

CHAPTER THREE

AGGREGATES

INTRODUCTION

- Aggregates occupy at least three quarters(75%) of volume of concrete.
- Quality is especially important.
- Cheaper than the cement.
- Higher volume stability and better durability than the cement paste alone.

Why Aggregate used with Cement Paste?

- 1- It very strong so that it gives the concrete its strength. Also its a filler materials.
- 2- Increase the stability of cement paste.
- 3- Increase the strength for the external force and weathering condition (humidity, temperature difference & freezing).
- 4- Inert, inexpensive materials so it uses in a large quantities.
- 5- Decrease the volume exchange of concrete due to high and low temperature.

Classification of Aggregates

a) According to Production Methods

- **Natural Aggregates:**

Taken from nature deposits without any change in their natural states during production except for crushing, grading or washing.

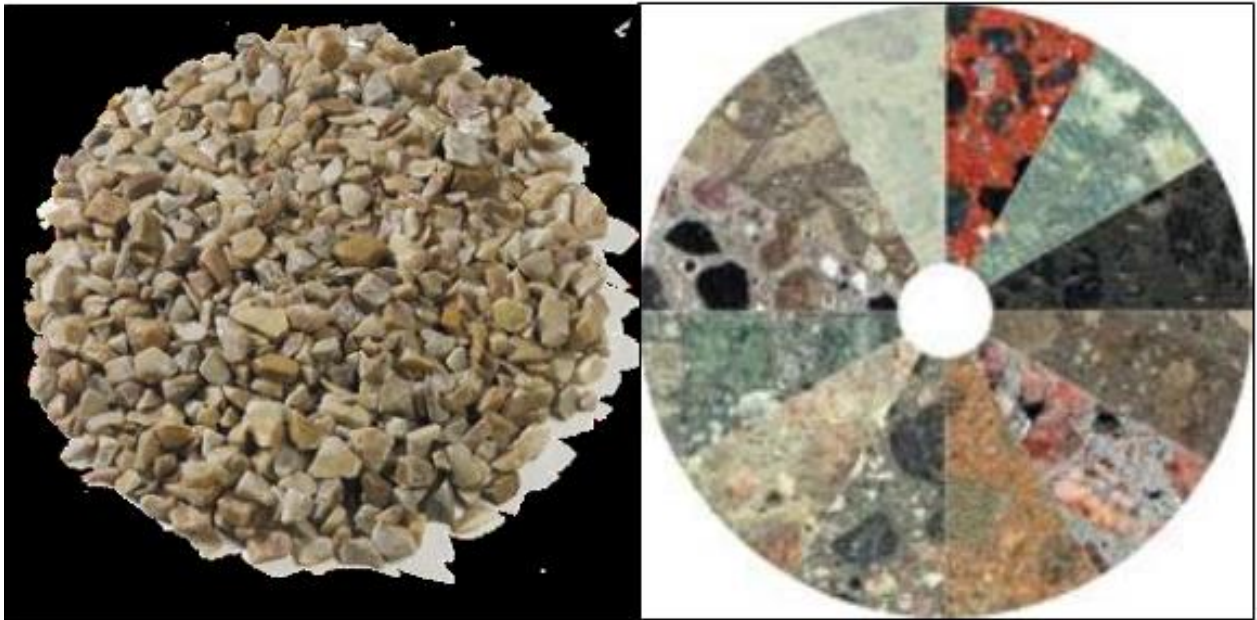
Example: Sedimentary rocks, volcanic rocks, metamorphic rocks.

- **Artificial Aggregates:**

Produced due to artificially operation such as (firing clays at high temperatures) or (aggregate produce from industrial waste as slag) or (aggregate prepared from coal waste).

- **Colored Aggregates:**

Glass, ceramics, manufactured marble for decorative and architectural purposes.



b) According to Petrological Characteristics

- **Igneous Rocks:** الصخور النارية

Example: Quartz, granite, basalt, etc.

- **Sedimentary Rocks:** الصخور الرسوبية

Obtained by the deposition of weathered and transported pre-existing rocks.

Example: Sandstone, limestone, shale.



Sedimentary Rocks

- **Metamorphic Rocks:** الصخور المتحولة

Formed at a depth under high heat and pressure by the alterations of either igneous rocks or sedimentary rocks.

Example: marble الرخام, slate الاردواز, schist شبيست.



c) According to Particle Size**1) Fine Aggregate (sand) (0.07 - 5mm):**

The part of aggregate which of (95-100%) pass through the sieve No.4 (5mm).

2) Coarse Aggregate (gravel) > 5mm:

The part of aggregate which of (95-100%) which cannot pass through the sieve No.4 (5mm).

Note:

Fine aggregate: sizes (0.07 – 5) mm.

Coarse aggregate: sizes > 5mm.

Silt: sizes (0.002-0.075) mm.

Clay: sizes smaller than 0.002 mm.

