Performance/Durability of **Cement Concrete**

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The Two Parameters of cement Concrete

Strength &

Performance/Durability

What is Durability ?

- Durability of cement concrete is defined as the ability of concrete to resist weathering action, chemical attack, abrasion or any other process of detoriation.
- Durable concrete will retain its original form ,quality and serviceability when exposed to the environment
- Durability by - Good cohesion, workability and reduced bleeding - due to optimum fineness

Defects of Concrete

The Main Tasks

How to attain the Strength of Cement Concrete?

How to improve Performance-Durability of Cement Concrete ?

Factors Affecting Durability

- Type, quality & quantity of Cement
- Quality of aggregates
- Constructional defects
- W/C ratio
- Environmental Conditions
- Workmanship (Compaction, cover, curing etc.)
- Strength of concrete
- Quality of water

Strength of Cement Concrete

- Design of Cement Concrete.
- Depends on Standard Execution procedures.
- Quality of CA, FA, Cement & Water.
- Use of Admixtures such as Plasticizers and other workability agents .
- Use of equipment such as Pin Vibrators , Flat Vibrators.

Performance/Durability

Performance/Durability is the greater challenge of the day.

IS:456-2000 gives special attention to Performance/Durability of Cement Concrete in Clause-8 .

Factors effecting Performance/Durability of Cement Concrete

IS:456-2000 , Clause-8 focused on

- Low permeability.
- Low Free water.
- Environment.
- Ingress of Water, Oxygen, **SO_2**, Chlorides & Sulphates & other deleterious material

Major Factors affecting the Durability of Cement Concrete

- ***Free Water in concrete.***
- ***Moderate to severe exposure conditions.***
- ***High humidity, Rain & Sea water exposure.***
- ***Permeability, Honeycombs, Shrinkage cracks,etc.***
- ***Chemical Resistance, Sulphate attacks .***
- ***Chloride resistance and steel corrosion.***
- ***Resistance to Alkali-silica reaction (ASR).***
- ***Carbonation due to pore connectivity.***

Main Focus

- **Reduce the permeability , pore volume and pore connectivity and make the Concrete impermeable.**
- Arrest the Migration of salts, chlorides, sea water, and other aggressive chemicals in to concrete.
- Concrete must be **Physically & Chemical Durable.**

How to address the factors affecting the Durability of Concrete.

Make dense concrete with low permeability , less pores and less or no free water- High Performance Concrete.

“High performance concrete”

Low permeability and resistance to chemical attack.

High workability.

High strength

High modulus of elasticity

High density

High dimensional stability

Micro Structure of Normal Cement Concrete.

