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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 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

California Test 539 – Sampling Fresh Concrete
 ASTM C 138 – Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete

C. APPARATUS

1. Measure: a cylindrical watertight, steel measure with two handles.
 - The capacity of the measure must conform to the requirements in the following table.

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

- It must have an inside height of 115 % ± 15 % of the inside diameter.
 - It must be constructed of No. 10 to No. 12 US gage steel.
 - It must be reinforced around the top with a steel band of the same thickness 1½ in. wide. The top rim must be machined to a plane surface.
2. Balance: a balance or scale of at least 105 lb capacity. 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 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. Cover plate: glass approximately 12 in. square, 1/4 in. thick, and wire-reinforced, or acrylic plastic cover plate approximately 12 in. square and 1/4 in. thick.
 5. Platform with hinged, collapsible wings on three sides, made of plywood, with level bubbles attached to the platform at 1 corner.

D. CALIBRATION OF MEASURE

Verify the value of the calibration factor at the start of each job and at any time there is reason to suspect a change. Calibrate the measure by filling it with water having a temperature 60°F to 70°F measured with a thermometer.

Place the cover 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 cover plate. Weigh to the nearest 0.05 lb with the cover plate in place. Subtract the tare weight of the empty, dry measure and cover plate. Compute the calibration factor, F .

$$\text{Where } F = \frac{62.3}{\text{weight of water}}$$

E. PROCEDURE

1. Sampling Fresh Concrete
 - a. Sample fresh mixed concrete in accordance with California Test 539.
 - b. Transport sample 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 3 layers of equal depth. Move the scoop around the perimeter of the measure opening to ensure an even distribution of the material with minimal segregation. Fill the topmost layer to over flowing. Level the surface of each layer with the fingers prior to tamping.
 - (1) Rod each layer 25 times with the rounded end of the tamping rod, distributing the strokes evenly over the surface of the layer.
 - (2) While rodding the first layer, penetrate nearly full depth into the layer, but avoid striking the measure bottom.
 - (3) While rodding the second and third layers, penetrate approximately 1 in. into the layer below with each stroke.
 - (4) After each layer is rodded, tap the sides of the measure with a hand, stake or mallet 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.
 - (5) Level the surface of the concrete 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.
 - (6) 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.

- (7) Avoid striking the top, machined edge of the measure with the rod.
 - (8) Clean the rim of the measure for a distance of about 6 in. Place one side of the cover 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 a gloved hand to shove them down into the concrete.
 - (9) Using a cloth or damp sponge, clean off all concrete or other material adhering to the outside of the measure and glass plate.
3. 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 cover plate in place, on the scale and weigh to the nearest 0.05 lb. Record the weight.
 4. Slide the cover 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 1 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. Determine unit weight of concrete:

$$W = \text{Net Weight of concrete} \times F \quad (1)$$

Where: W = Unit weight, lb/ft³ (to the nearest 0.1 lb)

F = Calibration factor for the measure used

$$\text{Net Weight of Concrete} = \frac{\text{Wt. of (Measure + Concrete + Cover Plate)} - \text{Wt. of (Measure + Cover Plate)}}{F}$$

2. Determine the volume of concrete, S , per batch:

$$S = \frac{(W_a + W_f + W_c + W_w)}{W} \quad (2)$$

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

Volume, $\text{yd}^3 = S / 27$

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 concrete, lb/ft^3 (Equation 1)

3. Determine the cement content, CC, in lb/yd^3 of concrete produced:

$$\text{CC} = \frac{N}{S}$$

Where:

N = Amount of cement in the batch, lb

CY = Volume of concrete produced per batch, cu yd (Equation 2)

G. PRECAUTIONS

1. Always use the standard rod. Do not substitute.
2. Keep scale level while weighing.
3. 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.
4. 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 weight and volume. Check tare weight before each test.

H. TEST REPORT

The test report must include:

- Penetration of the batch of concrete tested,
- Air content by the pressure method (if determined),
- Calculated unit weight, W , of the concrete in lb/ft^3 ,
- Calculated size of the batch, S , in yd^3 ,
- Calculated cement content, CC in lb/yd^3 ,
- Date and time, and
- 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

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(California Test 518 contains 5 Pages)**