AGGREGATES

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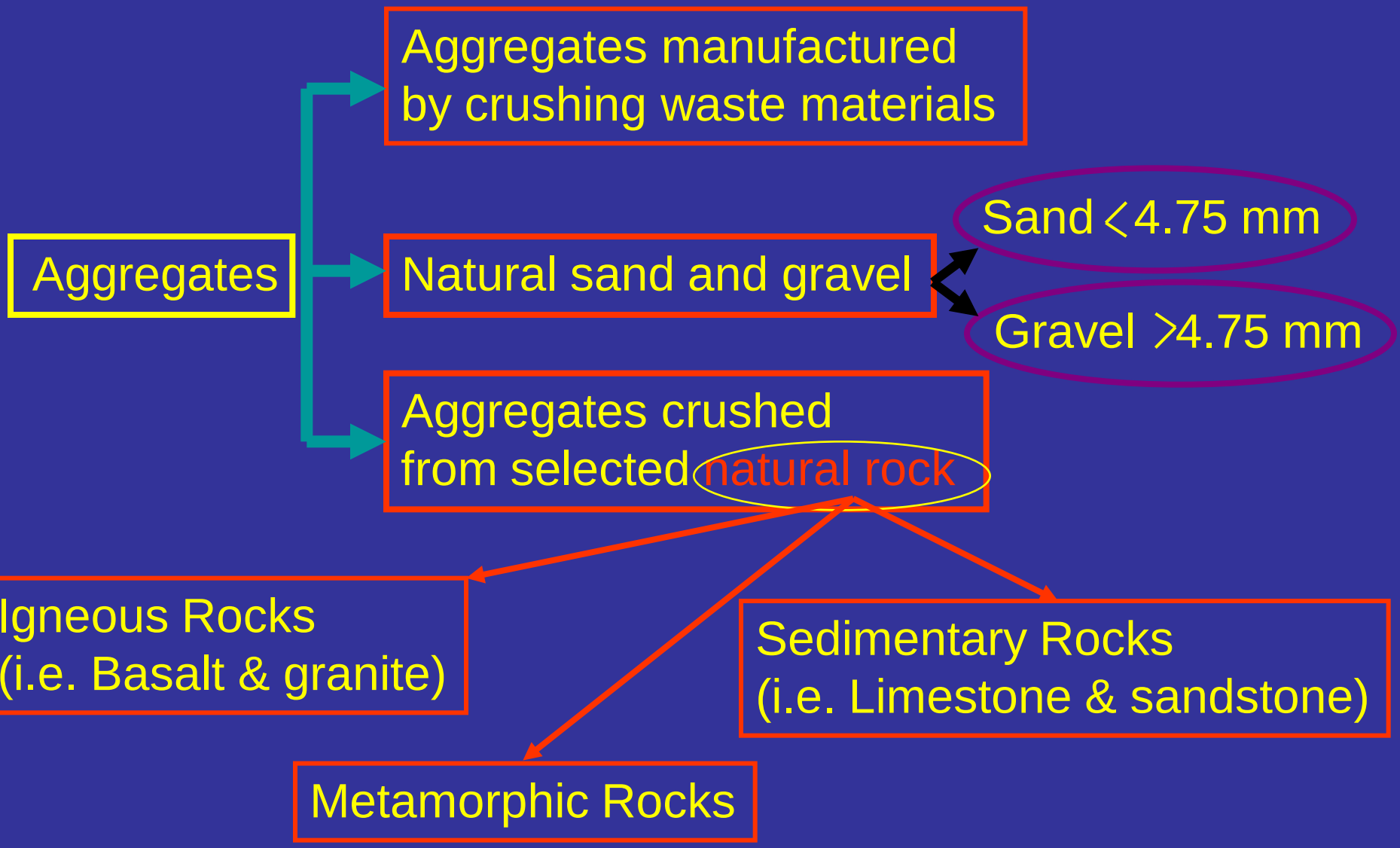
BACKGROUND


Aggregates
Aggregates manufactured by crushing waste materials
Natural sand and gravel
Sand < 4.75 mm
Gravel > 4.75 mm
Aggregates crushed from selected natural rock
Igneous Rocks (i.e. Basalt & granite)
Sedimentary Rocks (i.e. Limestone & sandstone)
Metamorphic Rocks

BACKGROUND

- Approximately 92 % - 96%of the volume of asphalt concrete is occupied by aggregates, thus, properties of aggregate can have a great influence on the quality of asphalt concrete.

- *Coarse* material resulting from disintegration of rocks is called *gravel*. **Fine** material (less than 4.74 mm) is called **sand**.

