Relative Density and Absorption

Important Properties

Gradation

Relative density and absorption

Hardness (resistance to wear)

Durability (resistance to weathering)

Shape and surface texture

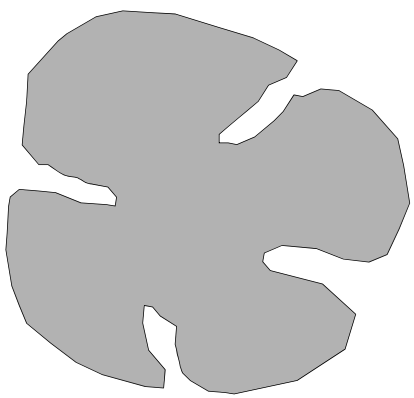
Deleterious substances

Crushing strength

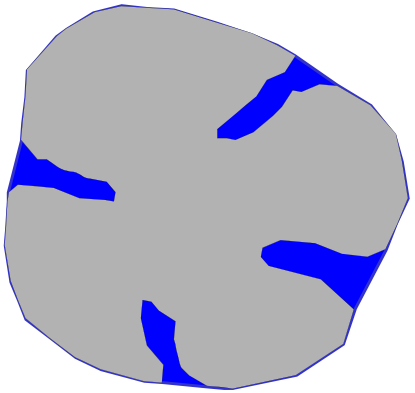
Soft and lightweight particles

Chemical stability

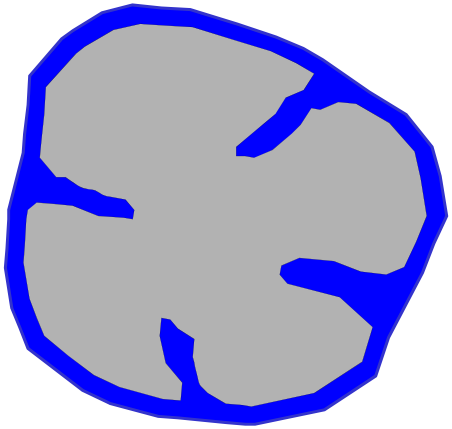
Absorption



Dry

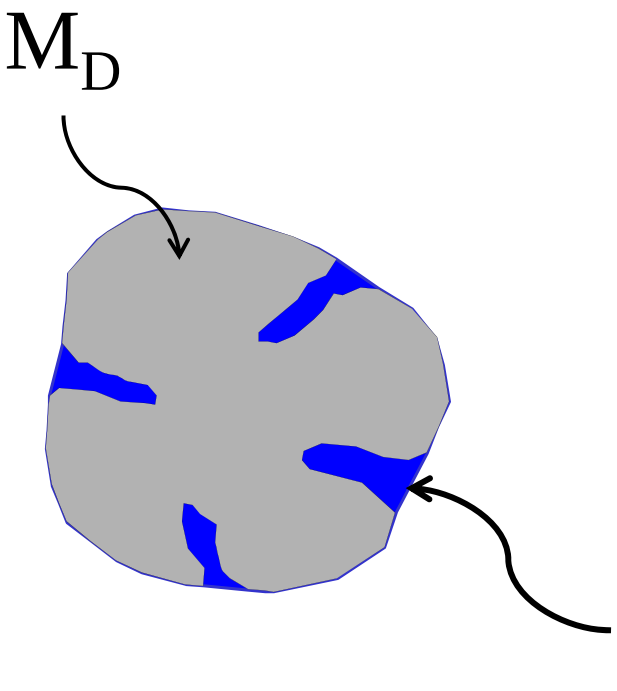


SSD



Wet

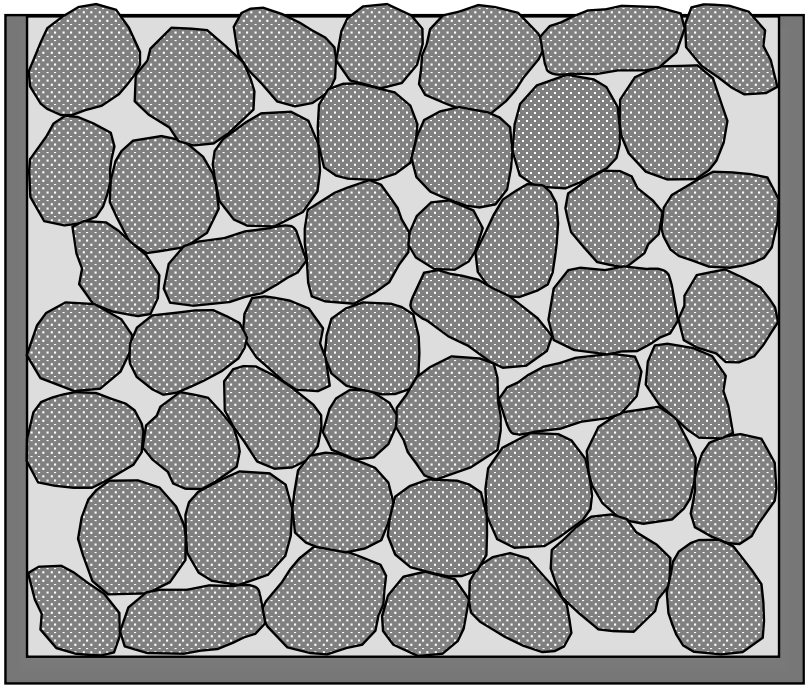
Absorption



$$\% \text{ Abs} = \frac{M_{AW}}{M_D} \times 100\%$$

Question

A 1-ft^3 bucket holds 100 lb. of aggregate. How much volume is occupied by the air and how much by the aggregate particles?



Particle Density

Particle density is the ratio of the mass of an aggregate particle to its own volume (also called mass density of solids).

$$\rho = \frac{M}{V}\left(\frac{kg}{m^3} \text{ or } \frac{g}{cm^3}\right)$$

