Internal Assessment Test 1 – Mar. 2018
Solution
Advance Concrete Technology 10CV81

1 **Explain the Structure of a Hydrated Cement Paste.**

Reactions of Hydration

- $2C_3S + 6H = C_3S_2H_3 + 3Ca(OH)_2$
  (100 + 24 = 75 + 49)
- $2\ C_2S + 4H = C_3S_2H_3 + Ca(OH)_2$
  (100 + 21 = 99 + 22)
- $C_3A + 6H = C_3AH_6$
  [C3A + CaSO4. 2H2O = 3Cao. Al2O3. 3CaSO4. 31H2O]
  Calcium Sulfoaluminate

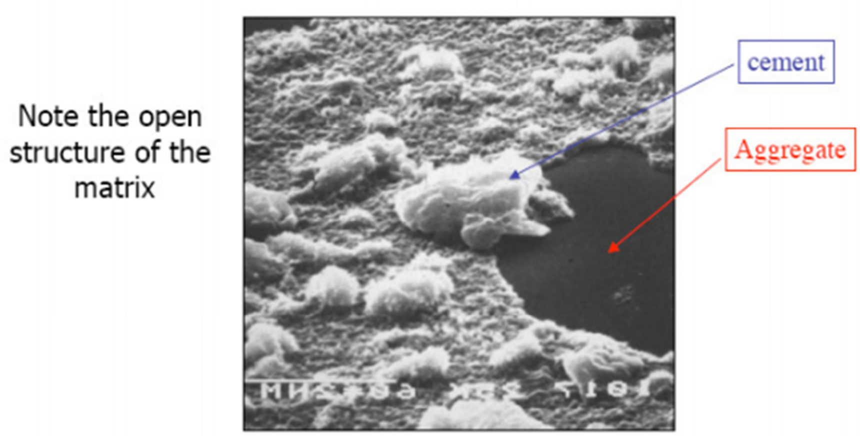
Heat of Hydration

The heat of hydration is the heat generated when water and Portland cement react. Heat of hydration is most influenced by the proportion of C_3S and C_3A in the cement, but is also influenced by water-cement ratio, fineness and curing temperature. As each one of these factors is increased, heat of hydration increases.

- For usual range of Portland cements, about one-half of the total heat is liberated between 1 and 3 days, about three-quarters in 7 days, and nearly 90 percent in 6 months.
- The heat of hydration depends on the chemical composition of cement.

2 (a) **Define the terms transition Zone, Elastic Modulus.**

Transition Zone



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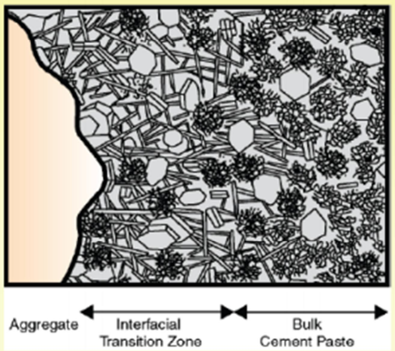
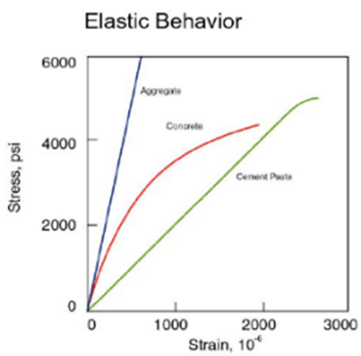
Interfacial Transition Zone



- The ITZ represents a small region next to the particles of coarse aggregate.
- Existing as a thin shell, typically 10 to 50 μm thick around large aggregate, the interfacial transition zone is generally weaker than either of the two main components of concrete, namely, the aggregate and the bulk hydrated cement paste.
- It has a far greater influence on the mechanical behavior of concrete than is reflected by its size.

Interfacial Transition Zone

Typical stress-strain diagrams of cement paste, aggregate, and concrete



Points to note:
- Aggregate and cement paste linear up to failure
- Concrete stress-strain response (elastic) in between aggregate and cement paste
- Concrete does not have a linear behavior up to failure

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Interfacial Transition Zone

Development

- in freshly compacted concrete, water films form around the large aggregate particles. This would account for a higher water-cement ratio closer to the larger aggregate than away from it.
- Due to the high water-cement ratio, calcium hydroxide and ettringite in the vicinity of the coarse aggregate consist of relatively larger crystals, and therefore form a more porous framework than in the bulk cement paste or mortar matrix.
- The platelike calcium hydroxide crystals tend to form in oriented layers with the -axis perpendicular to the aggregate surface.

