

CE-201

Engineering Materials

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MIST

AGGREGATE

Accumulation of non-metallic minerals available in particulate form and that can be processed and used in CE construction.

Types

- **Natural:** Different sorts of rocks
- **Artificial:**
 - Crushed brick
 - Crushed slag
 - Pulverized fuel ash (PFA)
 - Synthetic aggregate
 - Calcined bauxite

Properties of Good Aggregate

- + Should not contain deleterious material**
- + Should be strong and dense**
- + Should be hard and tough**
- + Should be durable**
- + Shape should be angular**
- + Surface should be rough**
- + Should have smaller porosity and absorption**
- + Should be clean and pure**
- + Should be well graded**

Test

- Angularity number test
- Bulking of sand test
- Clay lump and friable particle test
- Sieve analysis (CA)
- Sieve analysis (FA)
- Wash sieve analysis
- Soundness test
- Unit weight of aggregate
- Void ratio test

SAND

- ◎ A form of silica of small grains.
- ◎ Formed by the decomposition of sandstone due to various weathering effects.
- ◎ Mostly obtained from pits, shores, river beds and sea beds.
- ◎ F.A. contains 35-45% vol. of total aggregate.

Sources of Sand

- Pit sand
- River sand
- Sea sand

Pit Sand

- Obtained by forming pits into the soil
- Sharp, angular, porous and free from harmful salts.
- Clay and other impurities should be washed and screened before using it.
- Fine pit sand when rubbed between finger should not leave any strain on it.
- Used for mortars.

River Sand

- ▶ Found at river beds and banks.
- ▶ Fine, rounded and polished due rubbing action of water currents.
- ▶ Having less frictional strength because of roundness.
- ▶ Almost white in color.
- ▶ Grains are smaller than pit sand hence more suitable for plastering work.
- ▶ Normally available in pure condition and can be used in all kinds of CE works.

Sea Sand

- Obtained from sea shores.
- Fine, rounded and polished due to rubbing action of water .
- Light brown in color.
- Worst of the three types of sand because of containing lots of salts.

Sea Sand

- Salts absorb moisture from atmosphere and cause permanent dampness and efflorescence in the structure.
- Besides it contains shells and organic matter which decompose in the body of mortar and concrete and reduce their life and strength.
- Sea sand should as far as possible be discarded.

Sieve Analysis

Grading of Aggregate

Grading is the particle-size distribution of an aggregate as determined by a sieve analysis using wire mesh sieves with square opening.

Grading of Aggregate



Fig. Showing aggregates of different particle sizes

Fineness Modulus

- Fineness Modulus (FM) is an index which gives an idea about the fineness or coarseness of aggregate
- $(FM) = (\Sigma \text{ Cumulative \% retained on all the standard US sieve}) / 100$
- US standard sieves are 1.5in, 3/4 in, 3/8 in, #4 (4.75mm), #8 (2.36 mm), #16 (1.18mm), #30 (0.6mm), #50 (0.30mm), and #100 (0.15 mm)

Classification of Sand based on Fineness Modulus

- Fine sand: $FM=2.20 \sim 2.60;$
- Medium sand: $FM=2.60 \sim 2.90;$
- Coarse sand: $FM=2.90 \sim 3.20;$

Classification of Aggregate

➤ **Coarse aggregate:** aggregate retained on 4.75mm (#4) sieve

➤ **Fine aggregate:** aggregates passing through 4.75mm (#4) sieve and retained on 0.15 mm sieve

➤ **Silt and clay:** aggregate passing through 0.75 mm sieve.

