

DEPARTMENT OF TRANSPORTATION
DIVISION OF ENGINEERING SERVICES
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METHOD OF TEST FOR UNIT WEIGHT OF AGGREGATE

A. SCOPE

This test method describes the procedure for determining the compacted or loose weight per cubic foot of both fine and coarse aggregates.

B. REFERENCES

AASHTO T 19 - Bulk Density ("Unit Weight") and Voids in Aggregate

C. APPARATUS

1. Square-point shovel.
2. Quartering canvas (6 ft × 6 ft).
3. Balance: a balance or scale sensitive to 0.5 % of the weight of the sample to be weighed.
4. Tamping rod: a round, straight steel rod with a diameter of $\frac{5}{8}$ in. $\pm \frac{1}{16}$ in. and length of at least 4 in. greater than the depth of the measure (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.
5. Measure: a cylindrical metal measure preferably provided with handles, having the capacity required in Table 1 for the nominal size of the aggregate being tested. The measure must be watertight, with the top and bottom true and even, preferably machined to accurate dimensions on the inside, and of sufficient rigidity to retain its form under rough usage. Measures with capacities of $\frac{1}{2}$ cu. ft and 1 cu. ft and having a metal thickness less than 0.20 in. must be reinforced around the upper $1\frac{1}{2}$ in. with a steel band to provide a minimum thickness of 0.20 in.

TABLE 1

Dimensions of Measures

Capacity ft ³	Inside Diameter, In.	Inside Height, in.	Minimum Thickness of Metal, in.		Maximum Nominal Size of Aggregate, in.
			Bottom	Wall	
$\frac{1}{16}$	6.0 + 0.1 =	6.1 + 0.1 =	0.20	0.10	$\frac{1}{2}$
$\frac{1}{3}$	8.0 + 0.1 =	11.5 + 0.1 =	0.20	0.10	1
$\frac{1}{2}$	10.0 + 0.2 =	11.0 + 0.1 =	0.20	0.12	$1\frac{1}{2}$
1	14.0 + 0.2 =	11.2 + 0.1 =	0.20	0.10	4

D. CALIBRATION OF MEASURE

1. Fill the measure with water at room temperature and cover with a piece of plate glass in such a way as to eliminate bubbles and excess water.
2. Determine the net weight of water in the measure to an accuracy of $\pm 0.1\%$.
3. Measure the temperature of the water and determine its unit weight from Table 2, interpolating if necessary.
4. Calculate the Factor, F , for the measure by dividing the unit weight of the water by the weight required to fill the measure.

TABLE 2

Unit Weight of Water	
Temperature °F	Unit Weight lb/ft³
60	62.366
65	62.336
70	62.301
73.4	62.274
75	62.261
80	62.216
85	62.166

E. SAMPLE PREPARATION

Oven-dry aggregate to be tested at $230^{\circ}\text{F} \pm 9^{\circ}\text{F}$ to a constant weight in accordance with CT 226.

F. TEST PROCEDURE

1. Determine the tare weight of the empty measure.
2. Fill the measure with aggregate using the appropriate procedure described below:
 - a. Compacted Method (by Rodding):

This procedure is applicable to aggregates having a nominal maximum size of $1\frac{1}{2}$ in. or less.

- (1) Place the measure on a level, firm surface.
- (2) Using a scoop, fill the measure in 3 layers of equal depth. Fill the topmost layer to over flowing. Level the surface of each layer with the fingers prior to tamping.
 - Rod each layer 25 times with the tamping rod, distributing the strokes evenly over the surface of the layer.

- While rodding the first layer, penetrate nearly full depth into the layer, but avoid striking the bottom of the base.
 - While rodding the second and third layers, penetrate slightly into the layer below with each stroke.
- (3) 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.

b. Compacted Method (by Jigging).

This procedure is applicable to aggregates having a nominal maximum size greater than 1½ in. and not exceeding 4 in.

- (1) Place the measure on a level, firm surface.
- (2) Fill the measure ⅓ full and level the surface with the fingers.
- (3) Consolidate the material by alternately raising opposite sides of the measure about 2 in. and allowing the vessel to drop in such a manner as to hit with a sharp slapping blow. Repeat this raising and dropping action 50 times.
- (4) Fill the measure ⅔ full and repeat the leveling and consolidation procedure described above.
- (5) Fill the measure to overflowing and repeat the consolidation procedure described above.
- (6) 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.

c. Loose Method (by Shoveling):

The shoveling is applicable to aggregate having a maximum size of 4 in. or less.

- (1) Place the measure on a level, firm surface.
- (2) Fill a square-point shovel from the thoroughly mixed sample pile. Walk slowly around the measure, pouring aggregate from the shovel at a height not to exceed 2 in. above the top of the measure. Repeat until the measure is filled.
- (3) 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.

2. Weigh the measure full of compacted aggregate and subtract the tare weight of the empty measure to obtain the net weight of the aggregate required to fill the measure.
3. Repeat the above steps until a total of 3 weight determinations are obtained which do not differ by more than 1 %.

G. CALCULATIONS

1. Calculate the average net weight of aggregate required to fill the measure.
2. Calculate the unit weight of the aggregate from the following formula:

Unit weight per cubic foot = FA

Where: F = Factor obtained in Section D
 A = Average net weight of aggregate required to fill the measure

H. PRECAUTIONS

Avoid segregation of coarse and fine aggregate by mixing the material thoroughly on a quartering canvas, and by pressing the shovel tip down firmly enough to pick up fines from the quartering canvas.

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 212 contains 4 pages)**