**d) According to Their Unit Weights:****1) Normal Weight Aggregates:**

- Sand, gravel and crushed stone.
- Concrete produced by these aggregates: 2160 to 2560 kg/m³.

2) Light Weight Aggregates:

- Slag, fired clay and other light stones.
- Concrete produced by them: 240 to 1440 kg/m³.
- This concrete is normally used for insulation العزل purposes.

**3) Heavy Weight Aggregates:**

- Hemotite, barite magnetite, steel ore and iron parts.
- Concrete produced by them: 2800 to 6400 kg/m³.

Properties of Iraqi Aggregate

- 1- It's of sedimentary origin
- 2- Contains high percentage of sulfate (5% of sand weight).
- 3- Contains (0.5% of sand weight) fine materials (clay) which has size of $\geq 0.002\%$.
- 4- Don't reactivity with alkalis that found in cement.

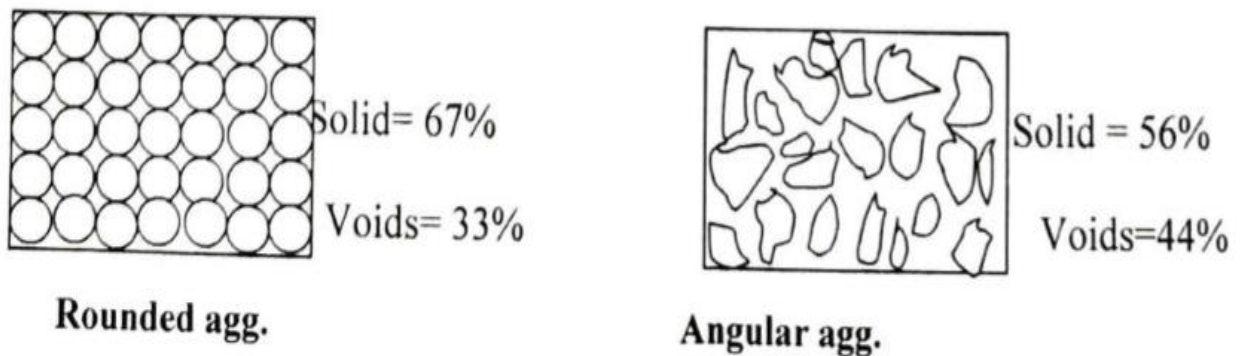
Note: Many properties of aggregate depend on the properties of its parent such as (mineral composition, strength, chemical stability, stiffness, specific gravity, color, etc.) while there are many properties of aggregate different from that of parent rocks such as particle size, surface texture, shape, abrasion)

❖ **Properties of Aggregate****1- practical shape of aggregate****Table 1: practical shape classification of aggregate with examples**

| Classification | Description | Examples |
|---------------------|---|--|
| Rounded | Fully water-worn or completely shaped by attrition | Reviver or seashore gravel; desert, seashore and wind-blown sand |
| Irregular | Naturally irregular, or parity shaped by attrition and having rounded edges | Other gravels; land or dug flint |
| Flaky | Material of which the thickness is small relative to the other two dimensions | Laminated rock |
| Angular | Possessing well- defined edges formed at the intersection of roughly planer face | Crushed rocks of all types; talus; crushed slag |
| Elongated | Material usually angular in which the length is considerably larger than the other two dimensions | ----- |
| Flaky and elongated | Material having the length considerably larger than the width, and the width considerably larger than the thickness | ----- |

The round aggregates give good workability to concrete but flaky and angular aggregates. In concrete produce weak workability?

Because high surface area of angular and flaky aggregates required high water for mixing and this led to produce more voids in concrete due to interlocking, so the concrete will be with low workability with angular and flaky aggregates.



2- Surface Texture of Aggregate

Aggregate also has been classified according to surface texture.

There are many types of surface texture for aggregates. (See Table 2)

- Rough aggregate produce concrete with high strength, but smooth agg. Produce concrete with low strength.
- Shape and surface texture of aggregate especially of fine aggregate have a large influence on water requirement of the mix. In practical term more water is required where there is a greater voids content.

Table 2: surface texture classification of aggregate with examples

| Group | Surface Texture | Characteristics | Examples |
|-------|--------------------------|--|--|
| 1 | Glassy زجاجي | Conchoidal fracture | Black flint, vitreous slag |
| 2 | Smooth املس | Water-worn, or smooth due to fracture of laminated or fine grained rock | Gravels, chert, slate, marble, some rhyolites |
| 3 | Granular حبيبي | Fracture showing more or less uniform rounded grains | Sandstone, oolite |
| 4 | Rough خشن | Rough fracture of fine- or medium-grained rock containing no easily visible crystalline constituents | Baslt, felsite, porphyry, limestone |
| 5 | Crystalline بلوري | Containing easily visible crystalline constituents | Granite, gabbro, gneiss |
| 6 | Honeycombed قرص العسل | With visible pores and cavities | Brick, pumice, foamed slag, clinker, expanded clay |