Fineness Modulus Determination

Classify sand based on fineness. A sample of 200 gm of sand was sieved through standard sieves and the following results were obtained:

Sieve No	Sieve Opening (mm)	Weight retained in gm
4	4.75	0
8	2.36	0
16	1.19	10
30	0.59	30
50	0.30	100
100	0.15	60

(FM)= (Σ Cumulative % retained on all the standard US sieve)/100

sieve	Size (mm)	Materials retained in (gm)	% M.R	Cumulative %M.R.	%finer
1.5in		0			
¾ in		0			
3/8 in		0			
#4	4.75	0			
#8	2.36	0			
#16	1.18	10			
#30	0.60	30			
#50	0.30	100			
#100	0.15	60			

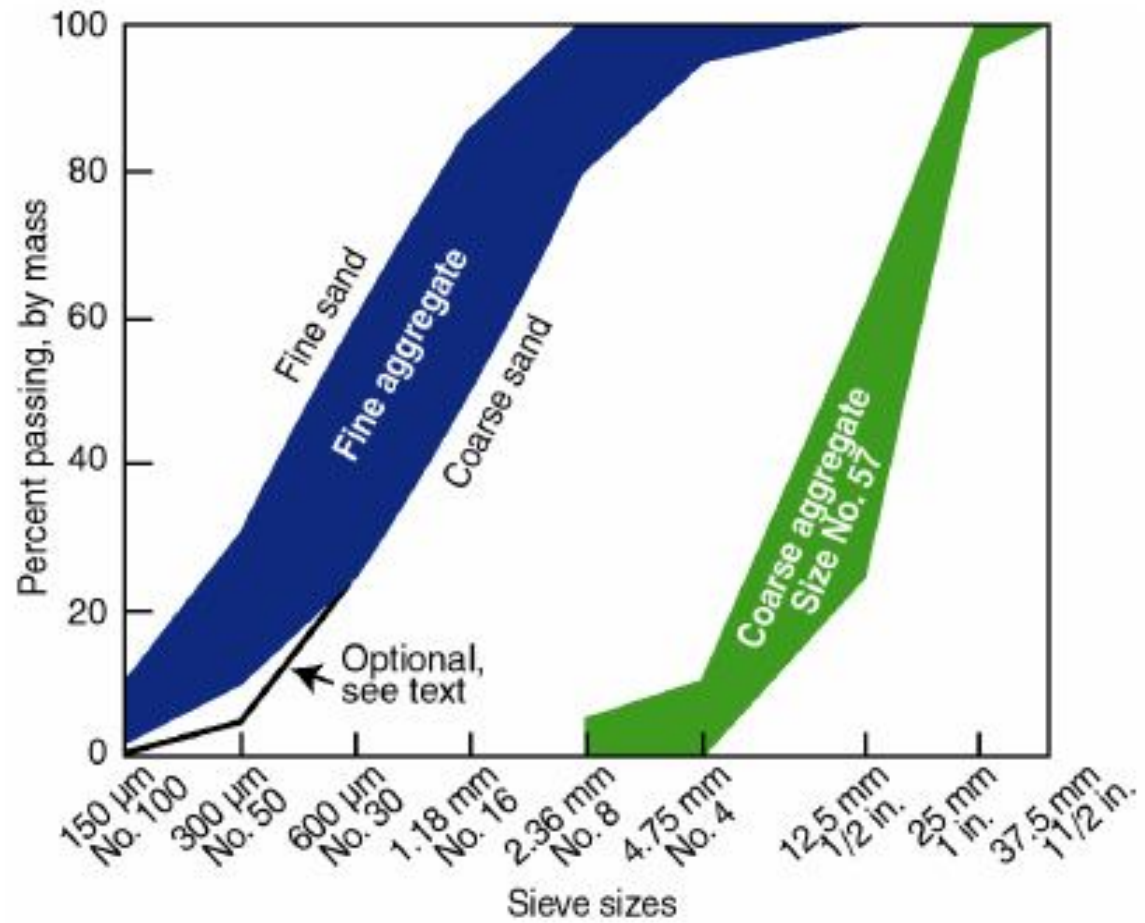
sieve	Size (mm)	Materials retained in (gm)	% M.R	Cumulative %M.R.	%finer
1.5in		0	0		
¾ in		0	0		
3/8 in		0	0		
#4	4.75	0	0		
#8	2.36	0	0		
#16	1.18	10	5		
#30	0.60	30	15		
#50	0.30	100	50		
#100	0.15	60	30		

