Tests on Aggregate:

Bulk Density "Unit Weight" & Voids in Aggregate

Objective

This test method is used to determine the bulk density and voids in fine and coarse aggregate.

Principles

- During the concrete mix design, when the aggregate is to be batched by volume or by weight, then it becomes necessary to know the mass of the aggregates that will fill the container of unit volume. If we know the bulk density of the aggregate material then we can easily determine the mass required to fill a unit volume container.
- Bulk density also indicates the percentage of voids present in the aggregate material. This percentage of voids affects the grading of the aggregates which is important in high strength concrete.
- Bulk density also indicates the compactive effort required to compact the concrete.

Bulk density of aggregates is the mass of aggregates required to fill the container of a unit volume after aggregates are batched based on volume.

- Bulk Density = Mass of the aggregate \ Volume of aggregate particles with voids between them. This bulk density is used to convert quantities by mass to quantities by volume.
- Bulk density depends on several factors: Size distribution of aggregates, Shape of particles and degree of compaction.
- There are two methods this quantity is measured by: (1) Loose method. (2) Compaction method.
- For test purpose, the degree of compaction has to be specified. BS EN 1097-3: 1998 recognizes two degrees: loose and compacted. Generally the standard condition is a compacted aggregate in a dry state. The ratio of the loose bulk density to the compacted bulk density lies usually between 0.87 and 0.96. The bulk density is used for converting proportions by weight into the proportions by volume.

Materials:

1. Coarse aggregate. 2. Fine aggregate. 3. Water .

Apparatus :

- Metal cylinder, the size depends on the maximum size of the aggregate.
- Balance .
- Tamping rod: a straight metal tamping rod of cylindrical cross section 16 mm in diameter and 600 mm long, rounded at one end.
- Shovel

Test Procedure

- ***Compacted bulk density,***
  1. Weight the empty cylinder (W1).
  2. Fill the cylinder with aggregate in three stages, each one-third of the volume being tamped a number of times depending on the maximum size of the aggregate with the tamping rod.
  3. Level the surface of the cylinder by rolling the tamping rod across the top.
  4. Weigh the cylinder with the compacted aggregate (W2).
  5. Weigh the cylinder filled with water (W3).

- ***Loose bulk density,***
  1. Fill the cylinder with aggregate in one stage at a height not exceeding 50 mm from the top of cylinder.
  2. Weigh the cylinder with the loose aggregate (W4).

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Note : Details of the cylinders used in bulk density of aggregate, according to B.S

Diameter (mm)	Height (mm)	Compacted Bulk Density	
		Max. Size of aggregate	No. of layers
350	300	50	100
250	300	28	50
200	225	14	30
100	150	6	20

Calculations

$$\text{Compacted bulk density} = \frac{W_2 - W_1}{\left(\frac{W_3 - W_1}{1000}\right)} \quad (\text{kg/m}^3)$$

$$\text{Loose bulk density} = \frac{W_4 - W_1}{\left(\frac{W_3 - W_1}{1000}\right)} \quad (\text{kg/m}^3)$$

$$\% \text{ Voids} = \left(1 - \frac{BulkDensiy}{SpecificGravity \times 1000}\right) \times 100$$