PROPERTIES

Classification

- Rock type
- Surface texture
- Particle shape

Physical

- Specific gravity (2.5 – 2.7)
- Bulk density (mass / V)
- Porosity and absorption
- Thermal

Mechanical

- Strength (ACV)
- Impact strength
- Abrasion

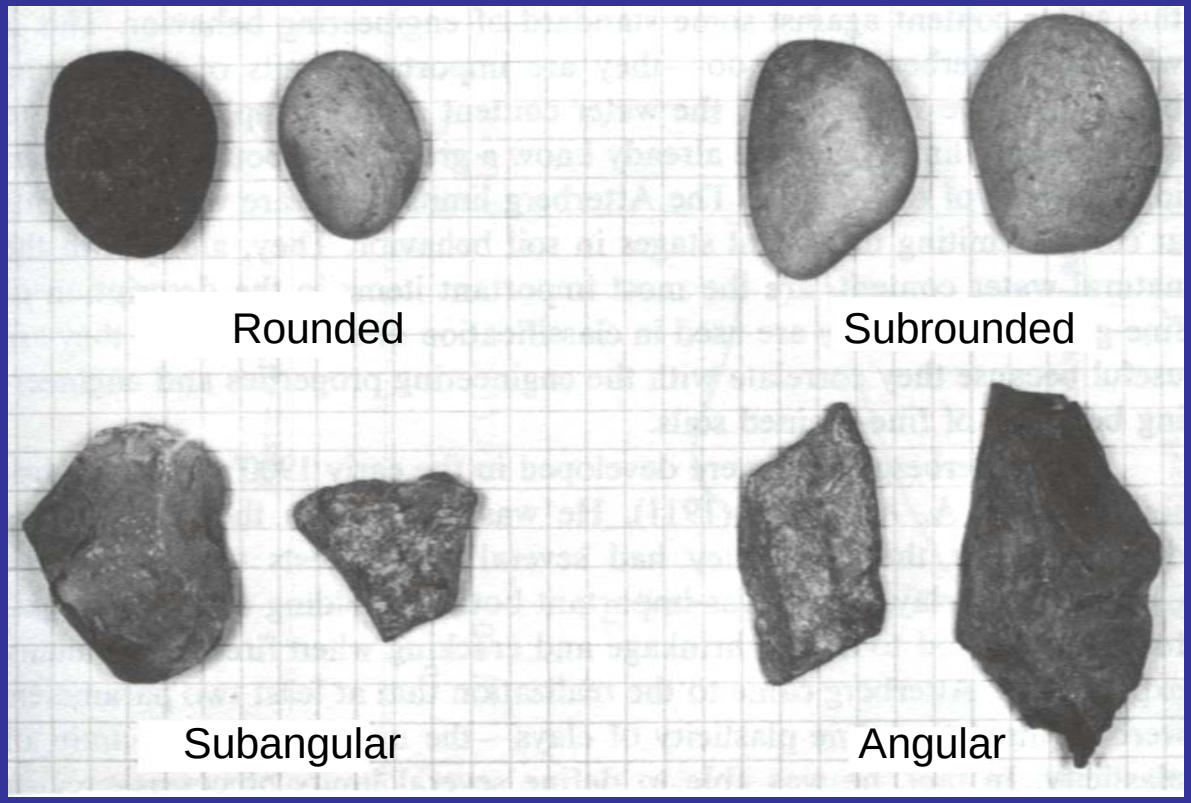
AGGREGATE SHAPE

Particle shape of aggregates (BS812)

CLASSIFICATION	DESCRIPTION
Rounded	Fully water-worn or shaped by attrition
Irregular	Naturally irregular (but rounded edges)
Flaky	Thickness is small / other dimensions
Angular	Well defined edges
Elongated	Length is larger than other dimensions
Flaky & Elongated	Long & small thickness