Modulus Elasticity

Defining modulus of elasticity of concrete is difficult; Because concrete is not a linearly elastic material

Since the slope of σ-ε curve of concrete is not constant. We must first describe modulus of elasticity (E_c).

In general; Modulus of elasticity defined for concrete is the instantaneous Ec. This is not influenced by

the time effect (mean Ec is function of many variables)

Instantaneous E_c can be defined in 3 ways.

– Initial Modulus of Elasticity, E

– Secant modulus

– Tangent modulus

(b) **List the factors affecting strength and elasticity of concrete.**

The "strength" of hardened concrete is its ability to resist strain or rupture induced by external forces. The resistance of concrete to compressive, tensile and bending stresses is known as compressive strength, tensile strength, and bending (or flexural) strength, respectively. The resistance of concrete to repeated stresses is called its fatigue strength. Strength is expressed in terms of kgf/cm_2 or MPa.

Factors Influencing Cube Compressive Strength

- Platen effect
- Rate of loading
- Size of the specimen
- Moisture content
- Age of the specimen

3 **What is Rheology of concrete in terms of Bingham's parameter?**

Rheology of Concrete.

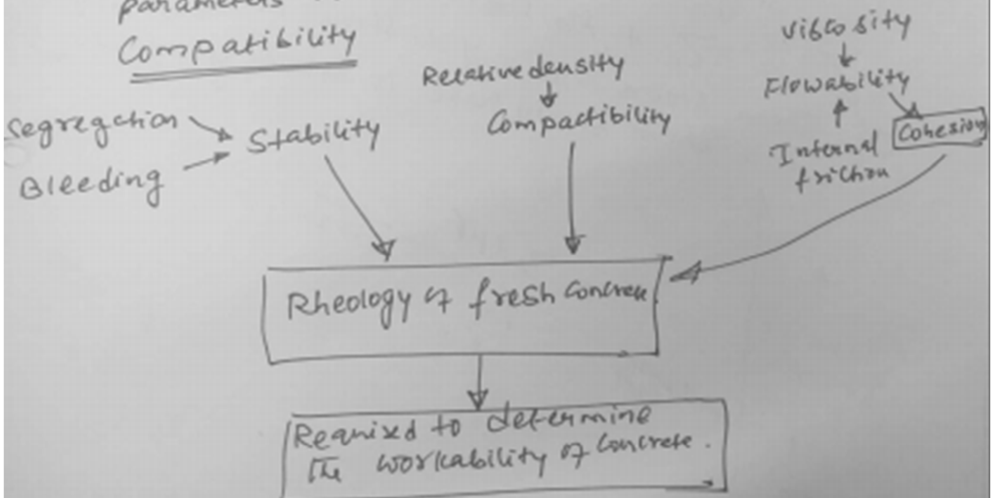
Explain Rehology of Concrete in terms of Bingham's parameter?

The Science of deformation and the flow of Materials and its concerned relationship between Stress, Strain, rate of Strain and time.

Rheology deals with the Materials whose flow properties are more complicated than those of simple fluids.

The Rheological principles and techniques is applied to Concrete, it includes Handling and placing of freshly mixed concrete.

The Rheology of fresh Concrete is defined by parameters such as Stability, Mobility and Compatibility



The Ideal Liquids which follow's Newton's Law of viscous flow.

⇒ Shear stress τ is directly proportional to rate of Shear strain γ (

$\tau \propto \gamma$ → Newtonion Liquids.

The flow of fresh concrete does not conform to this principle. Here Ratio of Shear stress to the rate of Shear strain is not constant.

The fact that the concrete can stand in Slump suggested that there is some minimum stress necessary for flow to occur.

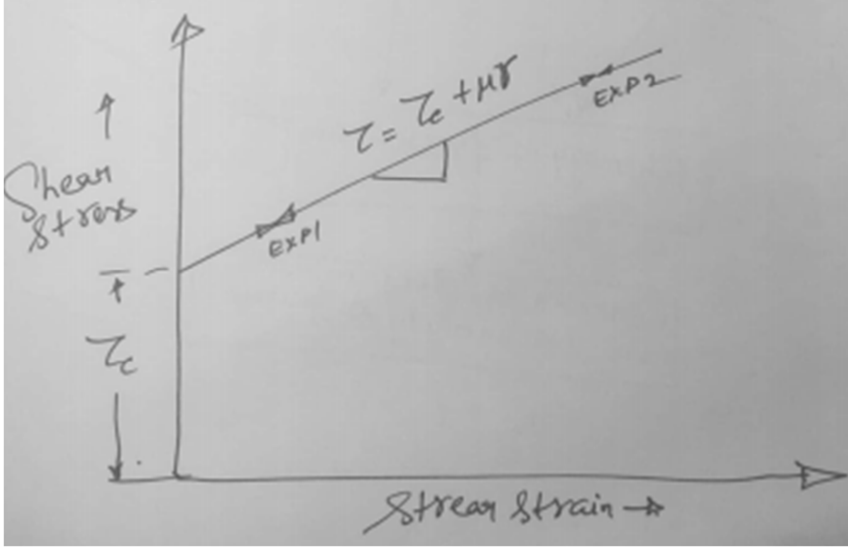
The minimum stress is called "yield stress τ_c"