Particle Density

Particle density can also be expressed as the ratio of the weight of an aggregate particle to its own volume.

$$\gamma = \frac{W}{V}\left(\frac{lb}{ft^3}\right)$$

Relative Density

Relative density is the mass density of an object relative to the mass density of water (also called specific gravity).

$$RD = \frac{\rho}{\rho_w} = \frac{M/V}{\rho_w} = \frac{M}{V \times \rho_w}$$

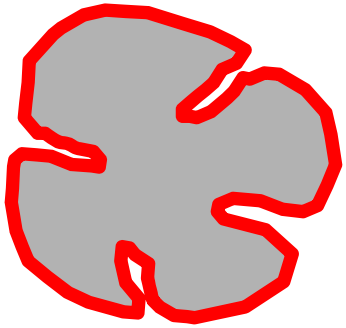
Relative Density

Relative density (specific gravity) can also be expressed in weight-based units.

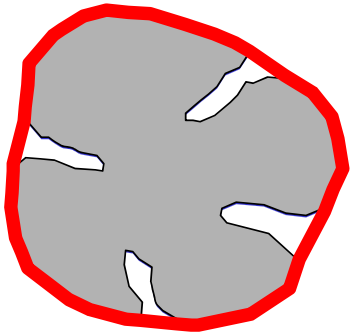
$$RD = \frac{\gamma}{\gamma_w} = \frac{W/V}{\gamma_w} = \frac{W}{V \times \gamma_w}$$

Relative Density

Relative density depends on the volume you assume for the aggregate particles.



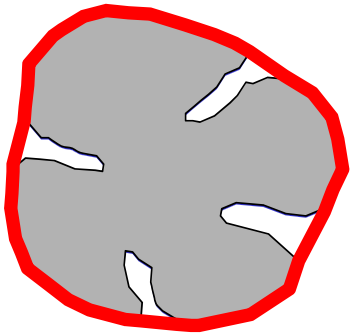
Net
Volume



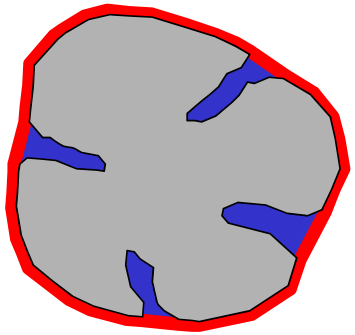
Bulk
Volume

Relative Density

It also depends on the mass you assume for the aggregate particles.



