Experiment 3

Experiment Name: Determination of Specific Gravity and Absorption of Fine and Coarse Aggregate

Objective

The objective of this experiment is to determine the specific gravity and absorption of fine and coarse aggregate.

Introduction

Aggregates generally contain pore, both permeable and impermeable, for which specific gravity has to be carefully defined. With this specific gravity of each constituent known, its weight can be converted into solid volume and hence a theoretical yield of concrete per unit volume can be calculated. Specific gravity of aggregate is also required in calculating the compacting factor in connection with the workability measurements. Knowing the specific gravity of aggregates is also critical to the construction of water filtration systems, slope stabilization projects, railway bedding and many other applications. Aggregate specific gravity is used in a number of applications including superpave mix design, deleterious particle identification and separation, and material property change identification. This test method covers the determination of bulk and apparent specific gravity, 23/23°C (73.4/72.4°F) and absorption of aggregates. Bulk specific gravity is used for a) calculation of the volume occupied by the aggregate in various mixtures containing aggregate on an absolute volume basis, b) the computation of voids in aggregate, and c) the determination of moisture in aggregate.

Absorption values are used to calculate the change in the weight of an aggregate due to water absorbed in the pore spaces within the constituent particles, compared to the dry condition. For an aggregate that has been in contact with water and that has free moisture on the particle surface, the percentage of free moisture can be determined by deducting the absorption from the total moisture content. The absorption capacity in aggregate is important in determining the net water-cement ratio in the concrete mix.

The specific gravity and absorption of coarse and fine aggregate are determined according to the specification ASTM C128-01 or AASHTO T84 (for fine aggregate) and ASTM C127-01 or AASHTO T85 (for coarse aggregate).

Moisture in Aggregate

- **Oven Dry (OD):** All moisture is removed from aggregate by heating at 110±5°C for 24 hours.
- **Air-Dry (AD):** All moisture is removed from the surface, but internal pores are partially filled.
- **Saturated Surface Dry (SSD):** All pores are completely filled with water, but no water is present on the exposed surface of the particles.
- **Moist Condition:** Pores are completely filled with water with excess amount of water on the surface.

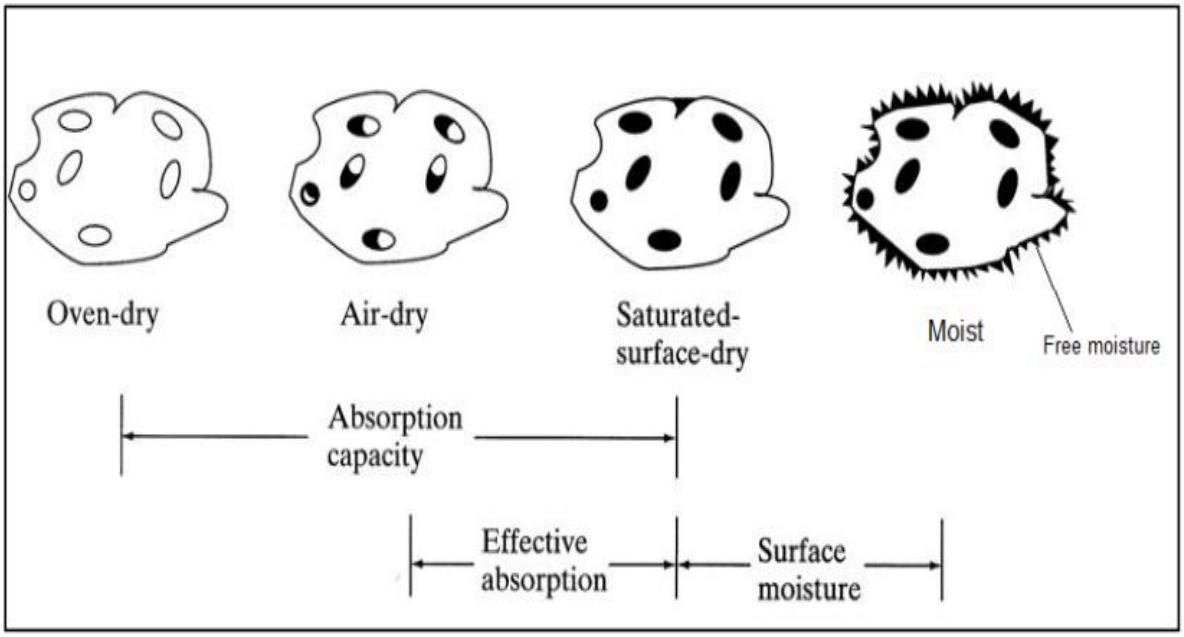


Fig: States of moisture in aggregate

Some Terms:

