Week #14

"Microscopic Study & Testing of Materials"

Microscopic study is the study of material using microscope and to examine the internal structure of material and types of bonding that form by the constituents of particles (material). This gave information about different properties of materials. For example its strength, composition, bonding etc.

Micro Structure of Concrete :-

The behavour of any material depend upon structure of its constituent & its bonding with each other. The study of relationship between structure & properties give another branch called material science

- Micro structure includes all structural level that is from smallest particles to engineering components for e.g grain boundries, pores & cracks
- If we have compler material its behavour can also be studied by micro structure
- For concrete we not success more because in

Concrete there no small part

→ In microstructural terms, the concrete is complex system of solid phases, pore, water & high degree of heterogenity.

- For simple level concrete is mixture of aggregate particles that is distributed in cement paste
- On more detailed level, it (Paste) is a mixture of unreacted cement, hydration products, pores and water.

(1) Microstructure of Anhydrous Cement:-

- In order to understand the micro structure of concrete we have to first know about its constituents microstructure

→ The micro structure of anhydrous cement can be determined from microstructure of clinker & way in which clinker break up

→ The microstructure of clinker consist of two components alite & balite.

→ Alite have hexagonal habit & balite have round structure.

→ Other components such as aluminate & ferrite

may be finely divided & intergrown.

→ The detail of microstructure such as shape & distribution of raw mix depend upon the physical & chemical characteristic of raw mix.

→ In general these properties mostly depend on clinkers.

→ Clinker with Gypsum is ground into powder to form very small sizes grains.

(±) Secondry Image Selection of fine cement powder give all information about cement.

→ It also reveals fine particles of Gypsum spread over grain surfaces.

d) The distribution of phases of cement can be studied by polish section prepared from Sample of cement in epoxy resin.

→ If we study such section by backscattered electron SEM, we will see the cracks on alite crystal dominates the grinding process.

→ Greate proportion of aluminate & ferrite exposed on surface of smaller grain & cracks also produced on these surfaces.

→ Usually all grains more than 2 to 3 μm are polymineralic

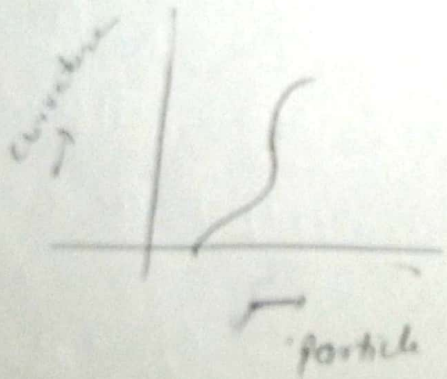
→ Nowadays, the cement is characterized by Mean surface area & oxide composition

→ Surface area can be find by permeability method

(1) This method give relative less area than absorbtion method

(2) Surface area give little information about particle size distribution which help us in determining packing of cement grains.

Laser method used to determine size distribution is shown as;



→ From oxide composition & Bouge calculation it is used to calculate the properties of (four main minerals in portland cement) may be used to estimate relative proportion of major phases

→ This calculation indicates complete reactions occur in kiln

• Quantitative x ray diffraction is used to measure proportion of clinker upto 1% accuracy.

• Analysis of clinker can also be obtained by optical microscopy using point count method

• Secondry ion mass spectroscopy show that surface of cement grains may contain high proportion of impurities which can effect its reactivity.

→ Understanding characteristic & properties of cement is important step which help us to understand properties of concrete.

2. Development of microstructure during Hydration or cement Paste :-

During hydration the fluid mixture of cement & water converted into rigid solid

→ The reactions occur during hydration are exothermic and can be studied by isothermal conduction calorimetry.

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→ From the curve of heat evolution for portland cement, various stages of hydration are identified which are helpful to understand the structure of cement & indirectly concrete.

Rate of hydration in different period:-

From 0 to 3 hours

- Large amount of heat is evolve
- It decreases with time.
- This time during which cement is workable & remain fluid called induction period.

- From 3 to 24 hours:-

During this period 30% of hydration occur.

- 24 hours onword:-

Heat evolution stop.

→ Although hydration still going on.

3. Micro Structure of Aggregate:-

Several types of aggregates are used for production of concrete.

→ For example mostly two types gravel &

granite are mainly used.

→ Gravel is natural aggregate having rounded shape.

→ While granite is obtained from crushing of rocks having angular & surface is uniform

→ During early stages of hydration, aggregate not play an active role in microstructural development.

→ The particle size of aggregate must be considered into account. For example if we use large aggregate the space between them should be completely covered.

→ The particle size & texture is difficult to characterize quantitavily.

• The workability & durability of concrete depend upon the following factors

• Physical appearance of aggregate particles:- For good concrete the size should be small

• Impurities & Contaminants:- The aggregate used for concrete should be impurities free.

· Mechanical & chemical stable:-

The aggregate should have good mechanical & chemical strength.

Reaction of aggregate:-

Over period of years the aggregates undergo several reactions

The most common is alkali reaction. In which component of aggregates react with alkali of Cement result gel, which may drink/absorb water & cause cracks.

· It is mostly caused by presence of amorphous a crystalline silica in aggregate but it also reported with Carbonate aggregate.

4. Cement Paste / Aggregate Interface:-

The interface of paste & aggregate are not studied in isolation as it only exist only as localized region in microstructure of concretes & mortar.

Over all Microstructure of Concrete:-

The overall microstructure of concrete is composition of aggregate, cement, sand and water.

→ For real concrete structure, the microstructure may vary throughout cast.

→ The microstructure of concrete changes throughout its life.

→ Other compound such as carbon dioxide also effect microstructure of concrete.

→ The microstructure that is develop during hydration of cement & concrete is well understood.

On different magnification we see different components in microstructure of concrete.

For example

If magnification is lower (at x25) we see large particles of aggregate & several sands in cement.

→ At magnification x100 the cement cores can be seen easily.

→ At x40 the microstructure of paste can be seen in more detail & distribution of larger pores can be seen.

→ At x600 gives impression of morphology & hydration products.

Role of Bonding strength development:-

Bond strength is resistance offer by concrete to surrounding pulling reinforcement.

→ It is of two types (i) Bonding b/w paste & reinforcement (ii) Bonding b/w paste & aggregates

→ It is not only important to ensure composite action but also to ensure ductile behavour of structure

Factor effecting bond strength:-

(i) Bar geometry (ii) Concrete properties (iii) Surface Condition of bar.

(iv) The studying of concrete for bond strength is done at high temperature.

→ At high temperature the dehydration of concrete start bet concrete's pores release pressure

→ Due to which strength of concrete reduces & causes structural failure

→ So it is important to study behavour of bonding b/w concrete & steel subjected to high temperature