

State of Nevada  
Department of Transportation  
Materials Division

**METHOD OF TEST FOR DENSITY (UNIT WEIGHT) AND VOLUME OF CONCRETE**

**SCOPE**

This test method describes the procedure for determining the density (unit weight) in  $\text{kg/m}^3$  ( $\text{lb/ft}^3$ ) of freshly mixed concrete and furnishes formulas for calculating the volume of concrete per batch (yield).

**APPARATUS**

1. Scale, minimum capacity of 45 kg (100 lb), sensitive to 0.1.
2. Measure, a cylindrical, watertight steel or aluminum measure having a nominal capacity of 14 L ( $0.5 \text{ ft}^3$ ) provided with handles, for maximum size aggregate up to 63 mm ( $2 \frac{1}{2} \text{ in.}$ ). It shall have an inside diameter of 254 mm (10 in.) and an inside height of 279 mm (11 in.). The top rim shall be machined to a plane surface. The measuring bowl from the Type B – Air Meter may be used as the measure, for maximum size aggregate up to 25 mm (1 in.).
3. Tamping rod, a round, straight, steel rod, 16 mm ( $\frac{5}{8} \text{ in.}$ ) in diameter approximately 600 mm (24 in.) long, having one end rounded to a hemispherical tip of the same diameter.
4. Internal vibrators, may have rigid or flexible shafts, preferably powered by electric motors. The frequency of vibration shall be 7000 vibrations per minute or greater while in use. The outside diameter or the side dimensions of the vibrating element shall be at least 19 mm ( $\frac{3}{4} \text{ in.}$ ) and not greater than 38 mm ( $1 \frac{1}{2} \text{ in.}$ ). The length of the shaft shall be at least 600 mm (24 in.).
5. Strike-Off plate, made of metal, reinforced glass or acrylic, approximately 300 mm (12 in.) square, 6 mm to 12 mm ( $\frac{1}{4} \text{ in.}$  to  $\frac{3}{4} \text{ in.}$ ) thick.
6. Mallet, with a rubber or rawhide head, weighing approximately  $0.60 \pm 0.25 \text{ kg}$  ( $1.25 \pm 0.50 \text{ lb}$ ) for use with measure of  $0.0142 \text{ m}^3$  ( $0.5 \text{ ft}^3$ ) or less, or a mallet weighing approximately  $1.0 \pm 0.25 \text{ kg}$  ( $2.25 \pm 0.50 \text{ lb}$ ) for use with a measure larger than  $0.0142 \text{ m}^3$  ( $0.5 \text{ ft}^3$ ).
7. Sponge or towel.
8. Large Scoop.

## CALIBRATION OF MEASURE

The calibration factor (f), shall be verified at the start of each contract and any time there is reason to suspect a change. Weigh the empty, dry measure and strike-off plate to the nearest 0.1 kg (0.1 lb) to obtain the tare weight. Fill the measure up with water having a temperature of  $25 \pm 3^{\circ}\text{C}$  ( $77 \pm 5^{\circ}\text{F}$ ). Place the strike-off 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 strike-off plate, weigh to the nearest 0.1 kg (0.1 lb). Take the total mass of the measure, water and strike-off plate and subtract the tare weight. Take  $999.6 \text{ kg/m}^3$  ( $62.4 \text{ lb/ft}^3$ ) / [Total Mass (measure, strike-off plate, and water) – Tare Weight (empty measure and strike-off plate)] to determine the calibration factor to the nearest 0.1 kg (0.001 lb).

Example:  $999.6 \text{ kg/m}^3$  ( $62.4 \text{ lb/ft}^3$ ) / [Total Mass (measure, strike-off plate, and water) – Tare Weight (empty measure and strike-off plate)] = f (calibration factor)

## SAMPLING

Obtain a representative sample per Test Method Nev. T425.

## TEST PROCEDURE

1. This test shall be started within 15 minutes of obtaining a representative sample.
2. Filling the measure and consolidating.
  - a. Dampen the measure and place on a flat level surface.
  - b. Method of consolidation should be determined per the results of the slump test, unless the method is stated in the specifications under which the work is being performed. The methods of consolidation are rodding and internal vibration. Rod concrete with a slump greater than 75 mm (3 in.). Rod or vibrate concrete with a slump of 25 to 75 mm (1 to 3 in.). Vibrate concrete with a slump less than 25 mm (1 in.).
  - c. Rodding - Place the concrete in the measure in three layers of approximately equal volume. Rod each layer with 25 strokes of the tamping rod. Rod the bottom layer throughout its depth but the rod shall not forcibly strike the bottom of the measure. Distribute the strokes uniformly over the cross section of the measure and for the top two layers, penetrate about 25 mm (1 in.) into the underlying layer. After each layer is rodded, lightly tap the sides of the measure 10 to 15 times with the appropriate mallet to close any voids left by the tamping rod and to release any larger air bubbles that may have been trapped. Add the final layer so as to avoid overfilling.

