

**DEPARTMENT OF TRANSPORTATION**  
**ENGINEERING SERVICE CENTER**  
 Transportation Laboratory  
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## METHOD OF TEST FOR DENSITY OF FRESH CONCRETE

**CAUTION:** Prior to handling test materials, performing equipment setups, and/or conducting this method, testers are required to read "SAFETY AND HEALTH" in Section H of this method. It is the responsibility of the user of this method to consult and use departmental safety and health practices and determine the applicability of regulatory limitations before any testing is performed.

### A. SCOPE

This test method describes the procedure for determining the density in kilograms per cubic meter of freshly mixed concrete. Formulas incorporating the measured density and mass of all ingredients are included for the calculation of batch volume and actual cement content.

### B. APPARATUS

The following equipment, which is necessary for this test, is available from the Office of Purchasing and Warehousing.

1. Measure: A cylindrical, water-tight, 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  $115 \pm 15\%$  of the inside diameter. It shall be constructed of  $3 \pm 0.5$  mm thick steel and shall be reinforced around the top with a steel band of the same thickness  $40 \pm 3$  mm 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
25.0 mm or less	0.007 m <sup>3</sup>
37.5 mm	0.012 m <sup>3</sup>

2. Scale: A scale of capacity equal to the mass of the measure plus  $2600 \text{ kg/m}^3$  times the volume of the measure used. Accuracy of the scale must be within 0.1 % of the required capacity for the entire range of use.
3. Tamping Rod: A round, straight, steel rod, 15 or 16 mm in diameter, approximately 600 mm long, having one end rounded to a hemispherical tip, the diameter of which is equal to that of the rod.
4. Glass Cover Plate: Approximately 300 mm square, 6 mm thick, and wire-reinforced, or acrylic plastic cover plate 6 mm 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.

### C. CALIBRATION OF MEASURE

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  $15.6^\circ\text{C}$  to  $21.1^\circ\text{C}$ , 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 0.02 kg with the glass plate in place. Subtract the tare mass of the empty, dry measure and glass plate. Compute the calibration factor, "F."

$$F = \frac{998.6}{\text{mass of water}}$$

#### D. 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 water-tight containers to the place where the test is to be performed.

##### 2. Filling the Measure with Concrete

- a. Fill the measure to about one-third its capacity. Use the tamping rod to rod the concrete as described in paragraph (b), below. Fill the measure to about two-thirds capacity, rod and tap as described under (b), below. Finally, fill the measure to overflowing, again rodding as described in paragraph (b).

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 50 mm and allowing it to drop in such a manner to impart a sharp, slapping blow.

- b. When rodding the first layer, do not permit the rod to forcibly strike the bottom of the measure. Rod each layer 25 times, distributing the strokes evenly over the surface. Then tap the exterior of the measure, or jig the measure sufficiently to cause the concrete to "flow" into any depression left by the rod and eliminate any large air bubbles which may have been entrapped while filling. When rodding the second and last layers of concrete, the rod should just penetrate the underlying layer only. Avoid striking the top, machined edge of the measure with the rod.

##### 3. 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 150 mm. 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 0.02 kg. Record the mass.

- 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 19 mm in diameter with a depth no greater than 1.5 mm 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 mass agrees within 0.05 kg with the first mass, the original mass may be taken as correct. If not within 0.05 kg, repeat sampling and testing procedures.

## E. CALCULATIONS

1. Density,  $W$ , in kilograms per cubic meter:

The net mass of the concrete sample is equal to the gross mass of the measure, concrete, and cover plate minus the mass of the measure and cover plate. Calculate the density of the concrete in kilograms per cubic meter by multiplying the net mass of the concrete in the container by the calibration factor, "F," determined for the measure used. Express the density to the nearest 1 kg.

$$W = \text{Net mass of concrete} \times \text{calibration factor, } F.$$

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

$$V = (M_a + M_f + M_c + M_w) / W$$

Where:

$V$  = Volume of concrete per batch in cubic meters.

$M_a$  = Total mass of cement in the batch, in kilograms.

$M_f$  = Total mass of fine aggregate, including moisture as batched, in kilograms.

$M_c$  = Total mass of coarse aggregate, including moisture as batched, in kilograms.

$M_w$  = Total mass of water added during mixing per batch, in kilograms.

$W$  = Density of the fresh concrete as determined under (1) above, in kilograms per cubic meter.

3. Cement Content:

The cement content, "CC", in kilograms per cubic meter of concrete produced is calculated as follows:

$$CC = M_a / V$$

Where:

$M_a$  = number of kilograms of cement in the batch.

$V$  = volume of concrete produced per batch in cubic meters as determined in (2) above.

## F. 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 wind shield 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 mass before each test.

#### **G. 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 density,  $W$ , of the concrete in kilograms per cubic meter; the calculated size of the batch,  $V$ ; 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.

#### **H. SAFETY AND HEALTH**

Prior to handling, testing or disposing of any waste materials, testers are required to read: Part A (Section 5.0), Part B (Sections: 5.0, 6.0 and 10.0) and Part C (Section 1.0) of Caltrans Laboratory Safety Manual. Users of this method do so at their own risk.

#### **REFERENCES:**

ASTM Designation C 138

End of Text (California Test 518 contains 4 pages)