped, as with the manually operated rammer. To make the adjustment of free fall, the portion of loose soil to receive the initial blow should be slightly compressed with the rammer to establish the point of impact from which the 12 in. (305 mm) drop is determined. Subsequent blows on the layer of soil-cement may all be applied by dropping the rammer from a height of 12 in. (305 mm) above the initial-setting elevation, or when the mechanical apparatus is designed with a height adjustment for each blow, all subsequent blows should have a rammer free fall of 12 in. (305 mm) measured from the elevation of the soil as compacted by the previous blow.

- 3.2.3** *Rammer Face* - The circular face rammer shall be used but a sector face rammer may be used as an alternative provided the report shall indicate type of face used other than the 2 in. (50.8 mm) circular face and it shall have an area equal to that of the circular face rammer.
- 3.3** *Sample Extruder* - A jack, lever, frame, or other device adopted for the purpose of extruding compacted specimens from the mold.
- 3.4** *Balances and Scales* - A balance or scale of at least 25 lb. capacity having a sensitivity and readability to 0.01 lb., or a balance or scale having a capacity of approximately 11.5 kg. and a sensitivity and readability to 5 grams. Also, a balance of at least 1 kg capacity with a sensitivity and readability to 0.1 gram.
- 3.5** *Drying Oven* - A thermostatically controlled drying oven capable of maintaining a temperature of $110 \pm 5^\circ$ C ($230 \pm 9^\circ$ F) for drying moisture samples.
- 3.6** *Straightedge* - A hardened steel straightedge at least 10 in. (254 mm) in length. It shall have one beveled edge, and at least one longitudinal surface (used for final trimming) shall be plane within 0.01 in. per 10 in. (0.1 percent) of length within the portion used for trimming the soil (Note 3).
- Note 3 - The beveled edge may be used for final trimming if the edge is true within a tolerance of 0.01 in. per 10 in. (0.1 percent) of length; however, with continued use, the cutting edge may become excessively worn and not suitable for trimming the soil to the level of the mold. The straightedge should not be so flexible that trimming the soil surface with the cutting edge will cause concave soil surface.*
- 3.7** *Sieves* - 50, 19.0, 4.75 mm sieves conforming to the requirements of MT-405, Sieves for Testing Purposes.
- 3.8** *Mixing Tools* - Miscellaneous tools such as mixing pan, spoon, trowel, spatula, etc., or a suitable mechanical device for thoroughly mixing the sample of soil with increments of water.
- 3.9** *Container* - A flat, round pan for moisture absorption by soil-cement mixtures about 12 in. (300 mm) in diameter and 2 in. (50 mm) deep.
- 3.10** *Moisture Containers* - Suitable containers made of material resistant to corrosion and not subject to change in weight or disintegration on repeated heating and cooling. Containers shall have close-fitting lids to prevent loss of moisture from samples before initial weighing and to prevent absorption of moisture from the atmosphere following drying and before final weighing. One container is needed for each moisture content determination.

Apparatus: (continued)

- 3.11** *Butcher Knife* - A butcher knife approximately 10 in. (250 mm) in length, for trimming the top of the specimens.

4 CTB Mix Design:

- 4.1** Verify that the contractor has submitted a cement treated base mix design to the Materials Bureau at least 15 working days before scheduled placement. Confirm with the Materials Bureau that the design is approved for use before allowing placement on the project.

5 Acceptance:

- 5.1** *In-Place Densities* - Test for compaction in accordance with subsection 304.03.5 of the specifications. In-place densities will be determined in accordance with MT 212. A corrected moisture curve must be established by correcting the nuclear moisture reading to oven-dry moisture contents.

- 5.2** *Field-Made Compression Specimens* – Mold a minimum of one set of compressive strength specimens for every 750 cubic yards of CTB. A set consists of three compressive strength specimens molded in accordance with section 6 of this procedure. It is desirable that these specimens represent the material placed at the locations of the in-place densities so moisture-density comparisons can be made. Two specimens from each set will be tested at 7-days to determine strength acceptance. The remaining specimens will be broken at 28-days to identify strength gain. A copy of the sample record containing moisture content, cementitious material content, and density must accompany each set of compressive strength specimens in the shipping boxes.

