Faculty of Engineering and Technology

Civil Engineering Department

Construction Materials Laboratory

ENCE215

Experiment # 4

" Aggregate: Specific gravity and water absorption "

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- **Introduction**

Background information

The term specific gravity is a unique defined characteristic of materials in general, and it is originated from a broader concept called the relative density. The relative density is defined as the ratio of the density of a curtain substance to the density of another reference substance, and as a special case if water happens to be our reference then the term specific gravity is used, in general specific gravity is the ratio of the mass of a substance to the mass of an equal volume of water. Since the specific gravity is a ratio it is a dimensionless quantity

The importance of calculating the specific gravity is represented in detecting invalid aggregates, contaminated or deleterious aggregates tend to be lighter than the natural ones, hence based on the differences rejection or acceptance of the aggregates could be decided. Specific gravity is also very important in the mix proportioning and the designation of concrete mixes using the absolute volume method. For most natural aggregates the specific gravity is between 2.40 and 2.90, physically this could be explained that aggregates are 2.40 to 2.90 as dense as water.

In usual aggregates have pores inside of them, the pores inside an aggregate that are wholly within the solid are called ' impermeable pores ', while the pores that are open to the surface are called ' permeable pores '. Taking the presence of pores in consideration requires defining different types of specific gravities:

1. Bulk specific gravity (Bulk dry specific gravity)($G.S_b$):

It is the ratio of the density of aggregate in air to the density of water, where the volume of the aggregates consists of the volume of the solid including all pores (permeable and impermeable ones).

$G.S_b = A / (B - C)$

Where:

A: The oven dry mass.

B: SSD mass in air.

C: SSD mass in water.

2. Bulk SSD specific gravity ($G.S_b$ SSD):

   The ratio of the density of aggregates in air including the mass of water inside the pores that were fill by overnight submerging (15 hours) to the density of water.

   $G.S_b$ SSD $= B / (B - C)$

   Where:

   B: SSD mass in air.

   C: SSD mass in water.

3. Apparent specific gravity ($G.S_a$):

   The ratio of the density of aggregate sample in air to the density of water, whereas the volume of aggregate referred to includes impermeable pores while excludes the capillary ones.

   Absorption of aggregates is a measurement of the weight of water absorbed by an oven dry sample of aggregates to reach the saturated surface dry condition, and is expressed as a percentage of the oven dry weight.

$G.S_a = A / (A - C)$

Where:

A: Oven dry mass.

C: SSD mass in water

The absorption is an indication of the quantity of the voids and pores inside the particles of aggregates. In addition, the calculating the absorption gives an indication of how " thirsty " is the aggregate, in other words, how much water is already present, and how much water is needed to get to an SSD condition. The absorption is always a positive value and it shall not be more than 0.6 per unit by weight.

$\%Abs = [(B - A) / A] * 100\%$

Where:

%Abs: The Absorption.

A: Oven dry mass.

B: SSD mass in air.

- **Purpose**

This experiment aims to calculate the different defined specific gravities, in addition to finding the percentage absorption for coarse and fine samples of aggregates.

- **Hypotheses**

The natural values of aggregates specific gravities lies within 2.40 to 2.90 according to the ASTM, hence our values should be within that range. The absorption for the

fines should be much smaller than those for the coarse ones, since the texture of the fines is more of a glassy texture, while the texture of the coarse is more porous.

- **Procedure**

1- Two samples of coarse aggregates and another two of fine aggregates where immersed in water for about 15 hours.
2- The water film surrounding the coarse samples was removed using dry clothe (SSD).
3- Each sample of coarse aggregates was weighed in air using balance to obtain mass (B).
4- Each sample of coarse aggregate was weighed in water to obtain mass (C), with the assistance of the suspending apparatus.
5- Each fine sample was heated using the heater until reaching a lighter colour and less cohesion (SSD).
6- The SSD mass of each fine aggregate sample was measured.
7- The pycnometer wass filled with water up to 500 ml.
8- The pycnometer jar filled with water was weighed.
9- Each fine aggregates sample was put inside the filled pycnometer, with taking care to rinse the sticking particles on the walls of the jar.
10- For each sample the pycnometer containing the water and the fines was weighed.
11- The pycnometer was emptied and the fine sample was taken out and put inside a separate tray.
12- The trays (two trays of fine and two trays of coarse) were placed inside the oven at 110^{o} for 24 hours.
13- The samples where weighed next day to obtain the air dry mass (A).

