3- Bond of Aggregate

Bond is the interlocking of the aggregate and cement paste owing to the roughness of the surface of aggregates. The bond between the cement paste and aggregates is highly influence on the concrete strength, because this bond may be one of reasons for cracking which occurs when the concrete is subject to high loads.

Bonds depends on:

- Shape of aggregates: large surface area of a more angular and flaky provides a greater bond.
- Surface texture: a rougher texture results in a greater adhesion or bond between particles and cement paste.
- Moisture in aggregates: great bond occurs when the particles surface are dry.
- Physical and chemical structure properties of aggregates.

4- Strength of Aggregates:

- The compressive strength of concrete cannot significantly exceed that of the major part of aggregates contained therin.
- It is not easy to determine the crushing strength of aggregates itself, but the required information about the strength of aggregate particles has to be obtained from indirect tests :

  Crushing strength of prepared rock samples, crushing value of bulk aggregate, and performance of aggregates in concrete.
- Strength and elasticity of aggregte depened on its composition and surface texture.
- Average value of crushing strength of aggregates is (80-200)Mpa

Crushing Value Test:

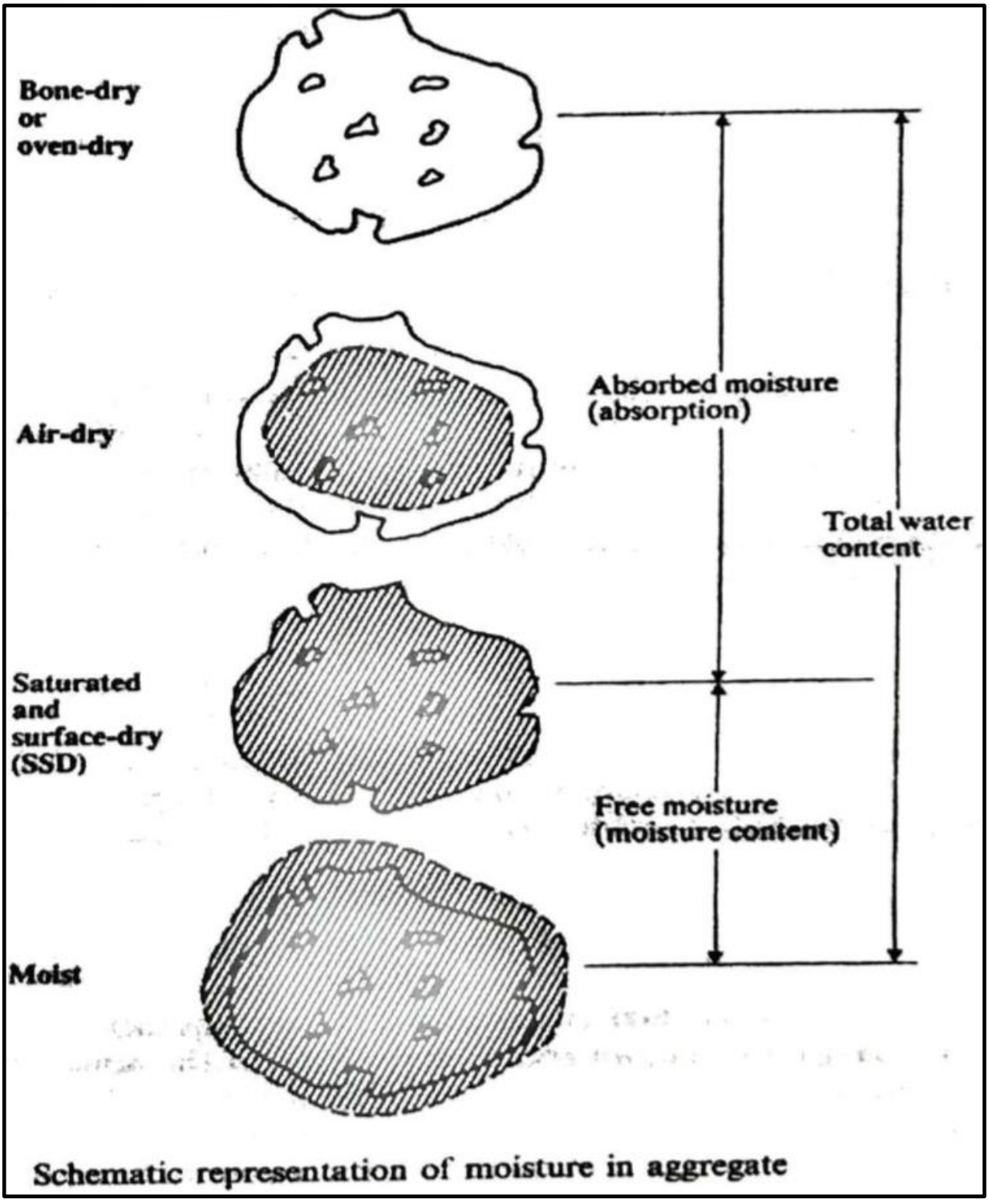
- The materials to be tested must pass through 14 mm sieve size and retain on 10 mm sieve size.
- Samples should be dried in oven at (100-110) ℃ for 4 hrs.
- Cylinder mould filled with sample with 3 layers each layer tamped with 25 strike, then total weight is taken as (A).
- Appling load of 400 Kn (40 ton) for 10 min, then aggregate removed from testing device and sieved on (2.36 mm), then the weight of aggregate was passed from seive (2.36 mm) as taken (B).
- Aggregate crushing value = pass from sieve 2.36 (B) /Total weight (A) %