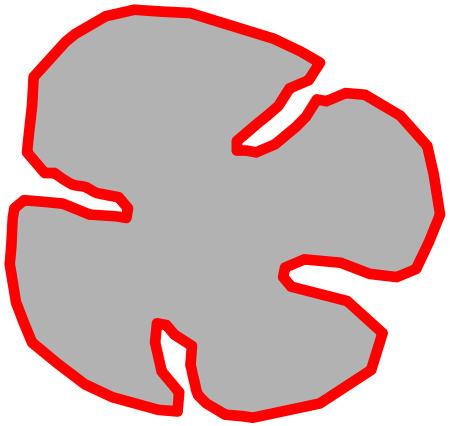
Dry
Mass



SSD
Mass

Apparent Relative Density

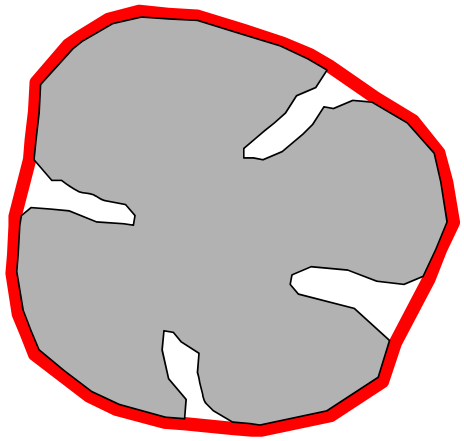
$$RD_A = \frac{M_D}{V_N \times \rho_w}$$



Net volume

Bulk (OD) Relative Density

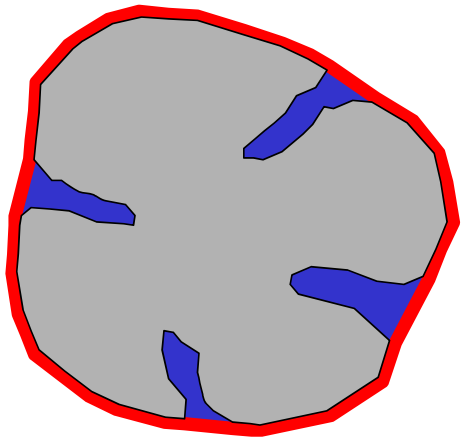
$$RD_B = \frac{M_D}{V_B \times \rho_w}$$