- **Instruments**

Apparatus and Tools:

fig.1: Coarse aggregates

fig.2: Fine aggregates

fig.3 Oven

fig.4: Balance

fig.5: Balance suspending apparatus

fig.6: Pycnometer jar

fig.7: water squirt bottle

fig.8: Heater

- **Data & Calculations:**

Coarse sample (1):

A = 394.8 gm.

B = 410.90 gm.

C = 246.60 gm.

$G.S_b$ = 394.8 / (410.90 - 246.60) =2.40

$G.S_b$ (SSD) = 410.90 / (410.90 - 246.60) = 2.50

$G.S_b$ = 394.8 / (394.8 - 246.60) = 2.66

%Abs = [(410.90 - 394.8) / 394.8] * 100 = 4.08 %

Coarse sample (2):

A = 465.30 gm.

B = 482.50 gm.

C = 292.05 gm.

$G.S_b$ = 465.30 / (482.50 - 292.05) = 2.44

$G.S_b$ (SSD) = 482.50 / (482.50 - 292.05) = 2.53

$G.S_b$ = 465.30 / (465.30 - 292.05) = 2.69

%Abs = [(482.50 - 465.30) / 465.30] * 100 = 3.70 %

Fine sample (1):

A = 243.20 gm.

B = 154.40 gm.

W_c (pycnometer + water) = 667.80 gm

W (pycnometer + water + fines) = 771.60 gm

C = W - W_c = 103.80 gm

$G.S_b$ = 243.20 / (154.40 - 103.80) = 4.81

$G.S_b$ (SSD) = 154.40 / (154.40 - 103.8) = 3.05

$G.S_b$ = 243.20 / (243.20 - 103.80) = 1.74

%Abs = [(154.40 - 243.20) / 243.20] * 100 = -36.5 %

Fine sample (2):

A = 265.30 gm.

B = 176.30 gm.

W_c (pycnometer + water) = 667.80 gm

W (pycnometer + water + fines) = 787.5 gm

C = W - W_c = 119.70 gm

$G.S_b$ = 265.30 / (176.30 - 119.70) = 4.69

$G.S_b$ (SSD) = 176.30 / (176.30 - 119.7) = 3.11

$G.S_b$ = 265.30 / (265.30 - 119.7) = 1.82

%Abs = [(154.40 - 243.20) / 243.20] * 100 = -33.5 %

- **Results & Conclusion**

Coarse (1):

$G.S_b$ = =2.40

$G.S_b$ (SSD) = 2.50

$G.S_b$ = 2.66

%Abs = 4.08 %

Coarse (2):

$G.S_b$ = 2.44

$G.S_b$ (SSD) = 2.53

$G.S_b$ = 2.69

%Abs = 3.70 %

Fine (1):

$G.S_b$ = 4.81

$G.S_b$ (SSD) = 3.05

$G.S_b$ = 1.74

%Abs = -36.5 %

Fine (2): $G.S_b$ = 4.69

$G.S_b$ (SSD) = 3.11

$G.S_b = 1.82$

%Abs = -33.5 %

For the coarse aggregates the specific gravities are within the range (2.40 to 2.90). However, the absorption capacities are higher than the permissible limit suggested by (BS 8007) which is 3%, hence these aggregates are rejected or the test should be remade. For fines, It turns out that we have a blunder (very large mistake), since the recorded oven dry weight is larger than the saturated surface dry weight, and hence most of the computations done are not correct, also the absorption could never be a negative value.

Source of error:

1- Systematic errors in the balance.
2- Maybe a misreporting blunder.
3- Improper drying of the water film surrounding the aggregates.
4- Overheating of the fine samples.
5- Errors in filling the pycnometer because of the meniscus reading difficulty.
6- Probable that tarring the balance was forgotten.
7- Loss of a portion of the fine sample while pouring the water out of the pycnometer.

- **References**

1. Department of Transportation (2006) Aggregate Production and Testing: Construction Inspector's Training Manual. Washington State, Department of Transportation. Environmental and Engineering Program, Construction office.

2. https://theconstructor.org/building/aggregates-specific-gravity-water-absorption-test/1358/?fbclid=IwAR0Bm89wilGozpszFxhqQuPu-WJ0GCbILwYJPGHOcE_mmZ8ZqxZEWibOIP8