- d. Internal Vibration - Fill and vibrate the measure in three layers of approximately equal volume. Place all of the concrete for each layer in the measure before starting vibration of that layer. Insert the vibrator at three different points for each layer. Throughout the consolidation process, do not allow the vibrator to rest on or touch the bottom or sides of the measure. The vibrator shall penetrate into the previous layer approximately 25 mm (1 in.). When withdrawing the vibrator, take care to avoid any air pockets being left in the specimen. The duration of vibration required will depend upon the workability of the concrete and the effectiveness of the vibrator. Continue vibration just long enough to achieve proper consolidation of the concrete. Usually, sufficient vibration has been applied as soon as the surface of the concrete becomes relatively smooth. Over vibration may cause segregation and loss of appreciable quantities of entrained air.
3. Strike-off, cleaning and weighing
    - a. After the last layer has been properly consolidated, use the tamping rod held horizontally to strike off the top surface to its approximately correct elevation. Work the rod 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 (6 in.). Place one side of the strike-off plate firmly in position on the cleaned portion of the rim. Advance the strike-off 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 strike-off plate. If particles of coarse aggregate appear in front of the advancing edge of the strike-off plate, use your hand to shove them down into the concrete. Using a cloth or damp sponge, clean off all the extra concrete or other material adhering to the outside of the measure and strike-off plate. Weigh the filled measure with the strike-off plate to the nearest 0.1 kg (0.1 lb.) and record the weight.
    - b. Slide the strike-off 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 (3/4 in.) in diameter with a depth no greater than 1.5 mm (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 strike-off plate into position. Weigh again. If the new mass agrees within 0.1 kg (0.1 lb) of the first mass, the original mass may be taken as correct.

## CALCULATIONS

1. Density (unit weight),  $W$ , in  $\text{kg/m}^3$  ( $\text{lb/ft}^3$ ). Calculate the density (unit weight) of the concrete in  $\text{kg/m}^3$  ( $\text{lb/ft}^3$ ) by multiplying the net weight of the concrete in the container by the calibration factor ( $f$ ), determined for the measure used.

Gross Weight (concrete, measure and strike-off plate) – Tare Weight (dry measure and strike-off plate) =  
Net Weight (concrete) x  $f$  (calibration factor) =  $W$  (Density (Unit Weight)) to the nearest  $0.001 \text{ kg/m}^3$   
( $0.1 \text{ lb/ft}^3$ ).

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

$$S = \frac{W_a + W_1 + W_c + W_w}{W}$$

Where:

S = volume of concrete per batch in cubic feet (cubic meter).

W<sub>a</sub> = total cement in the batch in pounds (kilograms).

W<sub>1</sub> = total fine aggregate, including moisture as batched, in pounds (kilograms).

W<sub>c</sub> = total coarse aggregate, including moisture as batched, in pounds (kilograms).

W<sub>w</sub> = total mixing water added during mixing per batch, in pounds (kilograms).

W = density (unit weight) of the fresh concrete as determined under (1) above, in pounds per cubic foot (kilograms per cubic meter).

## NOTES

This Test Method Nev. T435, the 14 L (0.5 ft<sup>3</sup>) measure shall be used for concrete containing up to 63 mm (2 1/2 in.) maximum size of aggregate. When testing for unit weight with concrete aggregate of 50 mm (2 in.) or larger, two tests shall be made from the same batch. The average of the two tests shall be reported as a single determination. The measuring bowl from the Type B – Air Meter may be used as the measure, for maximum size aggregate up to 25 mm (1 in.).

## REPORT

Report W, Density (Unit Weight) to the nearest 0.001 kg/m<sup>3</sup> (0.1 lb/ft<sup>3</sup>). Results should be recorded on NDOT form 020-017, 040-025 and/or 040-078. If not filling out NDOT form 040-025 then 040-078 should be utilized.