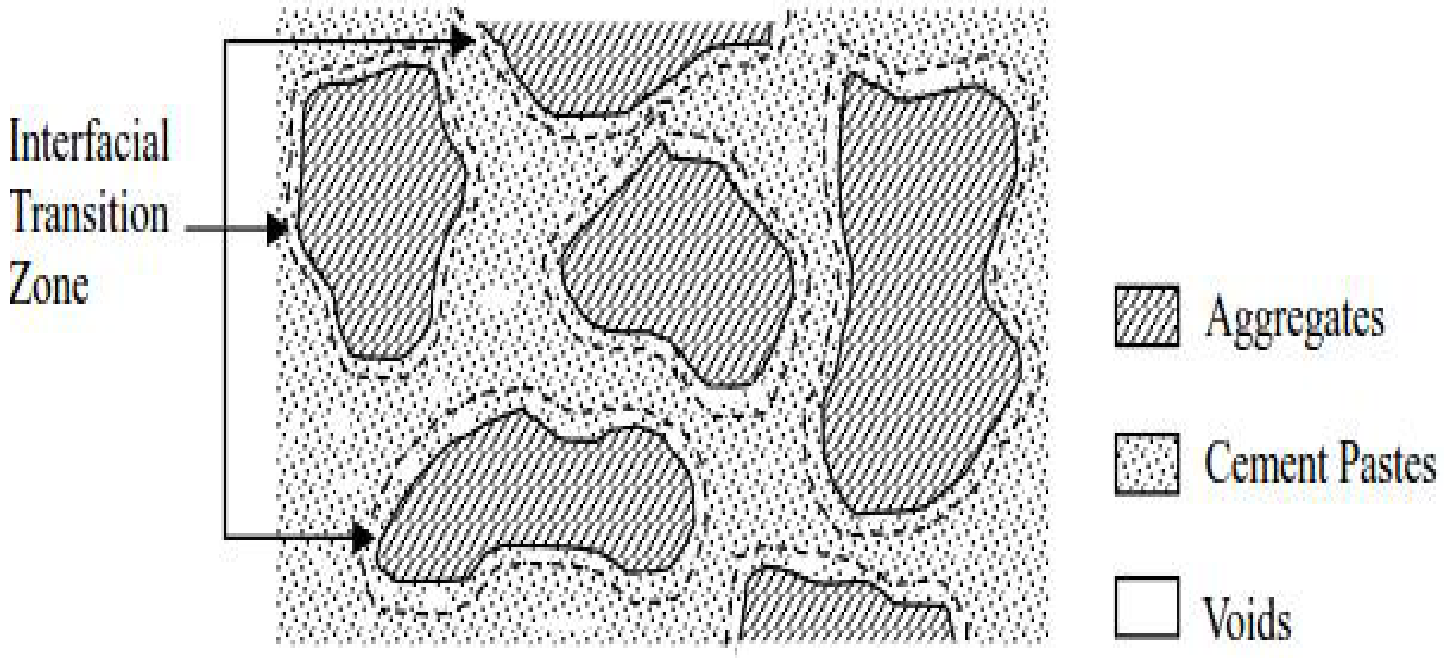

Figure 1: Microstructure of NSC

Micro Structure of High Performance Concrete.