Apparent Specific Gravity (O-D): This is the ratio of the oven dry (OD) weight of a unit volume of aggregate at a stated temperature to the weight of water occupying equal volume excluding permeable pores at the stated temperature.

$$\text{ASD (O-D) basis, } S_a = \frac{\text{O-D wt of aggregate}}{\text{wt. of water occupying equal volume excluding permeable pores}}$$

Bulk Specific Gravity (O-D): This is the ratio of the oven dry weight of a unit volume of aggregate at a stated temperature to the weight of water occupying equal volume including permeable pores at the stated temperature. It is also termed as the relative density of aggregate.

$$\text{BSG (O-D) basis, } S_d = \frac{\text{O-D wt of aggregate}}{\text{wt. of water occupying equal volume including permeable pores}}$$

Bulk Specific Gravity (SSD): It is the ratio of the weight of a unit volume of aggregate in the air including the weight of water completely filling the permeable pores in the aggregate to the weight of gas free distilled water occupying equal volume including permeable pores at the stated temperature.

$$\text{BSG (SSD), } S_s = \frac{\text{SSD wt of aggregate}}{\text{wt. of water occupying equal volume including permeable pores}}$$

Apparatus: See the lab videos that have been provided.

Procedure: See the lab videos that have been provided.

Formula (Fine Aggregate):

$$\text{Apparent Specific Gravity, } S_a = \frac{A}{(V-W)-(S-A)}$$

$$\text{Bulk Specific Gravity (O-D basis), } S_d = \frac{A}{(V-W)}$$

$$\text{Bulk Specific Gravity (SSD basic), } S_s = \frac{S}{(V-W)}$$

$$\text{Absorption Capacity, (D) in \% } = \frac{S-A}{A} \times 100$$

$$\text{Percent of Effective Absorption SSD basic } (D_e) = \frac{S-H}{S} \times 100$$

Sample Data

SSD wt of sample, (S) in = 500 gm
wt of empty pycnometer , (P) = 329 gm
wt of pycnometer + water, (B) =1323 gm
wt of pycnometer +sample+ water (C) = 1630 gm
Capacity of pycnometer, V=(B-P) gm
wt of water added, W= (C-S-P) gm
wt of oven dry sample, A = 496 gm
wt of air dry sample, H = 496 gm

Record all the weights to nearest 0.1 gm.

Formula (Coarse Aggregate):

Apparent Specific Gravity, $S_a = \frac{A}{A-C}$

Bulk specific Gravity (O-D basis), $S_d = \frac{A}{S-C}$

Bulk Specific Gravity (SSD basis), $S_s = \frac{S}{S-C}$

Absorption Capacity (D) in % = $\frac{S-A}{A} \times 100$

Percentage of Effective absorption SSD basis (D_e) = $\frac{S-H}{S} \times 100$

Sample Data:

wt of basket in air, B = 832.5 gm
wt of basket in water, E=734.5 gm
wt of basket+SSD sample, F=4852.5 gm
wt of basket+sample in water, G=3343 gm
SSD wt of sample, S= (F-B) gm
wt of SSD sample in water, C= (G-E) gm
wt of oven dry sample, A = 4002 gm
wt of air dry sample, H =4009 gm

Report:

Apparent Specific Gravity, S_a

Bulk Specific Gravity (O-D) basis, S_d

Bulk Specific Gravity (SSD) basis, S_s

Absorption capacity, (D) in %

Percentage of Effective absorption SSD basis, (D_e)

Write down the results of both coarse and fine aggregate**. Report specific gravity result to nearest 0.01 and absorption to nearest 0.1 %**.

Question:

1. What do you mean by effective absorption capacity?

2. What is the significance of determining the specific gravity and absorption capacity of aggregates?

Discussion: Hint: The significance of results, comparison etc.

Experiment Name :Determination of Unit Weight & Voids in Fine and Coarse Aggregate

Objectives: To determine the unit weight and voids in fine and coarse aggregate.

Introduction : The weight of aggregate in a unit volume is required to be determined for design of concrete structures. This method often used to determine bulk density values that are necessary for use in many methods of selecting proportions for concrete mixtures. The void content between particles affects the amount of cement paste required for the mix. Angularity aggregates increase the void content.

Larger sizes and improved gradation of aggregate decrease the void content. The unit weight or bulk density of aggregate is dependent on a number of parameters – moisture in aggregate, degree of compaction, aggregate gradation etc.

Unit weight values of aggregates are necessary for selecting proportions for concrete mixtures. They may also be used for determining mass/volume relationships for conversions and calculating the percentages of voids in aggregates.

Procedures:

This test method conforms to the ASTM standard requirements of specification C29.