Surface area

AGGREGATE SHAPE



Angular soil particle → higher friction •

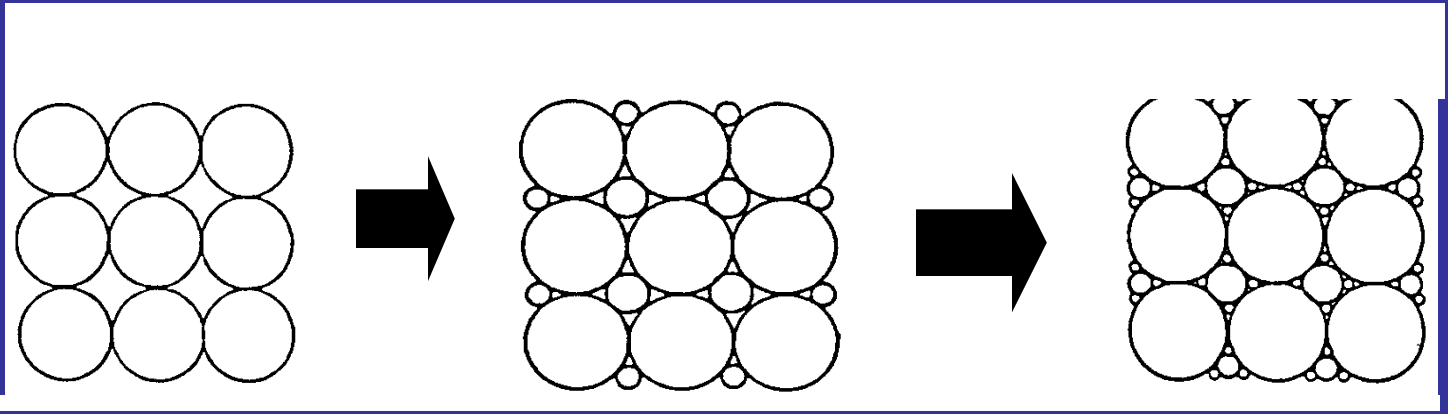
Round soil particle → lower friction •

AGGREGATE SIZE AND GRADING

- Aggregates sizes up to 50 mm is used in normal strength concrete. The size of aggregate influences the surface area and thus influence the amount of bitumen required to coat the surface of aggregates.

- Particle size distribution is called grading (**sieve analysis**). Grading controls packing density and therefore improves strength.

CONT. AGGREGATE SIZE AND GRADING



Effect of particle size and grading on packing density

SURFACE TEXTURE

Surface texture of aggregates (BS812)

SURFACE TEXT.	CHARACTERISTICS
Glassy	Fully water-worn or shaped by attrition
Smooth	Naturally irregular (but rounded edges)
Granular	Thickness is small / other dimensions
Rough	Well defined edges
Crystalline	Contains visible crystalline constituents
Honeycombed	With visible pores and cavities

CONT. SURFACE TEXTURE

- Rough textured aggregates is likely to show somewhat higher strength BUT rough aggregates have higher surface area, thus higher demand for bitumen.

Surface texture influences the skid resistance of asphalt Concrete – leave discussion to a latter session.

PHYSICAL PROPERTIES
SPECIFIC GRAVITY

Termed as relative density (G = 2.5 – 2.7)

$$= \frac{\text{Mass of unit volume of material}}{\text{Mass of the same volume of water}}$$

- It is not a measure of aggregate quality but variation in specific of gravity reflects the change in porosity.

PHYSICAL PROPERTIES
BULK DENSITY

- Represents the mass of aggregates that fills a container of unit volume (indication on how aggregates can be packed)

$$\text{Void ratio} = 1 - \frac{\text{Bulk density}}{\text{Specific gravity x unit weight of water}}$$

- Void ratio indicates the volume of bitumen and filler materials required to fill the space between the Coarse aggregate particles

PHYSICAL PROPERTIES POROSITY & ABSORPTION

- It’s the pores in aggregates. Pores in aggregates influence the porosity of asphalt concrete and amount of absorbed bitumen. It can also affect The durability of asphalt concrete.

PHYSICAL PROPERTIES
THERMAL

- There are three thermally related properties of aggregate which are important:
  -Thermal expansion
  - Specific heat
  - Thermal conductivity

(Less important)

MECHANICAL PROPERTIES STRENGTH

- Strength of asphalt concrete can not exceed the Strength of aggregates. The controlling factor is the Bond at interface between aggregates and bitumen **As well as the aggregate interlocking.**

- Strength of asphalt concrete is directly influenced by the grading and the aggregate size as they influence packing density.

MECHANICAL PROPERTIES STRENGTH

Why strength of aggregate is vital?

- To resist the action of rolling and compaction during construction.
- To resist abrasion and polishing caused by the moving rubber wheels during traffic and thus provide skid-resistance.

SPECIFICATION FOR CONCRETE AGGREGATES

- Concrete aggregates have to comply with the requirements of material standards. The following specifications are generally important and required by various standards:

Coarse aggregates
- Grading
- Dust content
- ACV
- 10 %FACT
- Flakiness index

Fine aggregates
- Grading
- Dust content
- Active clay
- Clay content
- Fineness modulus
- Chloride content
- Organic impurities
- Deleterious Impurities

DUST CONTENT (FINE & COARSE AGG.)

- Dust is the material passing a 0.075 mm sieve. The dust negatively influences the bond between Aggregates and bitumen thus reduces the strength Of asphalt concrete. Additionally, dust increases The total surface area and therefore increase the Demand for bitumen.

AGGREGATE CRUSHING VALUE (ACV) OR LA value

- ACV :determines the extend to which an aggregate crushes when subjected to a steady increasing load.

- LA (Los Angeles): to determine the response of aggregate to impact load.

- Determines the hardness or crushing resistance of the aggregate. If the aggregate is not strong enough, the failure (cracks) of asphalt concrete will occur within the aggregates and not in the Interface between bitumen and aggregates.

FLAKINESS INDEX (COARSE AGG.)

- Determines the amount of flat particles in the aggregate. Flat particles tend to be oriented at all angles in concrete mix and may prevent proper packing of the aggregate to obtain maximum density. It also tends to break more easily than more cubic particles and may influence the strength of asphalt concrete.