Bulk volume

SSD Relative Density

$$RD_{SSD} = \frac{M_{SSD}}{V_B \times \rho_w}$$



SSD aggregate

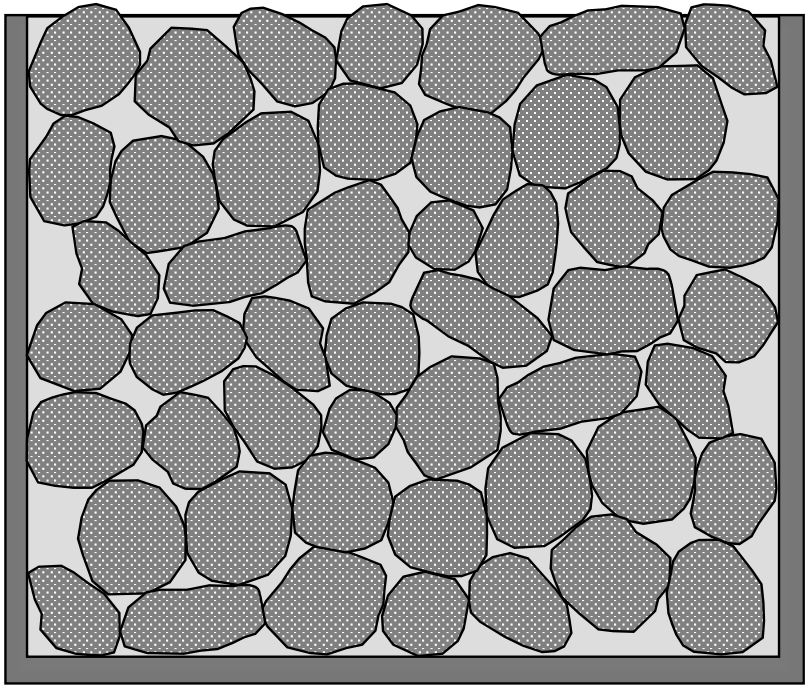
Example

An aggregate sample has an oven-dry mass of 3954.2 g, an SSD mass of 4006.8 g, and a net volume of 1532.6 cm^3.

Find RD_A, RD_B, RD_{SSD}, and %Abs

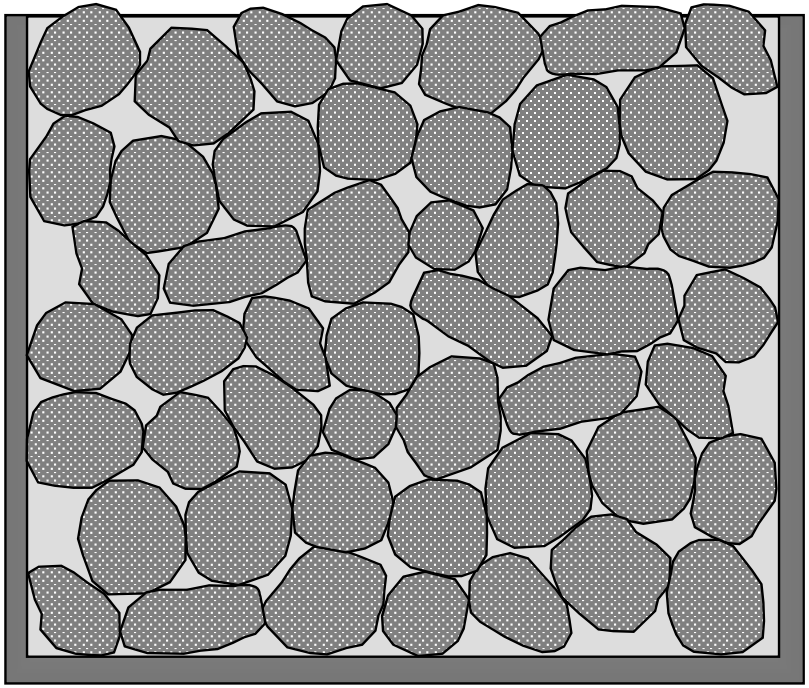
Question

A 1-ft^3 bucket holds 100 lb of aggregate from the last example. How much volume is occupied by the air and how much by the aggregate particles?



Question

A 1-m^3 bucket holds 1500 kg of aggregate from the last example. How much volume is occupied by the air and how much by the aggregate particles?



Measuring Relative Density

Lab 4.8-2

Designation: C 127 – 04

Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate[1]

This standard is issued under the fixed designation C 127; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope*

1.1 This test method covers the determination of the average density of a quantity of coarse aggregate particles (not including the volume of voids between the particles), the relative density (specific gravity), and the absorption of the coarse aggregate. Depending on the procedure used, the density (kg/m^3 (lb/ft^3)) is expressed as oven-dry (OD), saturated-surface-dry (SSD), or as apparent density. Likewise, relative density (specific gravity), a dimensionless quantity, is ex-

