

DEPARTMENT OF TRANSPORTATION
DIVISION OF ENGINEERING SERVICES
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METHOD OF TEST FOR UNIT WEIGHT OF FRESH CONCRETE

A. SCOPE

This test method describes the procedure for determining the unit weight in lb/ft³ foot of freshly mixed concrete. Formulas incorporating the measured unit weight and observed scale weights of all ingredients are included for the calculation of batch volume and actual cement content.

B. REFERENCES

ASTM C 138/C 138M - Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete

C. APPARATUS

The following equipment, which is necessary for this test, is available from the Division of Procurement and Contracts, Materials and Storage Warehouse.

1. Measure: A cylindrical, watertight, steel measure with two handles. The capacity of the measure shall conform to the requirements in the table below. It shall have an inside height of 115% ± 15% of the inside diameter. It shall be constructed of No. 10 to No. 12 US gage steel and shall be reinforced around the top with a steel band of the same thickness 1½ in. in width. The top rim shall be machined to a plane surface.

Minimum Capacity of Measure	
Maximum Size of Coarse Aggregate Specified	Capacity of Measure
1 in. or less	0.25 ft ³
1½ in.	0.50 ft ³

2. Scale: A balance or scale with a capacity of 105 lb, and accuracy within 0.1% of the required capacity for the entire range of use.
3. Tamping Rod: A round, straight, steel rod with a diameter of 5/8 in. ± 1/16 in. and length of at least 4 in. greater than the depth of the measure in which rodding is to be performed, but not more than 24 in. One or both ends of the tamping rod must be rounded to a hemispherical tip of the same diameter as the rod.
4. Glass Cover Plate: Approximately 12 in. square, 1/4 in. thick, and wire-reinforced, or acrylic plastic cover plate 1/4 in. thick.
5. Platform with hinged, collapsible wings on three sides, made of plywood, with level bubbles attached to the platform at one corner.

6. Rubber gloves.

D. CALIBRATION OF MEASURE

The volume of the measure shall be determined accurately by determining the weight and volume of water at 60 to 70 °F required to fill it. A calibration factor, “*F*”, shall be calculated for the measure by dividing 62.34 lb/ft³ by the weight of the water in lb required to fill it. The calibration factor “*F*” is given for new measures as they are shipped. See paragraph G.5. below. The value of the factor shall be verified at the start of each job and also at any time there is reason to suspect a change. Calibrate the measure by filling it with water having a temperature 60 to 70°F, as measured with a thermometer. Place the glass plate firmly in contact with the rim of the measure and add water if necessary to eliminate bubbles under the glass. Wipe surplus water from the outside of the measure and glass plate. Weigh to the nearest 0.05 lb with the glass plate in place. Subtract the tare weight of the empty, dry measure and glass plate. Compute the calibration factor, “*F*”.

$$F = (62.34 \text{ lb/ft}^3) / (\text{weight of water, lb})$$

E. PROCEDURE

1. Sampling Fresh Concrete
 - a. Whenever possible, take freshly mixed concrete from the mass as it is deposited in the work. When this is not possible, such as, when concrete is deposited in narrow forms, take the sample from the transporting buggy, or in the case of ready-mixed concrete, by repeatedly passing a receptacle through the discharge stream of the mixer or agitator. Do not, however, take a sample from the beginning or end portions of the discharged batch unless it is desired to check the uniformity of mixing.
 - b. Transport samples obtained by any of the above methods in watertight containers to the place where the test is to be performed.
2. Filling the Measure with Concrete
 - a. Place the measure on a level, firm surface.
 - b. Using a scoop, fill the measure in three layers of equal depth. Move the scoop around the perimeter of the measure opening to ensure an even distribution of the material with minimum segregation. Fill the topmost layer to over flowing. Level the surface of each layer with the fingers prior to tamping.
 - c. If harsh or stiff concrete is being tested, jig the measure after each addition of concrete to remove major air voids before rodding. Jigging consists of raising alternate sides of the measure about 2 in. and allowing it to drop in such a manner to impart a sharp, slapping blow.
3. Rod each layer 25 times with the rounded end of the tamping rod distributing the strokes evenly over the surface of the layer.
4. While rodding the first layer, penetrate nearly full depth into the layer, but avoid striking the bottom of the base.
5. While rodding the second and third layers, penetrate approximately 1 in. into the

layer below with each stroke. Avoid striking the top, machined edge of the measure with the rod.