Thus the flow Equation is written as (as per Bingham)

$$\tau = \tau_c + \mu\gamma$$

τ = Shear stress, τ_c = yield stress, μ = plastic viscosity

γ = Shear strain rate to strain gradient.



Yield stress and plastic viscosity are the parameters that characterize the flow properties of concrete.

Concrete can be defined by Bingham model showing a NON-ZERO ordinate @ the origin

ie The material will not flow until some particular minimum stress is reached.

4 **Define admixture and list the types of admixtures.**

An admixture is defined as a material other than water, aggregate, hydraulic cements and fiber reinforcement, used as an ingredient of concrete or mortar and added to the batch immediately before or during mixing.

1. CHEMICAL ADMIXTURES
    a. Plasticizers
    b. Super plasticizers
    c. Retarders and retarding plasticizers
    d. Accelerators and Accelerating Plasticizers
    e. Air-entraining Admixtures
    f. Mineral Admixtures
    g. New generation super plasticizers
2. POZZOLANIC OR MINERAL ADMIXTURES
    a. Flyash
    b. GGBS
    c. Ricehusk Ash
    d. Metakioline
    e. Nano silica or silica fume.

5 **Define Plasticizers, Super Plasticizers and Air-entraining admixtures.**

Plasticizers

Requirement of right workability is the essence of good Concrete. Concrete in different situations require different degree of workability. A high degree of workability is required in situations like deep beams, thin walls of water retaining structures with a high percentage of steel reinforcement, column and beam junctions, pumping of Concrete, hot weather Concreting. Today, we have plasticizers which can help in difficult conditions for obtaining higher workability without using excess of
water.

The organic substances or the combinations of organic and inorganic substances, which allow a high reduction in water content for the given workability or give a higher workability at the same water content, are termed as Plasticizing Admixtures.

The basic products constituting plasticizers are:

1. Anionic surfactants such as lignosulphonates and their modifications and derivatives, salts of sulphonates hydrocarbons.

2. Nonionic surfactants such as polyglycol esters, acid of hydroxylated carboxyl acids and their modifications and derivatives. 3. Other products, such as carbohydrates etc.

The action of plasticizers is mainly to fluidify the mix and improve the workability of concrete, mortar or grout. The mechanisms that are involved could be explained in the following way:

Dispersion: Portland cement, being in fine state of division, will have a tendency of flocculate in wet concrete. These flocculation entraps certain amount of water used in the mix and thereby all the water is not freely available to fluidify the mix.

When plasticizers are used, they get adsorbed on the cement particles. The adsorption of charged polymer on the particles of cement creates particle-to-particle repulsive forces which overcome the attractive forces. This repulsive force is called Zeta Potential, which depends on the base, solid content, quantity of plasticizer used. The overall result is that the cement particles are deflocculated and dispersed. When cement particles are deflocculated, the water trapped inside the flocs gets released

and now available to fluidify the mix.
When cement particles get flocculated there will be interparticles friction between particle to particle and floc to floc. But in the dispersed condition there is water in between the cement particle and hence the interparticle friction is reduced.
Retarding Effect: The plasticizer will get adsorbed on the surface of cement particles and form a thin sheath. This thin sheath inhibits the surface hydration reaction between water and cement as long as sufficient plasticizer molecules are available at the particle/solution interface. The quantity of available plasticizers will progressively decrease as the polymers become entrapped in hydration products.