priate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

C 29/C 29M Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate

C 125 Terminology Relating to Concrete and Concrete Aggregates

C 128 Test Method for Density, Relative Density (Specific

Measuring Relative Density

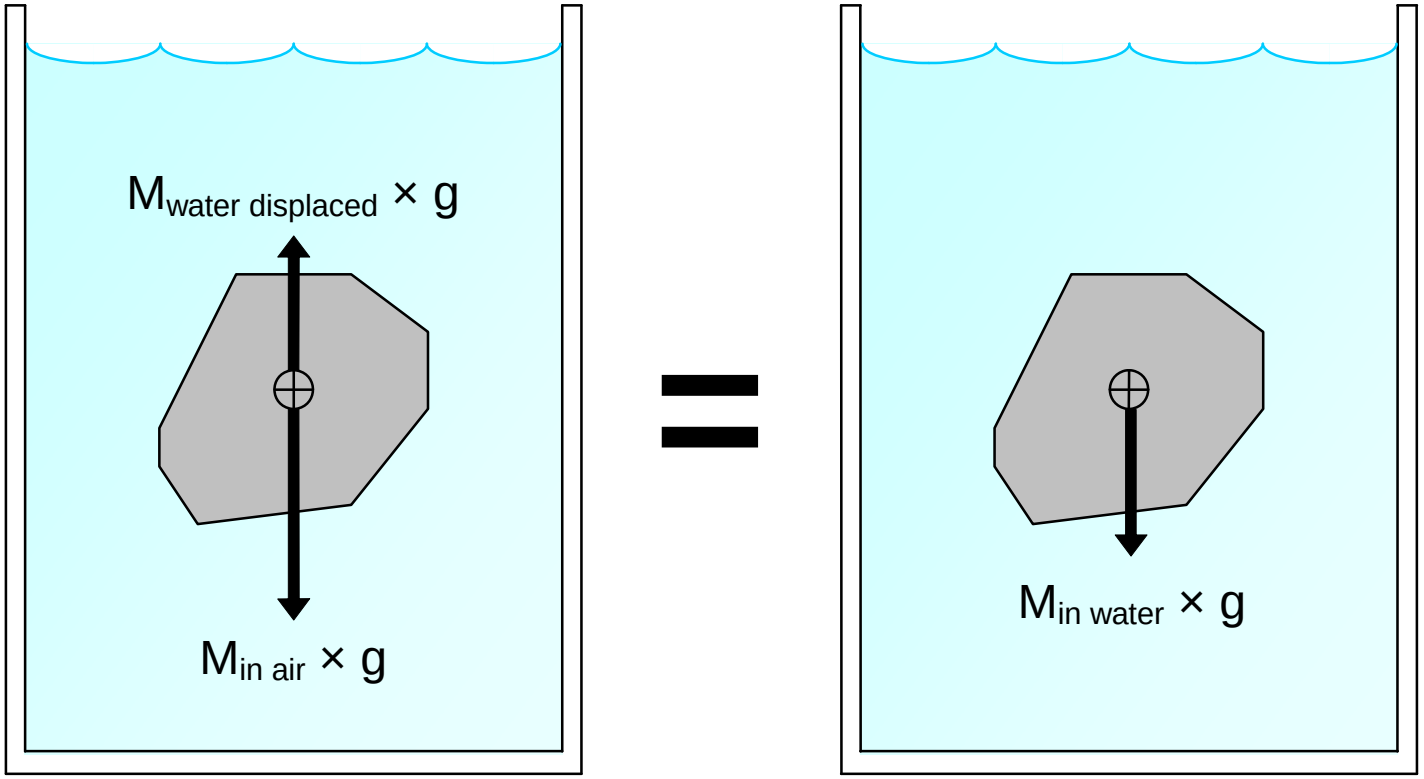
$$RD = \frac{M}{V \times \rho_w}$$

mass of water displaced

Measuring Relative Density

$$RD = \frac{M_{aggregate}}{M_{water\ displaced}}$$

Buoyancy

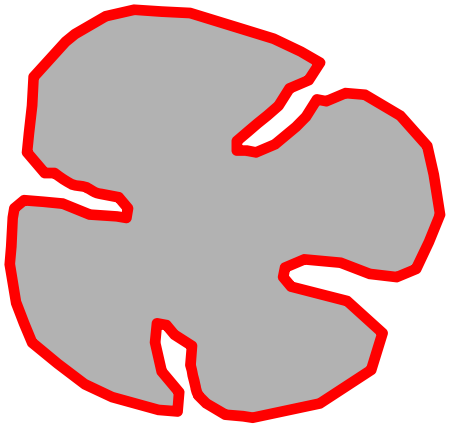


Measuring Relative Density

$$M_{\text{water displaced}} = M_{\text{in air}} - M_{\text{in water}}$$

Apparent Relative Density

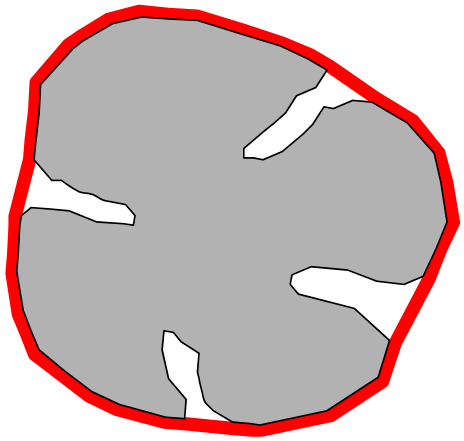
$$RD_A = \frac{M^{OD}_{\text{in air}}}{M^{OD}_{\text{in air}} - M_{\text{in water}}}$$



Net volume

Bulk (OD) Relative Density

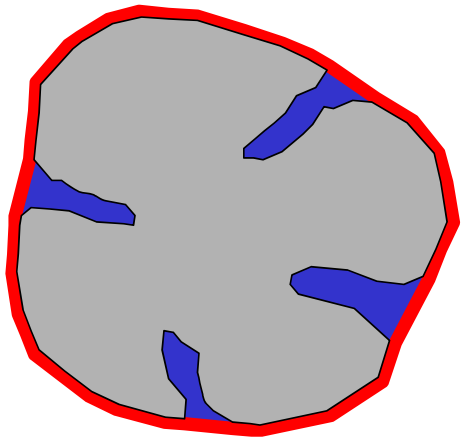
$$RD_B = \frac{M^{OD}_{\text{in air}}}{M^{SSD}_{\text{in air}} - M_{\text{in water}}}$$



Bulk volume

SSD Relative Density