- 5.3** *Acceptance Samples of Aggregate* - Sample for gradation analysis in accordance with subsection 304.03.1 of the specifications.

6 Molding Specimens in the Field:

- 6.1** Sample the CTB mixture placed on the roadway from a representative location. Obtain approximately one cubic foot of material and transport to the place of molding as quickly as possible in order to minimize hydration. (Excessive hydration can reduce the lubrication properties and result in less than maximum density and therefore lower strengths.) Remix the sample before and during molding to ensure uniformity and prevent segregation.

- 6.2** Form a specimen by immediately compacting the mixture in the mold in accordance with Section 5.2 of MT 211, (with the collar attached) and later trimming the specimen in accordance with Section 7.2 of MT 211. Uniformly distribute the material retained on the 4 Mesh (4.75) by spading along the inside of the mold with a spatula for each layer placed in the mold and before compaction. After compaction of the first and second layer, scarify or roughen the top of the layer in order to obtain a good bond between lifts.

- 6.3** During compaction, obtain a representative sample of the mixture, weighing not less than 500 grams. Weigh the sample immediately and dry in an oven at $230^{\circ} \pm 9^{\circ}\text{F}$ ($110^{\circ} \pm 5^{\circ}\text{C}$) to constant mass to determine the moisture content as a check against design moisture content.

- 6.4** Weigh the compacted specimen to check against design density and begin initial cure. (Note 3)

Note 3 - Once the specimen has been struck off to the required smoothness and weighed, cover the top of the mold with plastic and place the compaction collar back on the mold and plastic. Tighten the collar so that the plastic will make an airtight seal around the rim of the mold and the surface of the specimen. This shall be done in order to prevent moisture loss from the specimen during the initial curing. Once all specimens have been molded and sealed with plastic, place in a cure box to

protect the specimens from temperature extremes and from direct sunlight. Attempt to maintain a temperature range of 60° F to 80° F during initial curing in the field. Allow the specimens to cure initially in a location that is horizontally level, rigid, and free from vibration or other disturbances.

- 6.5** Form two additional specimens as rapidly as possible. Two specimens will be identified as 7-day compression specimens, and the third will be a 28-day compression specimen. (Note 4).

Note 4 - A satisfactory method of identifying the specimens for the 7-days or 28-days, of curing in the moist room, is to wrap a piece of masking tape around the specimen. Indicate on the masking tape the date made, stationing & lane, type of test, etc.

- 6.6** Cure the compacted specimens in the molds overnight. Extract the specimens from the molds, place in the shipping box packed in damp sawdust, and transport to the Materials Bureau as soon as possible so that final curing can be accomplished in the moist cure room for the remainder of the curing period.

7 Compressive Strength Determination.

- 7.1** Determine the diameter using two diameter measurements to the nearest 0.01 inches taken at 90 degrees to one another near the mid height of the specimen. Prior to placing compressive strength specimens in the compression machine, verify that both ends of the specimen are plane to within 0.002 in. If an end of the specimen is outside of the 0.002 in. tolerance, that end of the specimen shall be capped in accordance with AASHTO T 231.

- 7.2** Determine the 7 day unconfined compressive strength in accordance with ASTM D 1633 except as modified herein. The requirement for immersing cured specimens in water for 4 hours prior to testing shall be omitted.

- 7.3** Maintain free moisture on the outsides of specimens to prevent drying until testing is complete (except for the ends of the specimens when sulfur capping). When capping with sulfur, be certain that the ends of the specimen are dry enough to prevent small pockets of steam from forming within the capping compound.

8 Calculation.

- 8.1** Calculate the unit compressive strength of the specimen by dividing the maximum load by the cross-sectional area.

$$S = \frac{lbf}{\pi r^2}$$

Where:

S = Strength

lbf = Maximum Load

r = Radius of Specimen

- 8.2** For purposes of this method, strength determined for specimens at a height divided by diameter ratio (uncapped) of 1.15 is considered to be standard, and is not corrected by a length to diameter correction factor.