CE 331

Lab 5
Particle Size and Density

Objective

- Quantify some aggregates properties such as:
  - different types of density/specific gravity (DRUW, bulk specific gravity,SSD specific gravity and apparent specific gravity)
  - Percent of Absorption (ABS)

- Understanding the concept of packing of the aggregates and quantifying the particle size distribution and fineness modulus

Dry Rodded Unit Weight

The procedure:

-Calibrate the volume of bucket

-Take the mass of the bucket empty

-Fill the bucket with a sample of the ½ to ¾ inch size gravel (3 layers, 25 times)

-Take the mass of the full bucket

-Determine the DRUW

Temperature		kg/m³	lb/ft³
°C	°F		
15.6	60	999.01	62.366
18.3	65	998.54	62.336
21.1	70	997.97	62.301
23.0	73.4	997.54	62.274
23.9	75	997.32	62.261
26.7	80	996.59	62.216
29.4	85	995.83	62.166

Glass plate

Bucket

Tamping rod

Straight edge

Thermometer

ASTM C29

Dry Rodded Unit Weight

- $DRUW = \frac{(G-T)}{V}$
- G: Mass of aggregate, container, glass plate
- T: Mass of empty container, glass plate
- V: Volume of container
  - $V = \frac{G_{water}-T}{\rho_{water}}$

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Bulk, SSD, Apparent Specific Gravity and ABS

The procedure:

- Measure weights

Buoyant Mass

Oven Dry Mass

Saturated Surface Dry Mass

Bulk, SSD, Apparent Specific Gravity and ABS

Dry Rodded Unit Weigth Specific Gravity [-]
includes inter-particle pore space

$$G_{DRUW} = \frac{DRUW}{\rho_w}$$

Bulk Specific Gravity [-]

Excludes inter-particle pore space

Allows you to determine the volume occupied by the only dry particles if you know their mass, or viceversa

$$G_{sb} = \frac{M_{OD}}{M_{SSD} - M_{inW}}$$

Bulk SSD Specific Gravity [-]

Includes the mass of the intra-particle pore water

Useful when dealing with aggregate that has water in its pores

$$G_{SSD} = \frac{M_{SSD}}{M_{SSD} - M_{inW}}$$

Bulk, SSD, Apparent Specific Gravity and ABS

Apparent Specific Gravity [-]

Excludes all pore space

Approximates the true specific gravity of the material

$$G_{sa} = \frac{M_{OD}}{M_{OD} - M_{inW}}$$

Percentage Absorption [%]

It is an approximate measure of the intra-particle porosity

$$ABS = \frac{M_{SSD} - M_{OD}}{M_{OD}} \cdot 100$$

$$G_{SA} > G_{SSD} > G_{SB}$$

Particle Size Distribution and Fineness Modulus

Fineness Modulus [%]

The larger, the more coarse the aggregate

Typical fineness modulus for fine aggregates is between 2.7 and 3.0

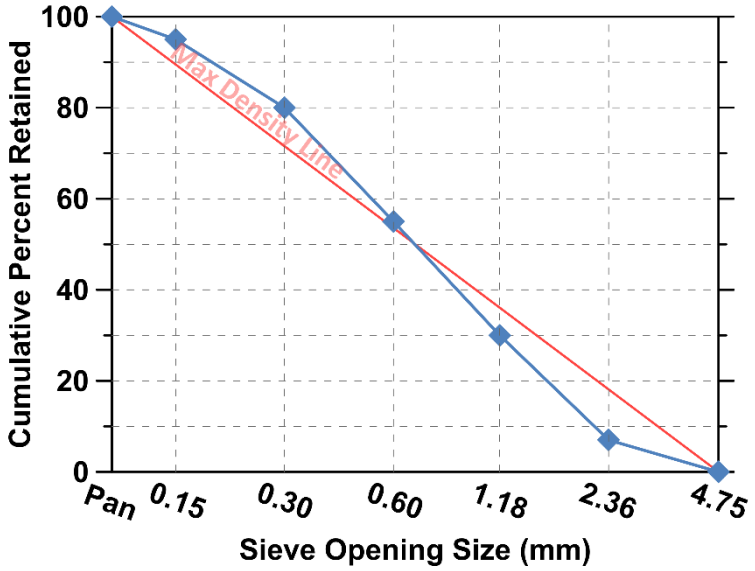
$$FM = \frac{\sum cumulative\ \%\ retained\ *}{100}$$