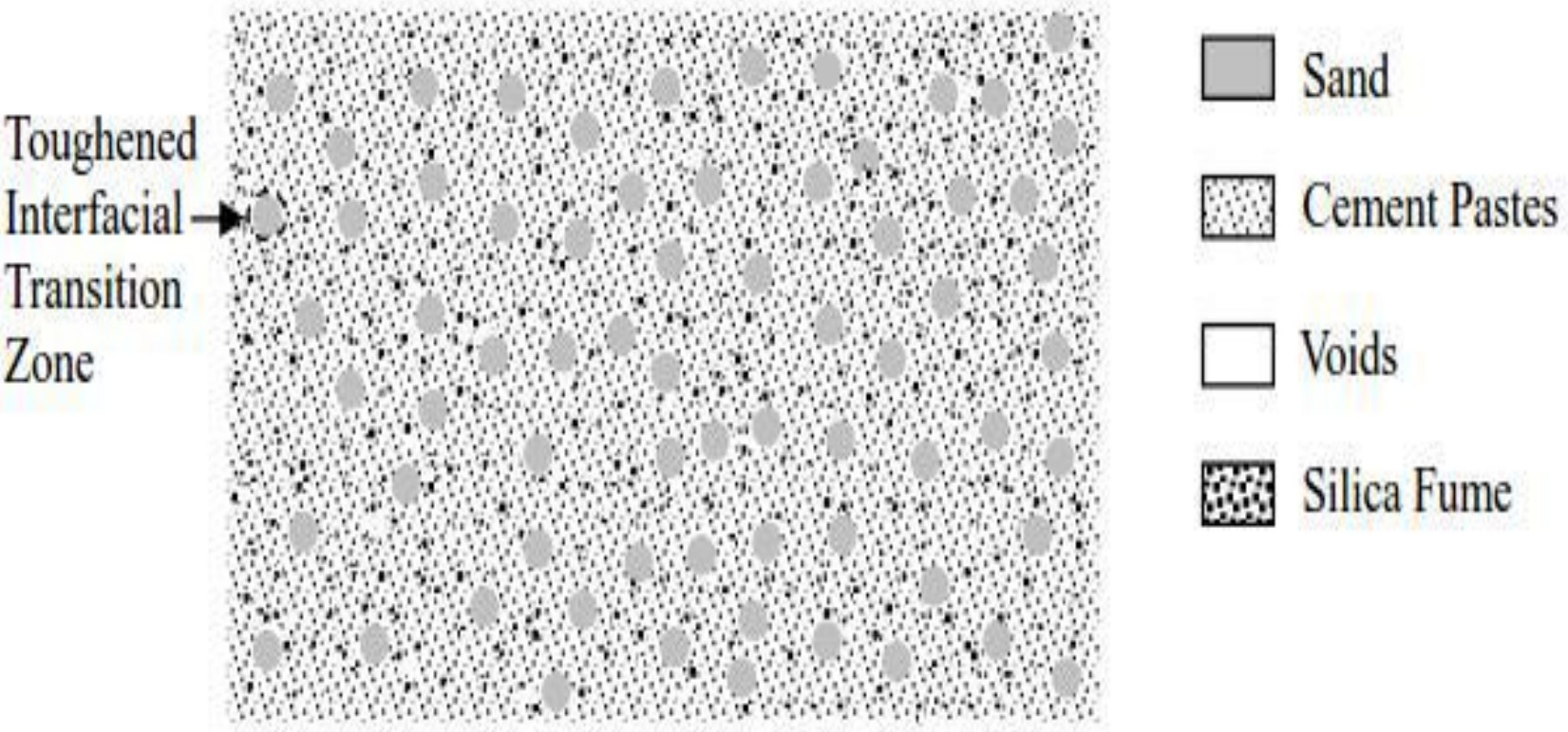

Figure 3: Microstructure of HPC

Hydration Process & Calcium Hydroxide, **$Ca(OH)_2$**

- During the hydration process and reaction of **C_3S and C_2S** with water, calcium silicate hydrate : C-S-H and calcium hydroxide, **$Ca(OH)_2$** are formed. Calcium silicate hydrates are the most important products. It is the essence that determines the good properties of concrete.
- **$Ca(OH)_2$ is not a desirable product in the concrete mass, it is soluble in water and gets leached out making the concrete porous**.

Calcium Hydroxide

Calcium Hydroxide

It constitutes 20 to 25 per cent of the volume of solids in the hydrated paste., accounts for he lack of durability of concrete and cause deterioration of concrete.

To reduce the quantity of Ca(OH)2 in concrete and to overcome its bad effects by converting it into cementitious product is an advancement in concrete technology.

The use of blending materials such as fly ash, silica fume and such other pozzolanic materials are the steps to overcome bad effect of Ca(OH)2 in concrete.

Pozzolanic activity

$Ca(OH)_2$ + Pozzolana + water → C – S – H (gel)

The deleterious **$Ca(OH)_2$** is converted to cementitious material CSH Gel, secondary reaction known as **"Pozzolanic activity".**

Reactive Silica Powders (**Pozzolanic Materials)** are **Slag, Silica Fume, GGBS, Fly Ash.**

“Pozzolanic Cements ”

Portland Slag Cement **PSC (IS:455-2015)**

and Portland Pozzolana Cement **PPC (IS:1489-2015)** are major **Pozzolanic Cements.**

Pozzolanic Cements decrease Permeability, Pores and free water.

Pozzolanic Cements make Dense & Durable concretes.

Myth & Misconceptions in cement / concrete

- The color of the cement - Color has no significance on any properties of the cement. The strength of the cement is dependent only on the proportion of raw materials in the mix..
- Concrete is always a gray color- Concrete designed for strength and durability, colour of concrete depend on raw material used
- The higher the compressive strength, the more durable the concrete – is not true, more durable concrete having more strong concrete
- Adding water to the mix is the only way to increase slump - There are other, more effective ways to increase concrete slump besides adding more water.

Task of the Day

STRENGTH

DURABILITY

SUSTAINABILITY

THANK YOU

Good Day