

## **CEEN 043 - Behavior & Properties of Engineering Materials**

### **Laboratory Experiment No. 5**

#### **Specific Gravity, Absorption and Unit Weight of PCC Aggregates and Mixing and Casting of PCC Cylinders**

**OBJECTIVE:** To determine the weight/volume properties of aggregates used in the making of Portland cement concrete (PCC) and to examine the effects of curing time and cementitious materials content on the strength of PCC.

**EQUIPMENT:** A balance, large pans, molds, volumetric flask, tampers, rods, concrete mixing equipment, slump cone, drying fans and ovens.

**ASTM REF:** C 29, C 127, C 128, C 136, C 143, C 138, C 192, C 1252

#### **PROCEDURES:**

##### **Part A - Specific Gravity & Absorption of Coarse Aggregate**

1. Obtain an 800 gram sample of saturated coarse aggregate and roll it in a large absorbent cloth to remove all visible films of water. Take care to avoid evaporation of water from aggregate pores during this operation. Remove approx 100 grams of the SSD stone and place in a tared moisture pan. Record the combined weight to the nearest 0.1 gram. Place the sample in an oven at 110 +/- 5 C. Remove the sample from the oven periodically and check its weight to the nearest 0.1 g. Continue drying and weighing until the aggregate has reached a constant weight, signified by two consecutive weight readings, separated by at least 10 minutes, giving identical weights.
2. Weigh the remaining test sample (in air) to the nearest 0.1 gram and record this weight on the data sheet in the space provided. Immediately after weighing in air, place the SSD sample in the sample basket and determine its weight submerged in water. Record this information on the data sheet.

##### **Part B – Specific Gravity and Absorption of Fine Aggregates**

1. Obtain a 500 gram sample of saturated fine aggregate. Place the aggregate sample on a flat non-absorbent surface exposed to a gently moving current of warm air and stir frequently to assure homogenous drying. Continue this operation until the test specimen approaches a free-flowing condition.
2. Continue drying and test at frequent intervals with the Cone Test until the sample has reached a saturated surface dry condition.

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3. Remove approx. 100 grams of the SSD sample and place into a tared moisture pan. Record the combined weight to the nearest 0.1 gram. Place the sample in an oven at 110 +/- 5 C. Remove the sample from the oven periodically and check its weight to the nearest 0.1 g. Continue drying and weighing until the aggregate has reached a constant weight, signified by two consecutive weight readings, separated by at least 10 minutes, giving identical weights.
5. Fill the volumetric flask to the calibration mark with distilled water. Dry all exterior and interior surfaces. Weigh to the nearest 0.1 g and record the water temperature to the nearest 0.1 °C.
6. Partially fill the volumetric flask with water and record the weight to the nearest 0.1g. Add approximately 100g of the SSD fine aggregate and determine the combined weight to the nearest 0.1g. Fill with additional water to approximately 90% of capacity. Eliminate air bubbles by rolling and agitating the flask while under a vacuum.
7. Adjust the water level to the calibration mark. Dry all exterior and interior surfaces. Weigh to the nearest 0.1 g and record the water temperature to the nearest 0.1 °C.

#### **Part C – Dry Rodded Unit Weight of Coarse Aggregate**

1. Weight the empty mold to the nearest 0.1 lb. Fill the mold with coarse aggregate one-third full and level the surface with the fingers. Rod the layer with 25 strokes of the tamping rod evenly distributed over the surface, but do not allow the rod to strike the bottom of the mold forcibly.
2. Fill the mold two-thirds full and again level and rod as above, but use no more force than is necessary to penetrate the previous layer of aggregate. Finally, fill the mold to overflowing and rod again manner previously mentioned. Level the surface of the mold with the fingers or a steel 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 mold.
3. Determine the weight of the mold filled with rodded aggregate to the nearest 0.1 lb.

