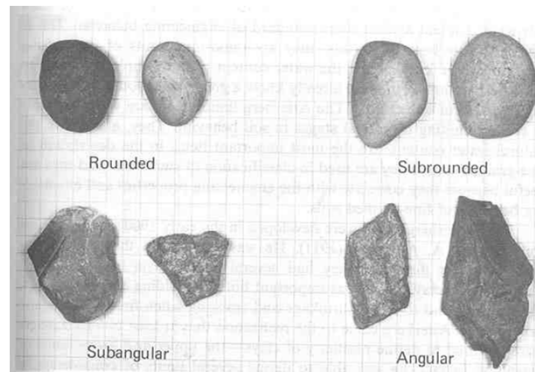# Section 2:
Particle Size, Shape and Texture

Particle Shapes

The shape of aggregate particles can be classified as either angular, subangular, subrounded or rounded.

Each shape has advantages and disadvantages depending on the desired properties of the finished product.

Surface Texture

How does it feel when rubbed between fingers?

Smooth ◄──────────────────────► Rough

Rounded   Subrounded   Subangular   Angular

Particle Shape and Surface Texture

Effects
- Strength of aggregate particles
- Bond with cementitous materials
- Resistance to sliding of one particle over another

Angular particles with a rough surface texture:
- Can create a very strong matrix, but
- Can also be very difficult to compact since the rough surface textures and angular particles can interlock together and resist compactive effort.

Rounded particles with smooth surface texture:
- Will compact readily, but
- Will be unstable under load since the particles will displace and slide against each other.

Particle Shape and Surface Texture

Flat, thin, long, needle-shaped particles break easily

- Want cubical or sphere-shaped particles instead

Rough and fractured faces allow a better bond with asphalt and cements than rounded, smooth faces

- More friction against sliding particles
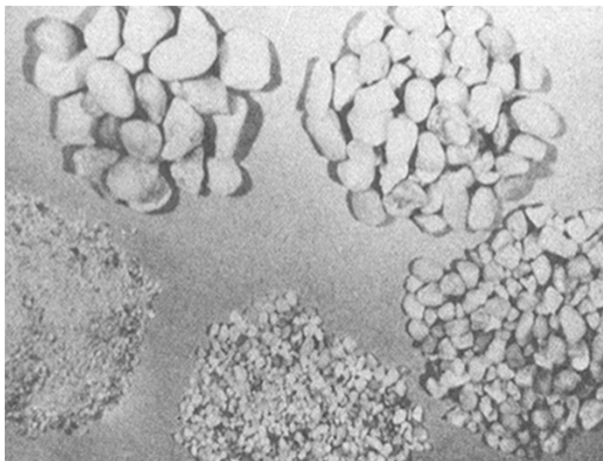- Better interlocking of particles to create a strong framework to resist loads

Particle Shape and Surface Texture

Specifications

- Are necessary to:
  - Define the desired properties that are important to the finished product and
  - Set limits or tolerances to account for production variability
- Restrict the percentage of long or thin particles
- Require that a percentage of particles have at least one fractured surface.

Particle Size

Is the particle sized like a ...
- Boulder (12 inches or more)?
- Cobble (3 to 12 inches)?
- gravel? (0.2 to 3 inches)?

What is the distribution of particle sizes?
- 57 Stone
    - Most sizes between 1 inch and No. 4 sieve (4.75mm)
- 789 Stone
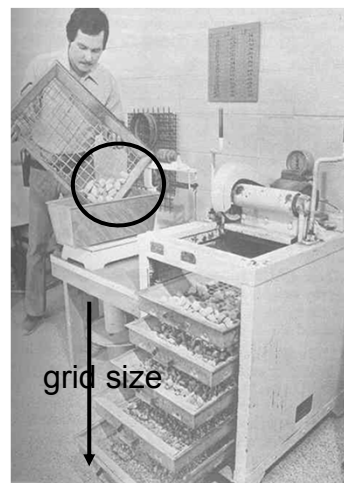   - Most sizes between ½ inch and No. 16 sieve (1.18mm)

Particle Size

Gradation

Particle size distribution is how most aggregates are specified.

- The desired gradation is determined based on the intended usage.
- Once the desired gradation is determined, tolerances are applied to create bands for each sieve to account for production variability.

Various specifications are required depending on usage

- 57 and 789 Stone (see Appendix 2)

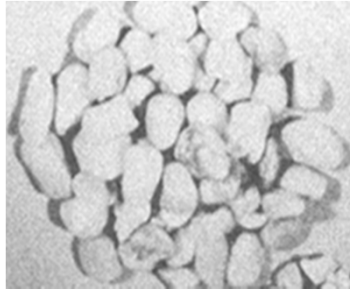Gradation is measured by sieve analysis

- Percent passing versus sieve size

Sieve Analysis

Sieve Analysis of Fine and Coarse Aggregates
ASTM C136 / AASHTO T 27

Place dried and weighed sample in a nest of screens with decreasing grid spacing.

Aggregate is agitated for a period of time then the amount of material retained on each sieve is determined as a percentage of the original sample weight.

grid size

Gradation

Uniform or Poorly-Graded Distribution

- Open space exists between particles
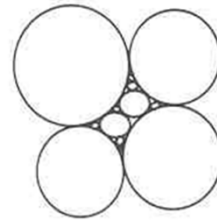- Majority of particles approximately the same size

Gradation

Well-Graded Distribution

- Particle sizes evenly distributed over a wide range
- Smaller particles fill open spaces between larger particles

Gradation

Dense-Graded Distribution

- increased resistance to shear failure from good interlock
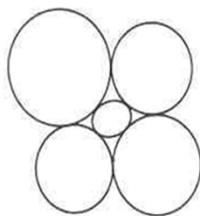- Is more economical in concrete and asphalt mixtures since less binder is required
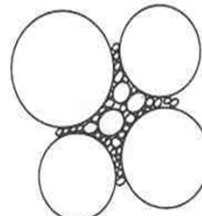
(a) dense graded

Gradation

Open-Graded Distribution

- good drainage capability due to large void space between the particles

(b) open graded   (c) excessive fines