Aggregate size Distribution

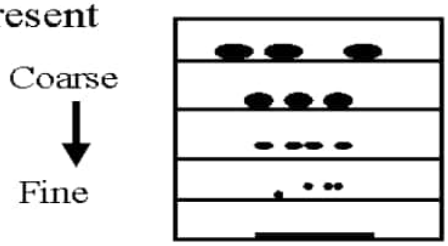
- Sieve Analysis
- maximum size
- nominal maximum size
- Significance of Grading
  - Economy
  - Consistency
  - Strength
  - Shrinkage
  - Finishability

Grading

- Refers to distribution of particle sizes
- Sieve Analysis

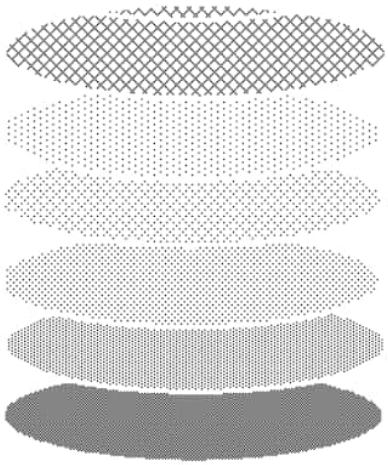
We are interested in:

- 1) Size largest particle present
- 2) Size Distribution



Sieve Analysis

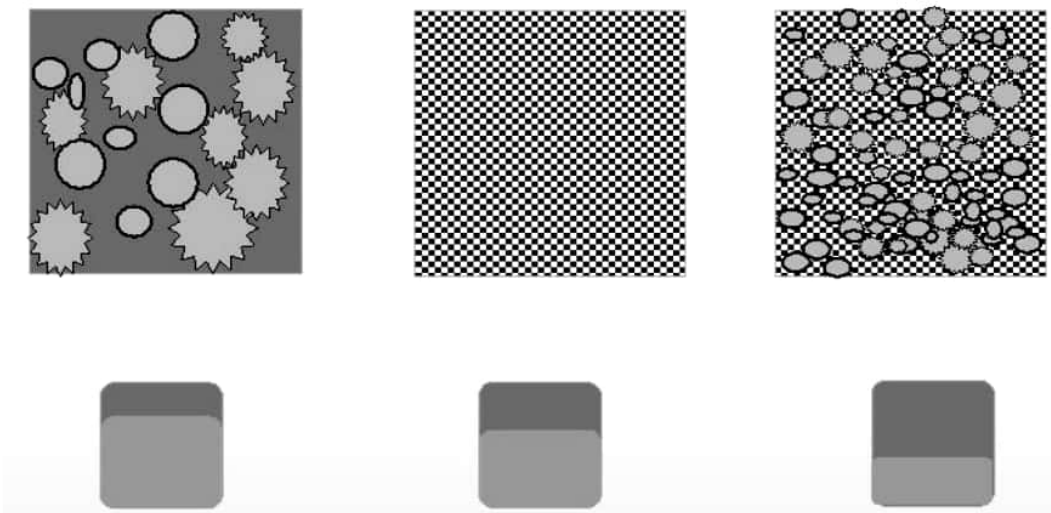
- sieve sizes for coarse aggregates
- 1.5",1",3/4",1/2",3/8", No.4, (0.187in)
- Coarse aggregate if less than 10% passes No.4 Sieve



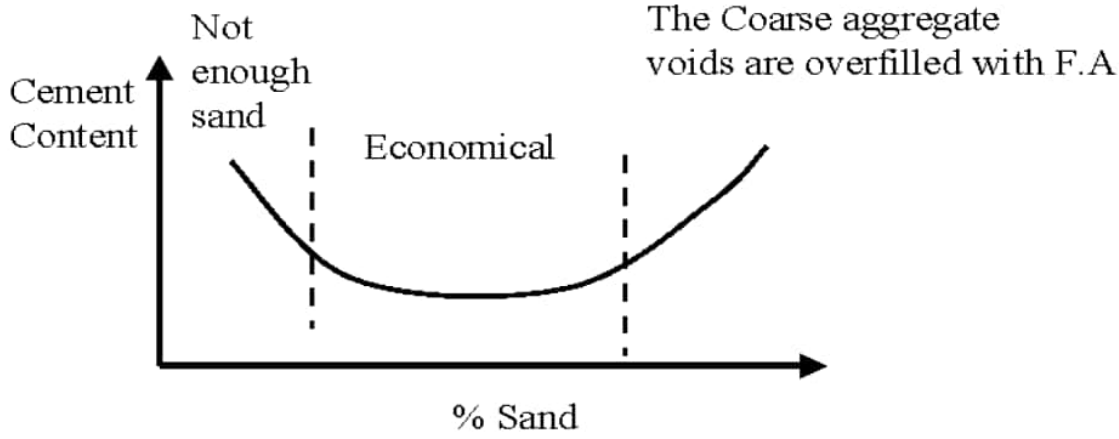
Sieve analysis and Fineness modulus of Sand

