

Absorption and Specific Gravity

Specific Gravity

- * Definition
 - * Ratio of the mass of a substance relative to the mass of an equal volume of water at a specified temperature.
 - * The density of water is 62.4 lb/ft³.

Specific Gravity

- * Relative density
 - * How much heavier is an aggregate particle compared to an equal volume of water?

specific gravity = $\frac{\text{WEIGHT OF ROCK}}{\text{WT. OF AN EQUAL VOL. OF WATER}}$

example: $\frac{270 \text{ GM (WEIGHT OF ROCK)}}{100 \text{ GM (WT. OF AN EQUAL VOL. OF WATER)}} = 2.70 = \text{SG}$

Aggregate Specific Gravity

Common Values

- * Granite : SG = 2.65
- * Marine Limestone : SG = 2.53
- * Gneiss : SG = 2.74

Specific Gravity of Other Materials

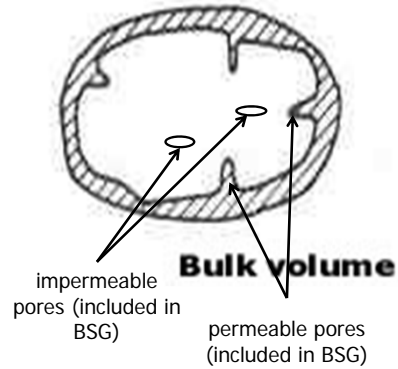
- * Water : $SG = 1$
- * Steel : $SG = 7.9$
- * Wood : $SG = 0.3-0.6$
- * Concrete : $SG = 2.4$
- * Aluminum : $SG = 2.6$

Specific Gravity

- * Bulk
- * Bulk, saturated surface dry (SSD)
- * Apparent
- * Effective

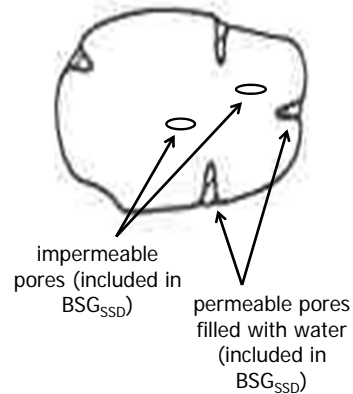
Bulk Dry Specific Gravity

- * Aggregate has tiny pores: permeable or impermeable to water.
- * Bulk dry specific gravity includes the volume of both permeable and impermeable pores.
- * 'Real' specific gravity



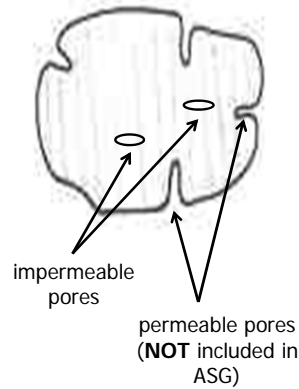
Bulk SSD Specific Gravity

- * Saturated Surface Dry (SSD)
- * Assumes all permeable pores filled with water (saturated)
- * Particles appear moist but not shiny (surface dry)



Apparent Specific Gravity

- * Apparent specific gravity includes only the volume of impermeable pores.

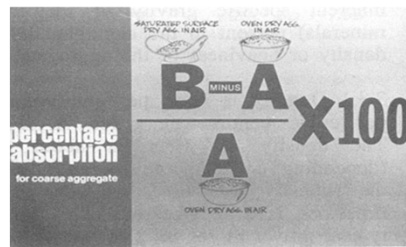


Effective Specific Gravity

- * Only a portion of the water-permeable pores are filled with asphalt cement.
- * Effective specific gravity includes the pores not accessible to asphalt.

Absorption

- * Definition
- * The penetration of a liquid into aggregate particles with resulting increase in particle weight



Absorption

- * Aggregates are like sponges
- * Amount of water absorbed into pores of aggregate particles
- * Expressed as percentage of water to dry weight



Absorption Common Values

- * Less than 2%
 - * If dry aggregate weighs 1 pound, water in pores weighs 0.02 pounds
- * Granite = 0.3%
- * Limestone = 0.9%
- * Sandstone = 1.8%

Specific Gravity and Absorption Tests

- * Specifications
 - * ASTM C127 for Coarse Aggregates
 - * ASTM C128 for Fine Aggregates
 - * AASHTO T85 for Coarse Aggregates
 - * AASHTO T84 for Fine Aggregates

Specific Gravity Significance and Use

- * Bulk specific gravity is generally used for the calculation of the volume occupied by the aggregate in various mixtures including Portland cement concrete and asphalt concrete.
- * Bulk SSD specific gravity is used if the aggregate is wet.