sieve	Size (mm)	Materials retained in (gm)	% M.R	Cumulative %M.R.	%finer
1.5in		0	0	0	
¾ in		0	0	0	
3/8 in		0	0	0	
#4	4.75	0	0	0	
#8	2.36	0	0	0	
#16	1.18	10	5	5	
#30	0.60	30	15	20	
#50	0.30	100	50	70	
#100	0.15	60	30	100	
			Σ	195	

sieve	Size (mm)	Materials retained in (gm)	% M.R	Cumulative %M.R.	%finer
1.5in		0	0	0	100
¾ in		0	0	0	100
3/8 in		0	0	0	100
#4	4.75	0	0	0	100
#8	2.36	0	0	0	100
#16	1.18	10	5	5	95
#30	0.60	30	15	20	80
#50	0.30	100	50	70	30
#100	0.15	60	30	100	0
			Σ	195	

sieve	Size (mm)	Materials retained in (gm)	% M.R	Cumulative %M.R.	%finer
1.5in		0			
¾ in		14			
3/8 in		46			
#4	4.75	55			
#8	2.36	65			
#16	1.18	10			
#30	0.60	30			
#50	0.30	50			
#100	0.15	60			
			Σ		

Grading Limits



**Aggregates for
Concrete**

Maximum Size vs. Nominal Maximum Size of Aggregate

- Maximum size — is the smallest sieve that all of a particular aggregate must pass through.
- Nominal maximum size — is the standard sieve opening immediately smaller than the smallest through which all of the aggregate must pass.
- The nominal maximum-size sieve may retain 5% to 15%



**Aggregates for
Concrete**

Desirable Properties of Sand

- Inert completely (i.e., should not have any chemical activity)
- Grains sharp, strong and angular
- Not contain hygroscopic salt
- Should not contain clay & silt, which are the harmful ingredients
- No organic matter

Functions of Sand in Mortar/Concrete

- Offers requisite surface area for the film of binding material to adhere and spread
- Increase the volume of mortar and consequently makes mortar more economical
- A well-graded sand adds to the density of mortars and concrete
- Prevents excessive shrinkage of mortar
- Since inert material, it renders structure more resistant against atmospheric agencies.

Tests for Sand

Test for silt and clay:

- ▶ If present in sand could be ascertained by determining the percentage loss in weight of a sample of sand after washing it with the aid of clean water.
- ▶ However, field test can be performed by rubbing a small amount of sand between finger tips. If clay spots are left on finger tips, it indicates the existence of clay in the considerable amount.

Tests for Sand

- **Test for salt:**

Can be tested by putting some amount in mouth. The test will reflect the presence of any salt.

Tests for Sand

- **Tests for organic matter:**

Make 3% solution of NaOH & put some sand into the solution. Close the bottle for 24 hrs and meanwhile shake the solution vigorously. The color of the liquid turns brown if any organic matter is present in sand. The darkness of color gives the estimation of the amount of organic matter that exists in the sand.

Uses

- Fine sand is used for plastering works
- Medium sand is used for masonry works
- Coarse sand is used for concrete work.

Substitute of Sand

If good sand is not available in the nearby of the site, the substitutes may be uses.

- ▶ **Stone screenings:** fine particles obtained by screening crushed stones. The grains are sharp and strong, and hence impart better strength to the concrete if used.
- ▶ **Shurki:** obtained from finely powdered burnt clay(bricks). Also obtained by grinding slightly under-burnt bricks. It disintegrates under the action of air & humidity; not used for external mortar.

Moisture Conditions

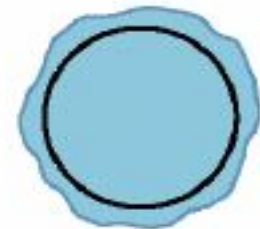
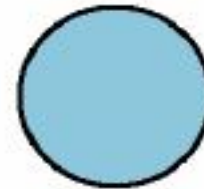
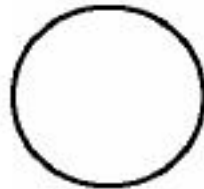
State