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##### **Part D – Mixing and Casting of PCC Cylinders**

1. Place one bag of concrete mix into the mixing pan. Add additional cementitious materials as directed by the lab instructor. Thoroughly dry mix until the coarse aggregates are uniformly distributed throughout the batch.
2. Add sufficient water and mix the mass until the concrete is homogeneous in appearance. Record the total amount of water added to the batch.
3. Place the fresh concrete in each mold using a scoop, blunted trowel, or shovel. Select each measure of concrete from the mixing pan to ensure that it is representative of the batch. It may be necessary to remix the concrete in the mixing pan to prevent segregation during the molding of the specimens. Move the scoop, shovel, or trowel around the top edge of the mold as the concrete is discharged in order to ensure a symmetrical distribution of the concrete and to minimize segregation of the coarse aggregate.
4. Fill the molds in three equal layers. Further distribute the concrete with a tamping rod prior to the start of consolidation. Rod each layer with the rounded end of the rod using 25 strokes per layer. Distribute the strokes uniformly over the cross section of the mold. Rod the bottom layer throughout its depth. For the two upper layers, allow the rod to penetrate about 1/2 inch into the layer below. In placing the final layer, attempt to add an amount of concrete that will exactly fill the mold after consolidation. After each layer is rodded, tap the outsides of the mold lightly 10 to 15 times with an open hand to close any holes left by the rodding and to release any large air bubbles that may have been trapped.
5. After consolidation of the final layer, strike off the top surface of the concrete and float or trowel the surface with the minimum manipulation necessary to produce a flat even surface that is level with the rim of the molds.
6. Weigh the filled molds, cover, and place in the environmental chamber to cure for 24 hours. After 24 hours, the concrete cylinders will be removed from the molds and placed in a saturated lime-water bath until testing. Measure the compressive strength of the concrete after 7 and 28 days of curing.

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**Report:**

**Parts A & B - Specific Gravity & Absorption of PCC Aggregates**

1. Determine the absorption capacity (AC %) for each aggregate type.
2. Determine the Apparent Specific Gravity, Bulk Specific Gravity and Bulk Specific Gravity SSD for each aggregate type.

**Part C - Bulk Unit Weight of Coarse Aggregate**

1. Determine the dry rodded unit weight for the coarse aggregate.

**Part C - Bulk Unit Weight of Coarse Aggregate**

1. Determine the water/cementitious materials (W/CM) ratio, cementitious factor (CF), yield (Y) and estimated cost (\$/CY) for each concrete mix type.

$W/CM = \text{Weight of Water} / (\text{Weight of Cement} + \text{Fly Ash})$  - No Units

$CF = 1/94 * (\text{Weight of Cement} + \text{Fly Ash}) / (\text{Yd}^3 \text{ of PCC})$  - Units = Sacks/Yd<sup>3</sup>

$Y = (\text{Ft}^3 \text{ of PCC}) / [1/94 * (\text{Weight of Cement} + \text{Fly Ash})]$  - Units = Ft<sup>3</sup>/Sack

2. Prepare a plot of average 7-day and 28-day compressive strength versus W/CM for all mix types. Comment on the trend(s) noted.

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**PART A – Specific Gravity and Absorption of Coarse Aggregate**

Wt of Moisture Tin, g	
Wt of Tin + SSD aggregate, g	
Wt of Tin + OD Aggregate, g	
Wt of SSD Aggregate in Air, g	
Wt of Submerged Aggregate, g	

**PART B – Specific Gravity and Absorption of Fine Aggregate**

Wt of Moisture Tin, g	
Wt of Tin + SSD aggregate, g	
Wt of Tin + OD Aggregate, g	
Wt of Filled Flask, g	
Water Temperature, C	
Wt of Partially Filled Flask, g	
Wt of Partially Filled Flask + SSD Aggregate, g	
Wt of Filled Flask + SSD Aggregate, g	
Water Temperature, C	

**PART C – Dry Rodded Unit Weight of Coarse Aggregate**

Wt of Mold, lb	
Wt of Mold + Dry Aggregate, lb	

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**PART D – Mixing and Casting of PCC Cylinders**

<b>Team</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
Mix Type	<b>OPC</b>	<b>Rich</b>	<b>FA</b>	<b>HRWR</b>
Wt of Mixing Pan, lb				
Wt of Dry Mix, lb				
Wt of Cement, lb (18%)				
Wt of Additional Cement, lb	0	5	0	0
Wt of Fly Ash, lb	0	0	5	0
Initial Mixing Water Weight, lb				
Final Mixing Water Weight, lb				
Wt of Filled 4x8 Mold, lb				
Wt of Pan + Excess PCC, lb				
7-Day Compressive Load, lb				
28-Day Compressive Load, lb				