$$RD_{SSD} = \frac{M_{\text{in air}}^{SSD}}{M_{\text{in air}}^{SSD} - M_{\text{in water}}}$$



Bulk volume

Measuring Relative Density

Lab 4.8-3

Designation: C 128 – 04a

Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate[1]

This standard is issued under the fixed designation C 128; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope*

1.1 This test method covers the determination of the average density of a quantity of fine aggregate particles (not including the volume of voids between the particles), the relative density (specific gravity), and the absorption of the fine aggregate. Depending on the procedure used, the density, in kg/m^3(lb/ft^3) is expressed as oven-dry (OD), saturated-surface-dry (SSD), or as apparent density. Likewise, relative density (specific gravity), a dimensionless quality, is expressed as OD, SSD, or as

priate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. Referenced Documents

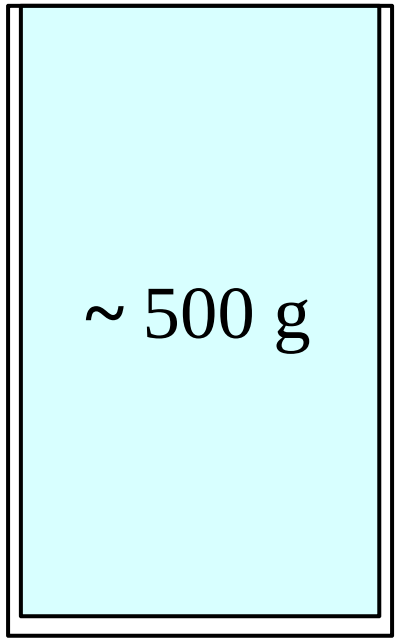
2.1 *ASTM Standards:* [2]

