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 describes procedures for making, curing, and testing cylindrical specimens from representative samples of Cement Treated Base (CTB).

2 Referenced Documents

AASHTO

R 18 Establishing and Implementing a Quality Management System for Construction Materials Testing Laboratories
T 19 Bulk Density ("Unit Weight") and Voids in Aggregate
T 134 Moisture-Density Relations of Soil-Cement Mixtures
T 231 Capping Cylindrical Concrete Specimens

ASTM

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

MT Materials Manual

MT 201 Sampling Roadway Materials
MT 212 Determination of Moisture and Density of In-Place Materials
MT 228 Method of Establishing Field Target Density for Cement Treated Base Density Control
MT 601 Materials Sampling, Testing and Acceptance Guide

3 Apparatus

3.1 *Molds* - Use solid-wall, metal cylinders manufactured with dimensions and capacities shown in 3.1.1. They must have a detachable collar assembly approximately 2.375 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 must be constructed so 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 in. (101.6 mm) mold having a capacity of 1/30 ± 0.0003 cu. ft. (943 ± 8 cm^3) with an internal diameter of 4.000 ± 0.016 in. (101.6 ± 0.41 mm) and a height of 4.584 ± 0.005 in. (116.43 ± 0.13 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 AASHTO T 19, Section 8 (Calibration of Measure), is used in the calculations.

3.2 *Rammer*

3.2.1 *Manually Operated* - Metal rammer having a flat circular face of 2.000 in. (50.8 mm) diameter, a manufacturing tolerance of ± 0.01 (0.25 mm) and weighing 5.50 ± 0.02 lb. (2.495 ± 0.009 kg). The in-service diameter of the flat circular face shall be not less than 1.985 in. (50.42 mm). Use a rammer equipped with a suitable guide-sleeve to control the height of drop to a free fall of 12.00 ± 0.06 in. (305 ± 2 mm) above the elevation of the soil. The guide-sleeve must have at least 4 vent holes, no smaller than ⅜ in. (9.5 mm) diameter spaced approximately 90 degrees (1.57 radius) apart and approximately ¾ in. (19 mm) from each end and provide sufficient clearance so the free fall of the rammer shaft and head is unrestricted.

3.2.2 Mechanically Operated - A metal rammer equipped with a device to control the height of drop to a free fall of 12.00 ± 0.06 in. (305 ± 2 mm) above the elevation of the soil and uniformly distributes such drops to the soil surface (Note 2). The rammer must have a flat circular face 2.000 in. (50.8 mm) diameter, a manufacturing tolerance of ± 0.01 (0.25 mm) and weighing 5.50 ± 0.02 lb. (2.495 ± 0.009 kg).

Note 2 – Calibrate the rammer apparatus with several soil-cement mixtures. Adjust the mass of the rammer, 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-cement as compacted by the previous blow.

3.2.3 Rammer Face – Use the circular face rammer. If necessary, use a sector face rammer as an alternative. Indicate the type of face used other than the 2 in. (50.8 mm) circular face in the report. The alternate must 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. (11.5 kg) capacity having sensitivity and readability to 0.01 lb. (5 grams). Also, a balance of at least 3 lb. (1 kg) capacity having sensitivity and readability to 0.003 oz. (0.1 gram). Use balances or scales of the same units shown in the contract.

3.5 *Heat Source* - Oven, hot plate or alternate heating source.

3.6 *Straightedge* - A hardened steel straightedge at least 10 in. (254 mm) in length. Use a straightedge with one beveled edge. At least one longitudinal surface (used for final trimming) must be plane within 0.01 in. per 10 in. (0.25 mm per 250 mm) (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. (0.25 mm per 250 mm) *(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 concave the soil surface.*

3.7 *Sieves* – 2 in. (50 mm), ¾ in. (19.0 mm), No. 4 (4.75 mm) sieves conforming to the requirements of AASHTO R 18.

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. (305 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. Use containers with 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.

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 10 business 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 Specifications 304.03.5. Determine in- place densities in accordance with MT 212. Establish a corrected moisture curve 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 (575 cubic meters) of CTB in accordance with MT 601. 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 Specification 304.03.1.

6 Molding Specimens in the Field

6.1 Sample the CTB mixture placed on the roadway from a representative location in accordance with MT 201. Obtain approximately one cubic foot of material and place in suitable container(s) lined with a plastic bag. Once the sample is complete, close the bag and place a lid on the container(s). This is done to reduce any possibility of moisture loss from the sample. Transport the sample 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 Immediately form a specimen by compacting the mixture in the mold in accordance with AASHTO T 134, Section 5.5 (with the collar attached). Trim the specimen in accordance with AASHTO T 134, Section 5.6. Uniformly distribute the material by spading along the inside of the mold with a spatula for each lift placed in the mold and before compaction. After compaction of each lift, 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 until further drying does not alter the weight greater than 0.1 percent, constant mass. Determine the moisture content as a check against design moisture content.

6.4 Weigh the compacted specimen to check against design density before beginning the initial cure. (Note 4)

Note 4 – 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, leaving the plastic in place. 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 is done to prevent moisture loss from the specimen during the initial cure. 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. Maintain a temperature range of 60° F to 80° F during the initial cure in the field. The location for the initial cure must be horizontally level, rigid, and free from vibration or other disturbances.

6.5 Maintain a running average of densities and moistures in accordance with MT 228 to establish density control.

6.6 Form two additional specimens in the same manner as the first as rapidly as possible. Identify two specimens as 7-day compression specimens, and the third as a 28-day compression specimen. (Note 5)

Note 5 – A satisfactory method of identifying the specimens for the 7-day or 28-day breaks 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.

6.7 Cure the compacted specimens in the molds a minimum of 24 hours. 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 the final cure 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 (0.25 mm) taken at 90 degrees to one another near 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 (0.05 mm). If an end of the specimen is outside of the 0.002 in. (0.05 mm) tolerance, cap that end of the specimen in accordance with AASHTO T 231.

7.2 Determine the 7-day unconfined compressive strength in accordance with ASTM D1633 except as modified herein. Omit the requirement for immersing cured specimens in water for 4 hours prior to testing.

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, determine strength of specimens using a height (uncapped) divided by diameter ratio of 1.15. This is standard and is not to be corrected by a length to diameter correction factor.

9 Report

9.1 The field technician is to report the following:
Sample Date the cylinder was made
Percent cement rounded to the nearest tenth
Percent fly ash rounded to the nearest tenth
Depth of material placed rounded to the nearest tenth of a ft (m)
Station where sample was taken
Density rounded to the nearest tenth of lbs per ft^3 (kg per m^3)
Moisture content rounded to the nearest tenth of a percent

9.2 The lab technician is to report the following:
Date the cylinder was broken
Diameter of the cylinder rounded to the nearest hundredth of an inch (mm)
Load rounded to the whole number in lbs per ft (kg per m)
Compressive strength rounded to the nearest whole number in lbs per in^2 (MPa)

Report the average strength of the two 7-day cylinders rounded to the nearest whole number.