5- Moisture Content in Aggregates:

The quantity of the water in aggregate has a large effect on concrete properties. Aggregate has been classified according to water content as follow:

- Oven-dry aggregate: Can be obtained by drying aggregate in oven at (110 $\pm$5℃) for 24 hr.
- Air dry aggregate: Can be obtained by drying aggregate in air, this aggregate have some moisture content in its pores with dry surface.
- Saturated surface dry aggregate: This aggregate have totally dry surface, but all its internal pores are saturated with water.
- Saturated aggregate: This aggregate contained pores filled by water with surface saturated by water in form of hydro surrounding the surface particles.

Total moisture = absorption + surface moisture



Schematic representation of moisture in aggregate

The most useful type of aggregate in concrete is saturated dry surface because the using of dry aggregate cause the absorbing of mixing water and therefore decreasing of workability has been occurs, while the using of wet

aggregate an addition water has to be added to mix and therefore an increasing in workability will occur and this lead to decrease in strength of concrete.

Deleterious substance in aggregate:المواد الضارة في الركام

1- **Organic impurities:** natural aggregate should not be used in concrete making if they contain organic impurities, because inter with process of cement hydration and this lead to preventing the development of good bonding between aggregate and cement paste. Organic impurities consist of product of decay of vegetable نتاج اضمحلال الخضروات in form of organic loam طمييه عضويه. These materials are often found in fine aggregate, while they are rarely نادرا ما found in coarse aggregates, which can be washed off easily.

- Not all organic impurities are harmful, it must be to check its effect by making " compressive test" to specimens.

2- **Clay and other fine materials:** clay may be present in aggregate in The form of surface coating, which effect on the bond between aggregate and cement paste. It found in form of:
    - Clay < 0.002 mm
    - Silt (0.66- 0.002 mm)
    - Crusher dust غبار التكسير

- Fine materials should not be present in excessive quantites beacause:

1- Because of their large finesses and therefore large surface area lead to increase the amount of mix water.

2- Decrease the bond strength between agg. And cement paste and this mean decrease the strength and durabiltiy of concrete.
3- It has unstable volume and this lead to shrinkage of concrete.