6. After each layer is rodded, tap the sides of the measure with a hand or stake or jig the measure (this will be determined by container or process) using such force so as to close any voids left by the tamping rod and to release any large bubbles of air that may have been trapped.
 - a. Level the surface of the compacted aggregate with the fingers or a straightedge in such a way that any slight projections of the larger pieces of coarse aggregate approximately balance the larger voids in the surface below the top of the measure.
7. Strike-off, Cleaning, and Weighing
 - a. After the last layer has been rodded and tapped, use the rod, held horizontally, to strike off the top surface to its approximately correct elevation. Work the rod or a straightedge back and forth across the top with a sawing motion until a reasonably plane surface is obtained with all particles of coarse aggregate well buried. Clean the rim of the measure for a distance of about 6 in. Place one side of the glass plate firmly in position on the cleaned portion of the rim. Advance the plate with a sawing motion across the measure using sufficient pressure to maintain tight contact with the rim. There should always be a slight surplus of mortar ahead of the plate. If particles of coarse aggregate appear in front of the advancing edge of the plate, use your gloved hand to shove them down into the concrete. Using a cloth or damp sponge, clean off all concrete or other material adhering to the outside of the measure and glass plate.
 - b. Adjust the plywood platform to a level condition with the wings set in position to eliminate the effect of wind. Place the scale on the platform and adjust the counterweight on the scale beam so that the pointer indicates "zero." Place the filled measure, with the glass plate in place, on the scales and weigh to the nearest 0.05 lb. Record the weight.
 - c. Slide the glass plate off the measure using a sawing motion. Examine the surface for evidence of incomplete filling of the measure. A slight depression of the surface near one edge of the measure and shallow voids up to $\frac{3}{4}$ in. in diameter with a depth no greater than $\frac{1}{16}$ in. may be disregarded. Deeper voids are indications that the measure was incompletely filled. In case of uncertainty, add a small amount of concrete and repeat the operations of screeding with the rod and working the glass plate into position. Weigh again. If the new weight agrees within 0.1 lb with the first weight, the original weight may be taken as correct. If not within 0.1 lb, repeat sampling and testing procedures.

F. CALCULATIONS

1. Unit Weight, W , lb/ft³:

The net weight of the concrete sample is equal to the combined weight of the measure, concrete, and cover plate minus the combined weight of the measure and cover plate. Calculate the density of the concrete in lb/ft³ by multiplying the net weight of the concrete in the container by the calibration factor, " F ," determined for

the measure used. Express the unit weight to the nearest 0.1 lb.

$$W = \text{Unit weight, lb/ft}^3 = \text{Net weight of concrete} \times \text{calibration factor, } F.$$

2. The volume of concrete, S , per batch is calculated as follows:

$$S = (W_a + W_f + W_c + W_w) / W$$

Where: S = Volume of concrete per batch, ft^3

W_a = Total weight of cement in the batch, lb

W_f = Total weight of fine aggregate, including moisture as batched, lb

W_c = Total weight of coarse aggregate, including moisture as batched, lb

W_w = Total weight of water added, during mixing per batch, lb

W = Unit Weight of fresh concrete as determined under F.1. above, lb/ft^3

The volume of the batch in cubic yards (CY) is determined by dividing the number of cubic feet in the batch, S , by 27.

3. The cement content, "CC", lb/yd^3 of concrete produced is calculated as follows:

$$CC = N / CY$$

Where: N = cement in the batch, lb

CY = concrete produced per batch as determined in (2) above, yd^3

G. PRECAUTIONS

1. Use proper lifting methods when lifting the measure full of concrete.
2. Always use the standard rod. Do not substitute.
3. Keep scale level while weighing.
4. The plywood windshield is helpful when weighing on a windy day. Watch for scale movements caused by wind and take the necessary steps to eliminate these effects.
5. Be sure to clean off all material adhering to the outside of the measure and glass cover plate before weighing. Clean the measure well, particularly around the handles and inside corners, to avoid build-up of any hardened concrete on the measure, thereby changing its tare mass and volume. Check tare weight before each test.

H. TEST REPORT

The test report shall include: the penetration of the batch of concrete tested; the air content by the pressure method (if determined); the calculated unit weight, W , of the concrete in pounds per cubic foot; the calculated size of the batch, S ; the calculated cement content, CC , together with suitable identification as to date and hour; and the station number or portion of the structure in which the concrete was placed.

I. HEALTH AND SAFETY

It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Prior to handling, testing or disposing of any materials, testers must be knowledgeable about safe laboratory practices, hazards and exposure, chemical procurement and storage, and personal protective apparel and equipment.

Caltrans Laboratory Safety Manual is available at:

http://www.dot.ca.gov/hq/esc/ctms/pdf/lab_safety_manual.pdf

**End of Text
(California Test 518 contains 5 pages)**