Sieve Size	% retained between sieves	Cum. % passing, by mass	Cum. % retained by mass
5 mm	2	98	2
2.5 mm	113	85	15
1.25 mm	20	65	35
630 microns	20	45	55
315 microns	24	21	79
160 microns	18	3	97
Fineness Modulus= 283/100=2.83			283

Importance of Gradation



Significance of Grading

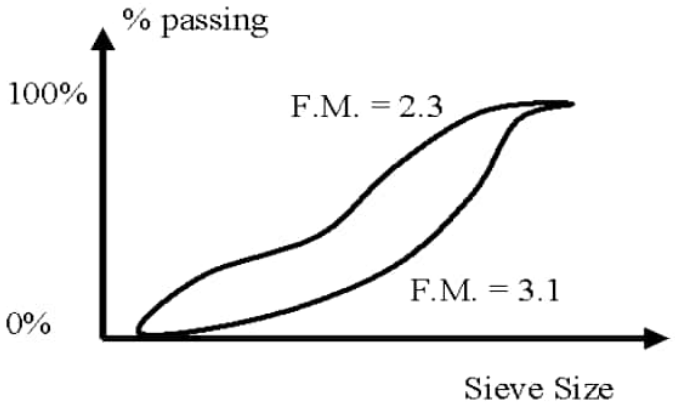


Fineness Modulus (FM)

- Index of fineness of an aggregate.
- The fineness modulus of the fine aggregate is required for mix design since sand gradation has the largest effect on workability. A fine sand (low FM) has much higher effect paste requirements for good workability.

- The FM of the coarse aggregate is not required for mix design purposes.

- It is computed by adding the cumulative percentages of aggregate retained on each of the specified series of sieves, and dividing the sum by 100 [smallest size sieve: No. 100 (150 μm)].



For concrete sand, FM range is 2.3 to 3.1

- Note: The higher the FM, the coarser the aggregate.

- It is important to note that the fineness modulus is just one number which only characterizes the average size of the aggregate, and different grading may have the same fineness modulus.

Maximum Aggregate Size (MSA)

Definition (ASTM): It is the smallest sieve opening through which the entire sample passes (or in practice only 5% retained on this sieve.

- MSA < 1/5 of the narrowest dimension of the form in which concrete is to be placed.

- Also: MSA < 3/4 of the minimum clear distance between the re-bars

Nominal Max Size – the largest size particle present significantly to affect concrete properties.

It affects the paste requirements, optimum grading depends on MSA and nominal max. size. The higher MSA, the lower the paste requirements for the mix.

Aggregate size affects the following concrete properties: water demand, cement content, microcracking (strength).

B. Shape and Surface Texture

Rough-textured and elongated particles require more cement paste to produce workable concrete mixtures, thus increasing the cost.

Shape:

- Round - loosing edges and corners.
- Angular - well defined edges and corners.
- Elongated- when length is considerably larger than the other two dimensions.
- Flaky or flat- when thickness is small relative to two other dimensions.

Surface Texture

The degree to which the aggregate surface is smooth or rough- (based on visual judgement).

- Depends on: rock hardness, grain size, porosity, previous exposure.

- Aggregate shape and texture affect the workability of fresh concrete through their influence on cement paste requirements.

- Sufficient paste is required to coat the aggregates and to provide lubrication to decrease interactions between aggregate particles during mixing.

- Ideal particle is one close to spherical in shape (well rounded and compact) with a relatively smooth surfaces (natural sands and gravels come close to this ideal).

- More angular shapes - rough surfaces – interfere with the movement of adjacent particles (less workable) – They also have a higher surface –to –volume ratio – more paste.

- Flat or elongated aggregates should be avoided.

- Rough surface requires more lubrication for movement (crushed stone).

- Shape can influence strength by increasing surface area available for bonding with the paste.

- Rough surfaces –improve mechanical bond.

- Irregular aggregates (angulars) –higher internal stress concentrations –easier bond failure.

What is Gap grading? How it is important for concrete? Where you can use it? Get more details from your text book.

What is meant by Grading curves?

C. Soundness

Aggregate is considered unsound when volume changes in the aggregate induced by weather, such as alternate cycles of wetting and drying or freezing and thawing, result in concrete deterioration.

It Depends on: porosity and contaminants.

Pumice- (10% absorption) - no problem with freezing and thawing.

Limestone - breaks: use smaller aggregates (critical size) (critical aggregate size: size below which high internal stresses capable of cracking the particle will not occur)

Durability of Aggregates

- Any lack of durability of the aggregate will have disastrous consequences for the concrete.
- Durability can be divided into physical and chemical causes.
- Physical durability – exposure to freezing and thawing, wetting and drying, physical wear.
- Chemical durability –various forms of cement – aggregate reactions (alkali –silica attack).

Physical Durability

- **Soundness: if volume changes accompanied with environmental changes lead to the deterioration of concrete –unsoundness.**
- **Volume changes: alternate freezing and thawing, repeated wetting and drying –internal stresses – volume increase.**
- **Wear resistance: resistance to surface abrasion and wear.**

Chemical Durability

- **It results from a reaction between reactive silica in aggregates and alkalis compounds contained in the cement –alkali-aggregate reaction.**