C 29/C 29M Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate

C 70 Test Method for Surface Moisture in Fine Aggregate

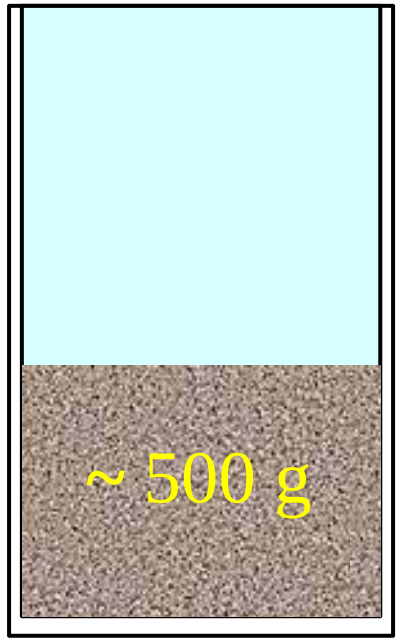
C 125 Terminology Relating to Concrete and Concrete

Measuring Relative Density



M_{water}

M_{sand}



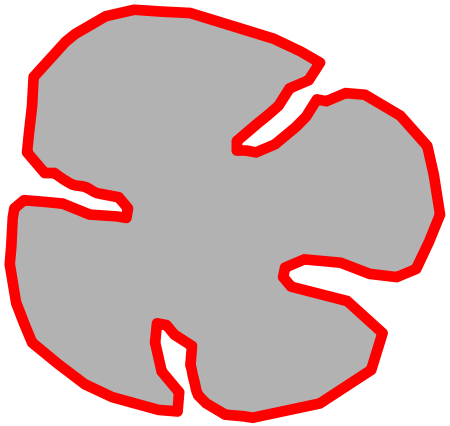
M_{blend}

Measuring Relative Density

$$M_{\text{water displaced}} = M_{\text{water}} + M_{\text{sand}} - M_{\text{blend}}$$

Apparent Relative Density

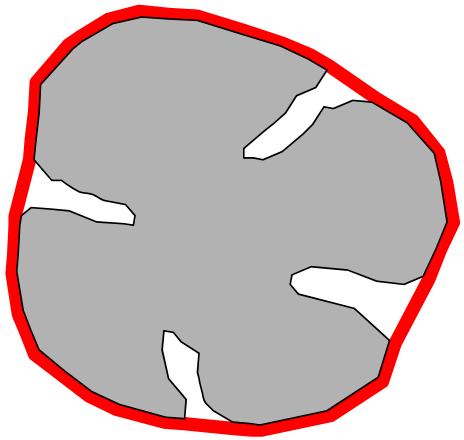
$$RD_A = \frac{M_{sand}^{OD}}{M_{water} + M_{sand}^{OD} - M_{blend}}$$



Net volume

Bulk (OD) Relative Density

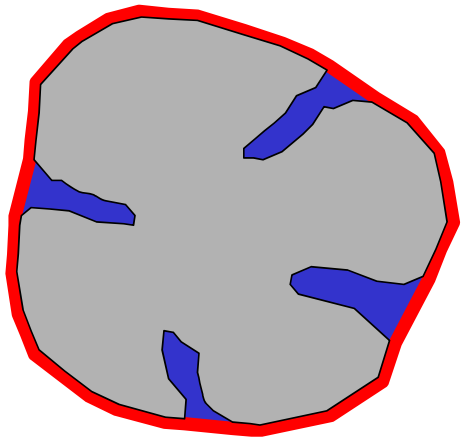
$$RD_B = \frac{M_{sand}^{OD}}{M_{water} + M_{sand}^{SSD} - M_{blend}}$$



Bulk volume

SSD Relative Density

$$RD_{SSD} = \frac{M_{sand}^{SSD}}{M_{water} + M_{sand}^{SSD} - M_{blend}}$$



Bulk volume

Achieving an SSD State

Coarse aggregate should be soaked in room temperature water for 24±4 h then rolled in a large absorbent cloth to remove all visible surface moisture.

Achieving an SSD State

Fine aggregate should be brought to a moisture content of at least 6% and allowed to stand for 24±4 h. Aggregate is then spread out on a nonabsorbent surface and air is blown across it until it attains a free flowing condition.

Achieving an SSD State