* On sieve sizes 0.15, 0.3, 0.6, 1.18, 2.36, 4.75 mm

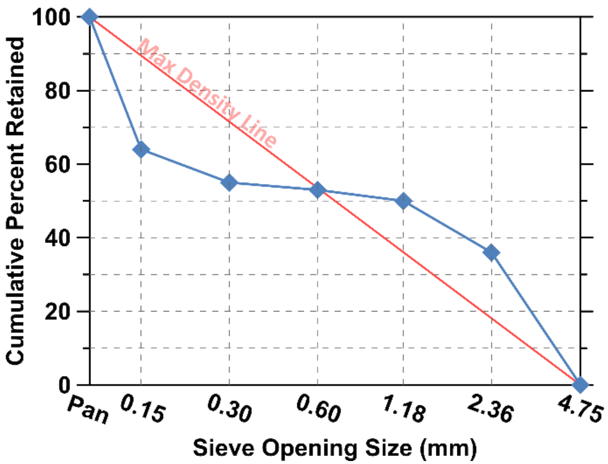
Particle Size Distribution

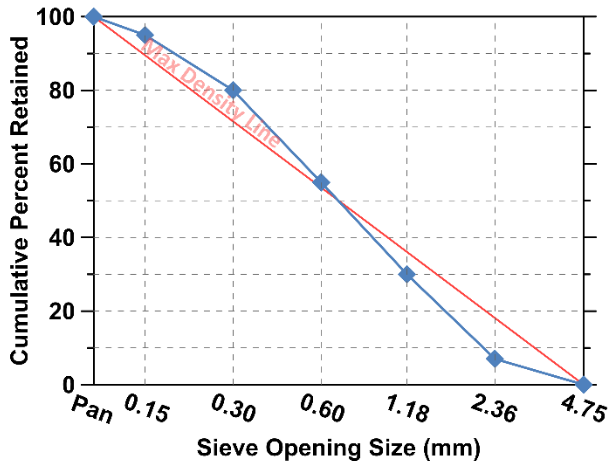
Well/Gap/Uniformly Graded

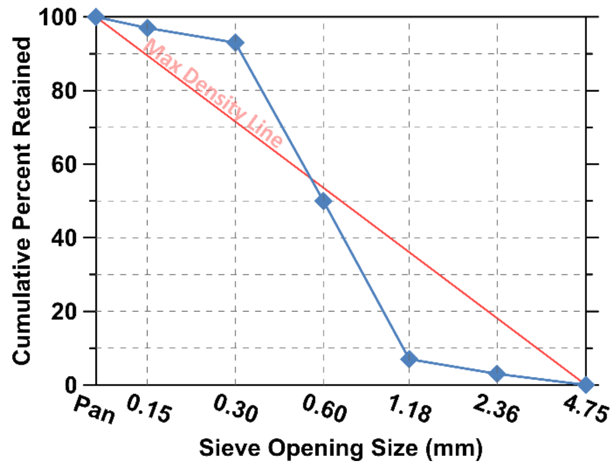
Max Density $P = \left(\frac{d}{D}\right)^{0.45}$

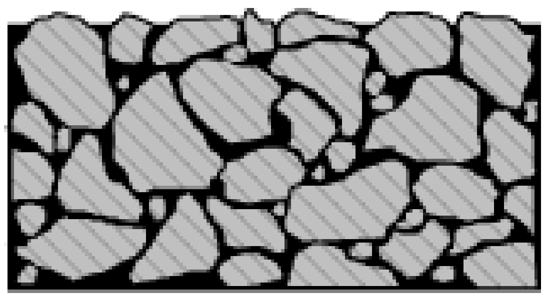


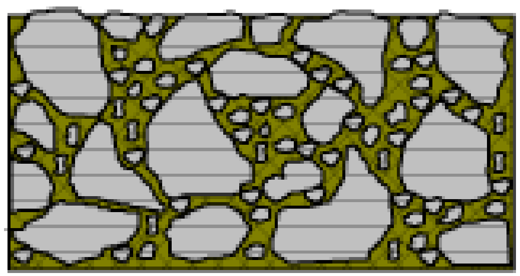
Particle Size Distribution and Fineness Modulus

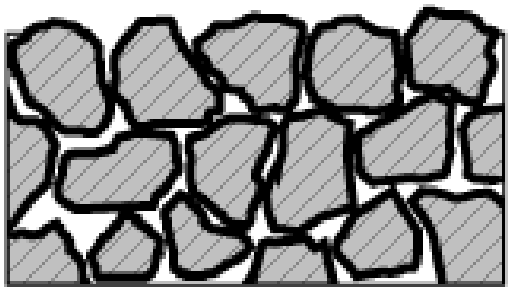












GAP-GRADED

WELL GRADED

UNIFORMLY-GRADED

CE 331 : Aggregates Lab

Name	Date	Session

Data Collection

DRUW	Bucket + Glass Plate [g]	
	Bucket + Glass Plate + Water [g]	
	Bucket + Glass Plate + Aggr [g]	
	Water Temperature [° C]	
	Aggregates [g]	

G and ABS	Dry Aggregate (M_{OD}) [g]	
	Saturated, Surface Dry Aggr (M_{SSD}) [g]	
	Buoyant Aggregate (M_{inW}) [g]	
	Water Absorbed (ABS %)	

Particle Size Distribution - FM					
Sieve Size [mm]	Mass of Sieve [g]	Mass of Sieve + Aggregate [g]	Mass of Aggregate [g]	Mass Retained [%]	Cumulative Retained [%]
4.75					
2.36					
1.18					
0.6					
0.3					
0.15					
Pan					

Sum:

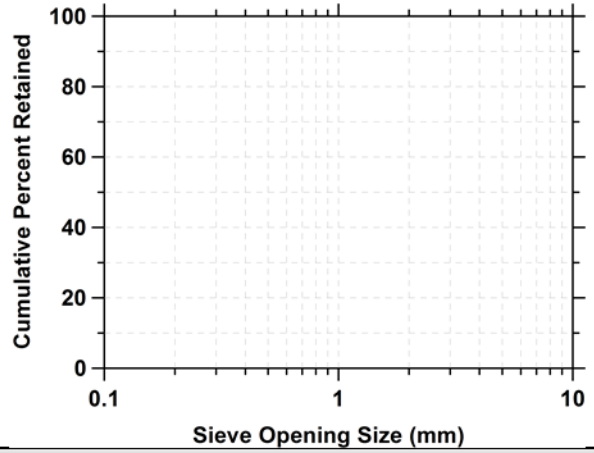
Results

	Unit	Value
DRUW		
G_{DRUW}		
G_{SB}		
G_{SSD}		
G_{SA}		
ABS		

	Unit	Value
Fineness Modulus		

Type of PSD	

Plot Cumulative Retained vs Sieve Size



Main steps of Hand Calculation