Super Plasticizers
Superplasticers constitute a relatively new category and improved version of plasticizer, the use of which was developed in Japan and Germany during 1960 and 1970 respectively. They are chemically different from normal plasticizers. Use of superplasticizer permits the reduction of water to the extent upto 30 per cent without reducing workability in contrast to the possible reduction up to 15 per cent in case of plasticizers.
The use of superplasticizer is practiced for production of flowing, self leveling, and self compacting and for the production of high strength and high performance concrete.
Super plasticizers can produce:
 At the same w/c ratio much more workable concrete than the plain ones,
 For the same workability, it permits the use of lower w/c ratio,
 As a consequence of increased strength with lower w/c ratio, it also permits a reduction of cement content.
The super plasticizers also produce a homogeneous, cohesive concrete generally without any tendency for segregation and bleeding. Classification of Superplasticizer:
Following are a few polymers which are commonly used as base for super plasticizers.
 Sulphonated melamine-formaldehyde condensates (SMF)
 Sulphonated naphthalene-formaldehyde condensates (SNF)
 Modified lignosulphonates (MLS)

RETARDING ADMIXTURES
It is mentioned earlier that all the plasticizers and super plasticizers by themselves show certain extent of retardation. Many a time this extent of retardation of setting time offered by admixtures will not be sufficient. Instead of adding retarders separately, retarders are mixed with plasticizers or super plasticizers at the time of commercial production. Such commercial brand is known as retarding plasticizers or retarding super plasticizers.

ACCELERATORS
Accelerating admixtures are added to concrete to increase the rate of early strength development in concrete to

- permit earlier removal of formwork;
- reduce the required period of curing;
- advance the time that a structure can be placed in service;
- partially compensate for the retarding effect of low temperature during cold weather concreting;
- in the emergency repair work.

AIR-ENTRAINING ADMIXTURE
Perhaps one of the important advancements made in concrete technology was the discovery of air entrained concrete. Since 1930 there has been an ever increasing use of air entrained concrete all over the world especially, in the United States and Canada. Due to the recognition of the merits of air entrained concrete, about 85 per cent of concrete manufactured in America

contains on or the other type of air entraining agent. So much so that air entraining agents have almost come to be considered a necessary 'fifth ingredient' in concrete making. Air entrained concrete is made by mixing a small quantity of air entraining agent or by using air entraining cement. These air entraining agents incorporate millions of no-coalescing air bubbles, which will act as flexible ball bearings and will modify the properties of plastic concrete regarding workability, segregation, bleeding and finishing quality of concrete. It also modifies the properties of hardened concrete regarding its resistance to frost action and permeability.

AIR ENTRAINING AGENTS

The following types of air entraining agents are used for making air entrained concrete.

(a) Natural wood resins

(b) Animal and vegetable fats and oils, such as tallow, olive oil and their fatty acids such as stearic and oleic acids.

(c) Various wetting agents such as alkali salts or sulphated and sulphonated organic compounds.

(d) Water soluble soaps of resin acids, and animal and vegetable fatty acids.

(e) Miscellaneous materials such as the sodium salts of petroleum sulphonic acids, hydrogen peroxide and aluminium powder, etc.

6 **Explain Marsh cone test and state its advantages.**

This simple field test shows also the optimum dose of the superplasticizer to the cement. Following methods could be adopted.

- Marsh cone test
- Mini slump test
- Flow table test.

Out of the above, Marsh cone test gives better results. In the Marsh cone test, cement slurry is made and its flow ability is found out. In concrete, really come to think of it, it is the cement paste that influence, it is the paste that influences flow ability. Although, the quantity of aggregates, its shape and texture etc. will have some influence, it is the paste that will have greater influence. The presence of aggregate will make the test more complex and often erratic. Whereas using grout alone will make the test simple, consistent and indicative of the fluidifying effect of superplasticizer with cement. The following procedure is adopted in Marsh cone test.

Marsh cone is a conical brass vessel, which has a smooth aperture at the bottom of diameter 5 mm. The profile of the apparatus,.

Take 2 kg cement, proposed to be used at the project. Take one liter of water (w/x= 0.5) and say 0.1% of plasticizer. Mix them thoroughly in a mechanical mixer (Hobart mixer is preferable) for two minutes. Hand mixing does not give consistent results because of unavoidable lump formation which blocks the aperture. If hand mixing is done, the slurry should be sieved through 1.18 sieve to exclude lumps.

Take one liter slurry and pour it into Marsh cone duly closing the aperture with a finger. Start a stop watch and simultaneously remove the finger. Find out the time taken in seconds, for complete flow out of the slurry. The time in seconds is called the "Marsh Cone Time". Repeat the test with different dosages of plasticizer.

The dose at which the Marsh cone time is lowest is called the saturation point. The dose is the optimum dose for that brand of cement and plasticizer or super plasticizer for that w/c ratio.