Module- 3

Hardened Concrete

Strength of cement paste $\propto$ cement content $\propto \frac{1}{\text{air content}} \propto \frac{1}{\text{water content}}$

Gel/ space Ratio :- The ratio is defined as the volume of hydrated paste to the some of volumes of hydrated cement and that of capillary force.

Gel space ratio is directly proportional to the strength of cement.

$$\text{Strength} = 240^{x}$$

$x \rightarrow$ Gel space ratio

maturity concept :-

$$\text{Maturity} = \sum [\text{time} \times \text{temperature}]$$

$$= \text{_____}\ ^{\circ}C\ \text{hrs}$$

problems on maturity contept :-

① The strength of a sample of fully matured concrete is found to be 40 mpa. Find the strength of identical concrete at the age of 7 days when cured at an average temperature during the day time at 20°c at night time 10°c.

Sol^{n} ∴ maturity at 7 days

$$7 \times 12 \times [20^{\circ} - (-11)] \rightarrow \text{day}$$

Maturity = 2604

$$7 \times 12 \times [10^{\circ} - (-11)] \rightarrow \text{Night}$$

Maturity = 1764

Maturity at 7 days = day + night

= 2604 + 1764

= 4368°C hours

[considering day as 12 hours and night as 12 hours]

maturity @ 7 days $= \left[7 \times 12 \times \left[20^{\circ}_{\text{day}} - (-11)\right]\right] + \left[7 \times 12 \times \left[10^{\circ}_{\text{night}} - (-11)\right]\right]$

$= 4368^{\circ}\,C$ hrs

The strength range of the concrete falls in zone - 3 for which $A = 32$ $B = 54$

The percentage strength of concrete at maturity of $4368^{\circ}\,C\,h$ =

$$A + B \log_{10}\left[\frac{\text{maturity}}{1000}\right]$$

The percentage strength of concrete at maturity of $4368^{\circ}\,C\,h = 32 + 54 \log_{10}\left[\frac{4368^{\circ}}{1000}\right]$

$= 66.57\ \%$

Identical strength $= \frac{40 \times 66.57}{100}$

$= 26.62$ mpa

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tension

Compression

High Strength concrete

The Special methods of making high Strength concrete are

(1) Seeding
(2) Revibration
(3) High speed slurry mixing
(4) use of admixtures
(5) Inhibition of cracks
(6) Sulphur infragnation
(7) use of cementaneous aggregates

(1) Seeding:-

* This involves adding a Small percentage of finely ground fully hydrated cement to fresh concrete mix

(2) Revibration :- Concrete undergoes plastic Shrinkage, mixing water contains cant create continous capillary charges bleeding and also water gets accumulated at Sme Selected places. All of these reduces the Strength of concrete. controlled revibration removes these deflects and increasee the Strength of concrete

(3) High Speed Slurry mixing :-

This process involves the advance preparation of cement water mixture which is then blend with the aggregate to produce high strength concrete.

(4) Use of Admixtures :-

Use of water reducing agents are known to produce increased compressive strengths stoping the

(5) Inhibition of cracks :- Inhibition → Internal development

concrete fails by the formation and propogation of cracks. If the propogation of cracks is inhibited (restricted) the strength will be higher. Replacement of 2-3% of fine aggregate by polythene or polysterene 0.025 mm thick and 3 to 4 mm in diameter increases the strength. They appered to act as crack erasters without necessiating extra water for workability

(6) Sulphur inpragnation :-

Satisfactorily high strength concrete have been produced by impragnating low strength porous concrete by sulphur.

The process consists of moist curing the fresh concrete specimen for 24 hours, drying them at 120°C for 24 hours, immersing the specimen in molten sulphur under the vaccum for 2 hours and then releasing the vaccum and cooking them for an additional or for further infiltration of sulphur.

(7) Use of cementitious aggregate :-

Elasticity :-

$$E_c = 5000\sqrt{f_{ck}} \quad N/mm^2$$

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Creep :- * Influence of aggregates

Strength of aggregates $\propto \frac{1}{\text{creep}}$

* Influence of mix proportion
* Influence of age

Shrinkage :-

① Plastic shrinkage

* Loss of water takes place

② Drying shrinkage

* Drying condition
* Relative humidity
* water / cement ratio
* moisture movement

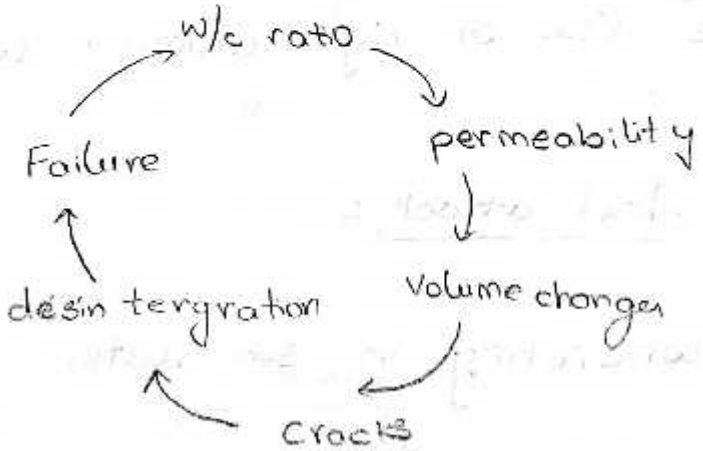
③ Autogeneous shrinkage

④ carbonation shrinkage

Durability :-

→ Resistance against weather
chemical attack
Abrasion

→ original
→ Form
→ quality
→ Serviceability



Sulphate attack

Na, Mg, K, Al, NH_4, Ca

$$Ca(OH)_2 + Na_2SO_4 \cdot 10H_2O \longrightarrow CaSO_4 \cdot 2H_2O + 2NaOH + 8H_2O$$

$$2\left[3CaO \cdot Al_2O_3 \cdot 12H_2O\right] + 3\left[Na_2SO_4 \cdot 10H_2O\right]$$

(Calcium Alumino Hydrate)

$$\longrightarrow 3CaO \cdot Al_2O_3 \cdot 3CaSO_4 \cdot 31H_2O + 2Al(OH)_3 + 6CaSO_4 + 17H_2O$$

Calcium alumino sulphate

[ETTRINGITE]

Controlling methods

1. Sulphate resisting cement
2. quality of concrete
3. use of high alumina content

Acid attack :-

Concreting in sea water

- chemical ($MgSO_4$)
- physical

Corrosion control in concrete

metallurgical methods

① Corrosion inhibitors

② Coating to reinforcement

* CECRI

* Derusting
* Phosphating
* cement coating
*

③ Galvanised reinforcement

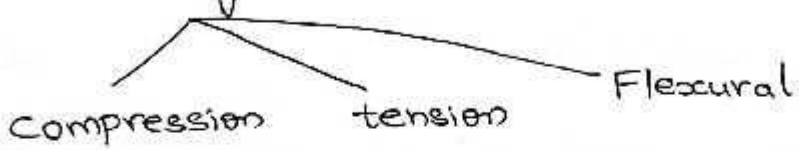
④ Cathodic protection

⑤ Coating the concrete

Nivelle

Tests on hardened concrete → 314 - 339

L> Strength test



Block

Split tensile test

Capping

L> Neat cement

L> Hard motar [42 mPa]

L> Lean mortar

L> Sulphur

Tests on hardened concrete

Destructive

- → Compression
- → Flexcure
- → Split tensile Strength

Non - destructive

- → Ultra - Violet pulse velocity test
- → Rebound Hammer / Schidmist Hammer
- → Absorption
- → Core extraction
- → Penetration test
- → pull out capacity