- British Standard (B.S. 812)
  1- Max. Amount of fine materials in Fine aggregate or crushed gravel sand $\leq$ 3%
  2- Max. Amount of fine materials in coarse aggregate $\leq$ 1%
- It can be removed by washing with water. Some insoluble materials such as sulphate cannot removed by water so that aggregate has been washed by hydraulic acid, and its percentage determined from:

  Fine materials % = $\frac{A-B}{A} * 100\%$

  A: dry weight of aggregate

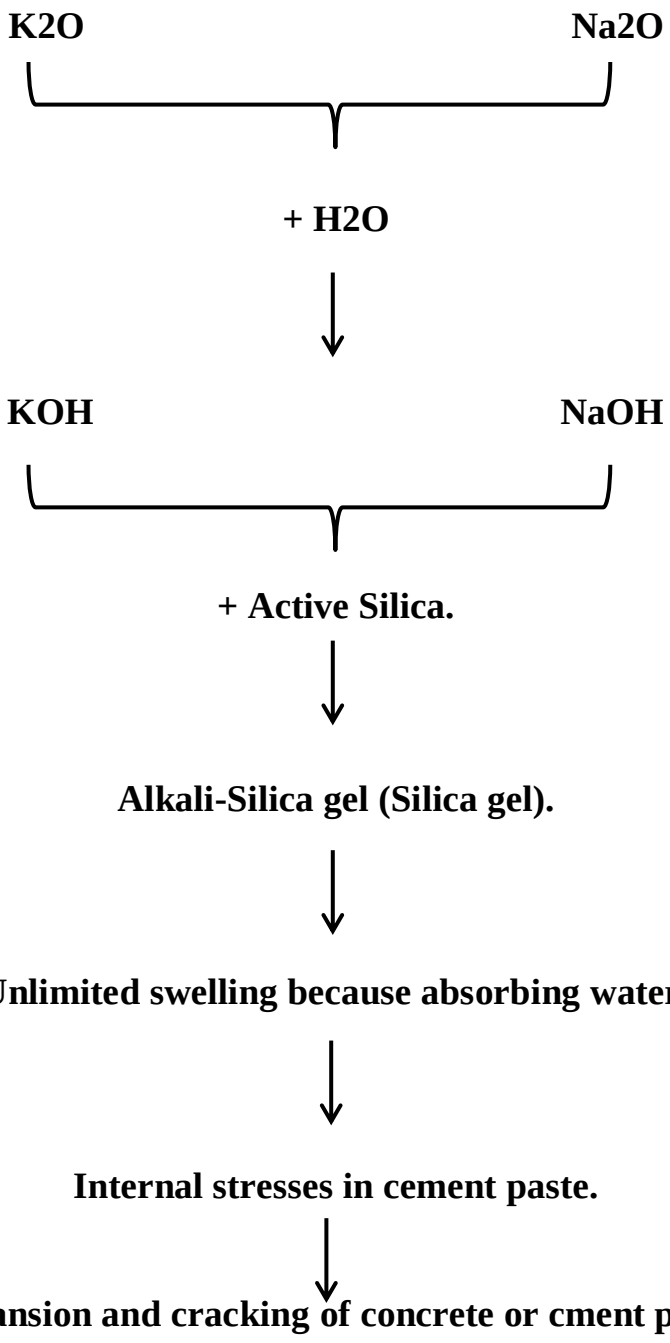
  B: aggregate weight after washing and drying

Unsoundness of aggregate

Aggregate soundness: it is resistance of aggregate to volume change due to physical conditions, such as cycles of wet and dry , heating and cooling, freezing and thawing. If aggregate dont resist this condition it called unsound.

Alkali- Silica Reaction:

It is harmful chemical reaction occurs between active silica in aggregate and alkalis present in cement. This reaction is very slow and occurs in many years.



Factor Affecting the Alkalis- Silica Reaction

1- Quantity of alkalis in cement: the reaction increase by increasing alkalis percentage.
2- Cement fineness: increase the surface area lead to increase the alkali rection.
3- Water percentage: alkali reaction occur with only min. Relative humidity of about 85 % at 20 ℃
4- Temperture: at high temperture, the reaction tack place quickly.
5- Dry and wet process increase the alkali reaction

How we can decrease the alkali reaction

Increase the amount of fine active silica more than 5% to cement mix lead to decrease the expansion resulting from alkali-silica reaction, because incrasing the surface area of the reaction zone with constant amount of alkali in cement and that lead to decrease the internal stresses and decrease the expansion.