Ovendry

Air dry

Saturated,
surface dry

Damp
or wet



None

Less than
potential
absorption

Equal to
potential
absorption

Greater
than
absorption

Total moisture

**Aggregates for
Concrete**

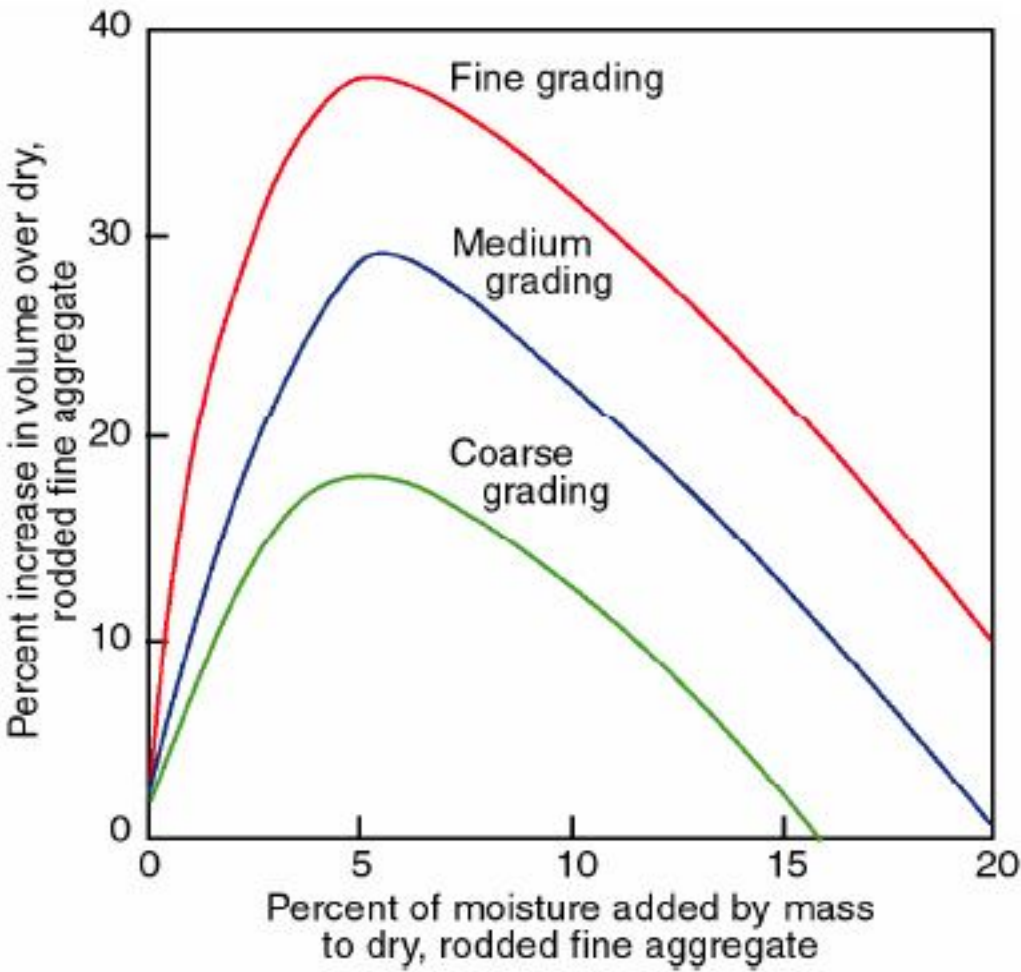
Bulking of Sand

- ▶ Means increase in volume. Fine aggregate (i.e., sand) increases in volume when they possess some moisture.
- ▶ It is due to the formation of a thin film of water around the aggregate or sand particles.
- ▶ The thickness of this film goes on increasing with more and more moisture. Therefore, the increase in volume of sand mass continues. This increase in volume varies 20~30% (vol. basis) depending upon the fineness of sand. The finer will undergo with greater increase in volume.

Bulking of Sand

- After certain % of water (5~8%, also depends on the fineness of sand), the volume of sand starts decreasing with the further increase in water and eventually the increased volume completely vanishes, and at this moment, the volume occupied by sand becomes the volume of dry sand.
- Bulking of sand affects W/C ratio and also the proportioning of aggregate.

Bulking of Sand



Thank You