Absorption Significance and Use

- * Absorption values are used to calculate the change in the weight of aggregate due to water absorbed in the pore spaces.
- * They are also used to calculate the amount of water that is absorbed by aggregates during Portland concrete mix preparation.

Specific Gravity and Absorption Significance and Use

Material Use	Specification
Used in Double Treatment (w/o adjustments)	2.65 Apparent
Combined aggregate in asphalt concrete	2.90 Max (ESG)
HMA Interstate/Primary Surface and Intermediate Courses, and Thin Lift Seal Course	1.5% Max (Absorption)

Specific Gravity and Absorption Testing Frequencies

Test	Procedure	Materials	Value Range ⁽¹⁾	Min. Testing Frequency
Specific Gravity (Bulk, Bulk (SSD), Apparent) & % Absorption	AASHTO T85	Stone (non-slag)	2.85 & above (apparent)	1 weekly
			Less than 2.85 (apparent)	1 every 3 months
		Slag	2.00 & less (apparent)	1 weekly
			2.10 – 2.84 (apparent)	1 every 3 months
			2.85 & above (apparent)	1 weekly

⁽¹⁾This range will be determined for each source by the Geotechnical Materials Engineer based on the most recent individual test results from the supplier

Specific Gravity and Absorption Apparatus

- * Scale accurate to 0.05% of the sample weight or 0.5 grams, whichever is greater
- * Wire basket No. 6 or finer mesh
- * Water tank
- * No. 4 sieve or other sizes as needed

Specific Gravity and Absorption Test Specimen

- * Thoroughly mix the aggregate sample and reduce it to the approximate quantity needed using an aggregate sample splitter or by quartering.
- * Reject all materials passing No.4 sieve by dry sieving and thoroughly washing to remove dust or other coatings from the surface.
- * The minimum weight of test specimen to be used depends on the nominal maximum size as follows:

Nominal Max Size (in.)	Min Mass, lb
½	4.4
¾	6.6
1	8.8
1 ½	11.0

Specific Gravity and Absorption Test Procedure

1. Dry the test sample to a constant weight at a temperature of 230 ± 9 °F, cool in air at room temperature for 1 to 3h. Immerse the aggregate in water at room temperature for a period of 15 to 19 hours.
2. Remove the test specimen from water and roll it in a large absorbent cloth until all visible films of water are removed. Wipe the larger particles individually.

Specific Gravity and Absorption Test Procedure

3. Weigh the test sample in saturated-surface dry (SSD) condition and record it as B. Record the weight and all subsequent weights to the nearest 0.5 grams or 0.05% of the sample weight, whichever is greater.

Specific Gravity and Absorption Test Procedure

4. Place the specimen in the wire basket and determine its weight while it is submerged in water at a temperature of $73.4 \pm 3^\circ\text{F}$ and record it as C. Take care to remove all entrapped air before weighing it by agitating the container while it is immersed.
5. Dry the test sample to a constant mass at a temperature of $230 \pm 9^\circ\text{F}$, cool in air at room temperature 1 to 3h, and weigh it and record this weight as A.

Specific Gravity and Absorption Test Calculations

Name	Equation
Bulk Specific Gravity	$\frac{A}{(B - C)}$
Bulk Specific Gravity, SSD	$\frac{B}{(B - C)}$
Apparent Specific Gravity	$\frac{A}{(A - C)}$
Absorption	$\frac{(B - A)}{A} \times 100\%$

Specific Gravity and Absorption

Common Errors

- * Improper identification of SSD(over or under-drying)
- * Air entrapped in suspended sample or sample immersion container
- * Suspension apparatus in contact with another object, resulting in false reading
- * Loss of material during transfer to the drying pans
- * Weighing errors (improper tare weights or loss of material)