

Determination of Bulk Density, Voids and Bulking of Aggregate

Lab Test Reference British Standard Reference

**BS EN 1097-3:1998
Tests for mechanical and physical properties of aggregates
Part 3: Determination of loose bulk density and voids**

Principal Apparatus as follows:

- i. Riffle boxes, 63mm, 50mm, 40mm, 14mm gaps should be at hand and available for use depending on the nominal size of aggregate being tested. Type as shown in **BS EN 933-1:1996 Tests for geometrical properties of aggregates - Part 2: Determination of particle size distribution: Test sieves, nominal size of apertures**
- ii. A ventilated drying oven controlled to maintain a temperature of 105 +/- 5 deg C.
- iii. Electronic Balance to weigh at least 30kg to 0.1gm.
- iv. Cylindrical metal containers of the following approximate dimensions.

Compacted Bulk Density		Uncompacted Bulk Density				
Nominal Volume	Internal Diameter Approx	Internal Depth Approx.	Minimum Thickness of wall	Nominal Agg. up to and include.	Number of blows per Layer	Nominal Size of aggregate up to and including
m3	mm	mm	mm	mm		mm
0.03	350	300	5	50	100	50
0.015	250	300	4	28	50	14
0.007	200	225	3	14	30	6
0.003	150	150	3	6	20	-

- v. A straight metal tamping rod of circular cross section 16mm dia. and 600mm long.
- vi. Clean square trays sufficiently large to completely contain the sample
- 1. Preliminaries
 - 1.0 A designated area will be used to perform this test and a clear area of bench must first be allotted before this test proceeds.
 - 1.1 Ensure that the Sample Number and the Test Schedule correspond.
 - 1.2 Obtain a Test Worksheet

- 1.3 All Equipment to be used in this test must first be checked.
- 1.4 Ensure that the Riffle Boxes to be used are clean and are in good condition.
- 1.5 Ensure that the oven has had recent calibration and is in working order.
- 1.6 Ensure that the balance is reading accurately.
- 1.7 Ensure that the Containers have been calibrated for volume. This is done by filling the containers with water $20 \pm 2^{\circ}\text{C}$ so that there is no meniscus and weighing to the nearest gram. The volume is the weight of water divided by 1000 to express the weight in kg.
- 1.8.1 The appropriate log will then be signed accepting that the Equipment is in a satisfactory condition before testing begins.
- 1 Standard Test Method
- 2.0 Sample Preparation.
- 2.1 The aggregate used in this test will have been obtained from a bulk sample that was initially taken and prepared in the manner described in BS812: 1985 Part 102.
- 2.2 Bulk density may be performed on either saturated surface dry material or oven dried material.
- 2.3 Voids will be determined on oven dried material.
- 2.3.1 Bulking will first be performed on oven dried material and then on material at a given moisture content.
- 3.0 Test Procedure
- 3.1 The size of container will be chosen from the above table.
- 3.1.1 Compacted Bulk Density. Unsuitable from moist sands.
- 3.1.2 Fill the container about one third full with the thoroughly mixed aggregate discharging the material from the scoop at a height not exceeding 50mm above the top of the container
- 3.1.3 The layer will then be given the number of compactive blows shown on the above table appropriate for the nominal aggregate size.
- 3.1.4 Each blow is delivered by allowing the rod to fall freely from a height of 50mm above the surface of the aggregate and being evenly distributed over the surface.
- 3.1.5 Further layers will then be added and the procedure in 3.1.2 to 3.1.4. will be repeated with the final layer overflowing the container.
- 3.1.6 Excess material will then be removed by rolling the tamping rod across the surface until the aggregate is level with the top of the cylinder.
- 3.1.7 Any larger piece that impedes this operation will be removed by hand.
- 3.1.8 Obvious depressions will be filled with small material.
- 3.1.9 Weigh the sample either in the container or where the combined weight of the material and container is greater than the balance capacity remove the aggregate and weigh separately.

3.1.10 A second test will then be performed.

3.1.11 Record each weight on the test sheet as (mass A) and (mass B) (g).

3.1.12 The Bulk density is calculated as follows:

$$\text{Mean Mass} = \frac{\text{Test 1} + \text{Test 2}}{2} \text{ kg} \quad \text{Bulk Density} = \frac{\text{Mean Mass}}{\text{Volume of Cylinder}} \text{ kg/m}^3$$

Volume of Cylinder* *This is the figure written on the outside of the cylinder used in the test.

3.2.1. Un-compacted bulk density.

3.2.2. The above procedure will be used but the tamping operation will be omitted.

4.0 Calculation of Voids

4.1 Voids in the sample are expressed as a percentage of the volume of the cylinder, as in the following calculation.

$$\text{Percentage Voids} = 100 \left(\frac{a - (b/1000)/a}{a} \right) \text{ where}$$

(a) is the relative density of the aggregate on an oven dried basis.

(b) is the bulk density, oven dried, compacted or un-compacted.

5.0 Calculation of Bulking

5.1 Bulking is expressed as the increase in volume as a percentage of the original volume, as in the following calculation. Percentage Bulking at a given test moisture content $M = \left(\frac{b_i(100+M)}{c} \right) - 100$ where (b_i) is the uncompact density of the oven dry fine aggregate.

(c) is the uncompact density at the test moisture content. (M) is the moisture content of the sample.

6.0 Reporting Results

6.1 The Bulk Density shall be reported as the compacted or the uncompact bulk density in Kg/m^3 .

6.2 The condition of the aggregate will be stated as either, Oven Dry, Saturated, Saturated Surface Dry.

6.3 The percentage voids if required.

6.4 The percentage bulking if required. All to the

nearest whole number.