For determination of unit weight and voids in aggregate three different procedures are generally followed:

a. Shoveling procedure- measure aggregate unit weight in loose condition.

b. Rodding procedure- used for determination of compacted unit weight of aggregate having a nominal maximum size of 1.5 in (37.5 mm) or less.

c. Jigging procedure- used for determination of compacted unit weight of aggregate having a nominal maximum size greater than1.5 in (37.5 mm) and not exceeding 6 inch (150 mm).

See the lab videos for detailed procedures.

Shoveling Procedure:

1. Fill the measure to overflowing by means of a shovel or scoop, discharging the aggregate from a height not exceeding 2 inch (50 mm) above the top of the measure. Exercise care to prevent, so far as possible, segregation of the particle sizes of which the sample is composed.

2. Level the surface of the aggregate with the fingers or a straightedge in such a way that any slight projections of the larger pieces of the coarse aggregate approximately balance the larger voids in the surface below the top of the measure.

3. Determine the mass of the measure plus its contents, and the mass of the measure alone, and record the values to the nearest 0.1 lb (0.05 kg).

Rodding Method:

1. Fill the measure one- third full and level the surface with fingers.

2. Rod the layer of aggregate with 25 strokes of the tamping rod evenly distributed over the surface. It is not allowed the rod to strike the bottom of the measure forcibly.

3. Fill the measure two-thirds full and again level as above.

4. Finally, fill the measure to overflowing and rod again in the manner previously mentioned.

5. Level the surface of the aggregate with the fingers or a straightedge in such a way that any slight projections of the larger pieces of the coarse aggregate approximately balance the larger voids in the surface below the top of the measure.

6. In rodding the second and third layers, use vigorous effort, but do not apply such force to cause the tamping rod to penetrate to the previous layer of the aggregate.

7. Determine the mass of the measure plus its contents, and the mass of the measure alone, and record the values to the nearest 0.1 lb (0.05 kg).

Formulas:

Unit weight, $M = \frac{G-T}{V}$

Here, M= unit weight of aggregate (kg/m^3) or lb/ft^3

G = mass of the aggregate + measure, lb(kg)

T = mass of the measure, lb (kg)

V = volume of the measure ft^3 (m^3)

Report the results for the unit weight to the nearest 1 lb/ft^3 (10 kg/m^3)

The unit weight determined by this test method is for aggregate in an oven-dry condition. If the unit weight in terms of saturated-surface-dry (SSD) condition is desired, use the exact procedure in this test method, and then calculate the SSD unit weight using the following formula:

$$M_{SSD} = \left(1 + \frac{A}{100} \right) \times M$$

Where, ,

M_{SSD} = unit weight of aggregate in SSD condition, (kg/m^3) or lb/ft^3

A = absorption capacity in aggregate (%)

void content in the aggregate using the corresponding unit weight:

$$\% \text{ void} = 100 \times \left(\frac{S \times W - M}{S \times W} \right)$$

Where, ,

M= unit weight of the aggregate, lb/ft^3 (kg/m^3)

S = bulk specific gravity (O-D) basis determined in previous experiment

W= density of water (kg/m^3) or lb/ft^3

Sample Data:

Weight of measure, T (lb) = lb
Volume of the measure to be used in the calculation, V = ft^3
Bulk specific gravity (O-D) basis, S (from previous exp)

Absorption capacity, A(%) (from previous exp)

Material	Method	Wt of measure+ materials G (lb)	Wt of material, G-T lb	Average wt of material, lb	Unit weight M (lb/ft^3)	SSD unit wt, M_{SSD} (lb/ft^3)	% void
Fine aggregate	Shoveling	17.6					
		17.8					
	Rodding	18.4					
		18.5					

Material	Method	Wt of measure+ materials G (lb)	Wt of material, G-T lb	Average wt of material, lb	Unit weight M (lb/ft^3)	SSD unit wt, M_{SSD} (lb/ft^3)	% void
Coarse aggregate	Shoveling	50.7					
		50.9					
	Rodding	52.4					
		52.3					

Use your own group data of coarse and fine aggregate for calculation.

Results:

Unit weight, M (lb/ft^3)

SSD unit wt, M_{SSD} (lb/ft^3)

% void

Write down the results for both fine and coarse aggregate.

Report the results for the void content to the nearest 1% and unit weight to nearest 1 lb/ft^3 or 10 kg/m^3.

Discussion: Hint: The significance of results.

Questions:

1. Briefly describe the rodding procedure.

2. What is the significance of determining the void contents of aggregates?

Full Report:

- Experiment No
- Experiment Name
- Objectives
- Apparatus
- Procedure
- Sample Calculations
- Graph

- Data Table
- Result
- Discussion
- Question Answer

Do not copy discussion and question-answer.