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Q1:

A. (ans) There are three primary reasons.
    - First, concrete possesses excellent resistance to water. Unlike wood and ordinary steel, the ability of concrete to withstand the action of water without serious deterioration makes it an ideal material for building structures to control, store, and transport water.
    - The second reason for the widespread use of concrete is the ease with which structural concrete elements can be formed into a variety of shapes and sizes. This is because freshly made concrete is of a plastic nature, which enables the material to flow into preinstalled formwork. After a number of hours when the concrete has solidified and hardened to a strong mass, the formwork can be removed for reuse.
    - The third reason for the popularity of concrete with engineers is that it is usually the cheapest and most readily available material on the job. The principal components for making concrete, namely aggregate, water, and Portland cement are relatively inexpensive and are commonly available in most parts of the world.

Q1)

B. (Ans) It has been observed that the compressive (crushing) strength of concrete is influenced by a huge number of factors.
   Some of the most important factors are:
    1. **Type of Cement:**
        - The composition, quality and "age" of the material which is used in the manufacture of cement that have been stored for the considerable time make concrete of lower strength.
        - Cement with higher proportions of tri-calcium silicate produce concrete that show higher strengths, at least in earlier stages.
        - Similarly, finer the particle size of the cement, higher is the ultimate compressive strength.
    2. **Nature of Aggregates.**
        - Sand and coarse a`egates are the other two essential components of concrete. A good bond between cement and the aggregates is possible only when the aggregates have sharp edges, clean surfaces, and rough texture.
        - Smooth and rounded aggregates result in comparatively weak bonds. Similarly, the aggregates used in the concrete making should have in themselves good compressive strength.

- For example, if chalk (very soft limestone) is used in making of concrete instead stone crush, the resulting concrete will be weak in compressive strength because of the reduced strength of the aggregate.

3. **Water-Cement Ratio.**
    - The compressive strength decreases, in general, with increasing water cement ratio.
    - Hence, when minimum water has been used just to ensure complete hydration of the cement, the resulting concrete will give maximum compressive strength on proper compaction.
4. **Curing Conditions.**
    - Great importance is attached to proper curing of concrete after it's laying for obtaining maximum compressive strength.
    - Incomplete curing and irregular drying of concrete during the curing period may cause a loss in the compressive strength to the extent of 40 percent or even more.
5. **Weather Conditions.**
    - The same concrete placed in different climates -extremely cold and dry hot, may develop different strength values.
    - The cause is related to incomplete hydration of the cement in the concrete.
6. **Admixtures.**
    - Certain admixtures are added to the concrete at the mixing stage for achieving some specific purposes.
    - It has been observed that certain admixtures especially calcium chloride, increase the compressive strength.
    - Some other admixtures (e.g., air entraining agents) however, affect the compressive strength adversely if proper controls are not maintained on the water-cement ratio.
7. **Method of Preparation**
    - Improper mixing of the concrete and careless transport and placing may result in poor (in strength) quality, despite the best cement and aggregates used in it.
    - It is the workmanship that determines the quality of the concrete. A skilled worker can produce best concrete-mix.
    - An incompetent labor, however, may spoil the entire work despite being given the best-designed concrete-mix.
    - The voids left in the concrete on compaction and curing have a profound influence on the strength of the concrete.

Q2:

A. (Ans) Micro Structure of hydrated cement paste
    - When Portland cement is dispersed in water, as a result of interaction between calcium, sulfate, aluminate, and hydroxyl ions within a few minutes of cement hydration, the needle-shaped crystals of calcium trisulfo-aluminate hydrate, called ettringite, first make their appearance having low surface area and volume.
    - A few hours later, large hexagonal shaped crystals of calcium hydroxide also known as Portlandite and calcium silicate hydrates (C-S-H gel) having high surface area and volume begin to fill the empty space formerly occupied by water and the dissolving cement particles.
    - After some days, depending on the alumina-to-sulfate ratio of the Portland cement, ettringite may become unstable and will decompose to form mono-sulfo-aluminate hydrate, which has a plane hexagonal in structure.

1. Calcium sulfo-aluminates hydrates
   low surface area: 2 m2/g
    - Calcium sulfo-aluminate hydrates occupy 15 to 20 percent of the solid volume in the hydrated paste and, therefore, play only a minor role in the microstructureproperty relationships.
    - In pastes of ordinary portland cement, ettringite eventually transforms to the monosulfate hydrate which forms plane hexagonal-plate crystals.
    - The presence of the monosulfate hydrate in portland cement concrete makes the concrete weak to sulfate attack.

   Calcium Hydroxide or Portlandite
    - Calcium hydroxide crystals (also called Portlandite) occupy 20 to 25 percent of the volume of solids in the hydrated paste.
    - It tends to form large crystals with a hexagonal-prism shape. The shape is usually affected by the available space, temperature of hydration, and impurities.
    - Calcium hydroxide have lower surface area (0.5 m2/g).

   Calcium Silicate Hydrate or C-S-H gel
    - The calcium silicate hydrate phase, abbreviated as CS-H, makes up 50 to 60 percent of the volume of solids in a completely hydrated Portland cement paste and is, therefore, the most important phase determining the properties of the paste.
    - Although the exact structure of C-S-H is not known, several models have been proposed to explain the structure and surface area.

- According to the Powers-Brunauer model, the material has a layer structure with a very high surface area. Depending on the measurement technique, surface areas on the order of 100 to 700 m^2 /g have been proposed for C-S-H
- The Feldman-Sereda model visualizes the C-S-H structure as being composed of an irregular or linked array of layers which are randomly arranged of different shapes and sizes

Q2:

B. (Ans) Thermal Properties of Concrete.
The thermal properties that influence temperature rise and distribution in a concrete structural member are thermal conductivity, specific heat, thermal diffusivity, and mass loss.

- To study about the thermal properties of concrete the following properties needs to be known:
    1) Thermal conductivity.
    2) Thermal diffusivity.
    3) Specific heat.
    4) Coefficient of thermal expansion.

1. Thermal conductivity
    - The thermal conductivity of a material is a measure of it ability to conduct heat.
      It is commonly denoted by k .
    - $k=Q*L/A(T2-T1)$
    - Where: Q = heat flow (W)
      L = length or thickness of the material (m)
      A = surface area of material (m^2)
      $T2-T1$ = temperature gradient
2. Thermal diffusivity.
    - In heat transfer analysis, thermal diffusivity is the thermal conductivity divided by density and specific heat capacity at constant pressure. It measures the rate of transfer of heat of a material from the hot end to the cold end. It has the SI derived unit of m^2/s.
    - D = K/Sd
      D = Thermal diffusivity (m^2/s)
      K = Thermal conductivity (J/s)
      S = Specific heat (J/kg)
      d = Density of concrete (kg/m^3)
3. Specific heat.
    - Specific Heat is defined as the quantity of heat required to raise the temperature of a unit mass of concrete by $1^{\circ}C$.

- The Common range of values for concrete is between 840 and 1170 J/kg per 1°C.
- Specific heat represents the heat capacity of concrete
- It increases with the moisture content of concrete and is affected by the mineralogical character of the aggregate,
- Specific heat increases with an increase in temperature.
- It also increases with a decrease in the density of concrete

4. Coefficient of thermal expansion.
   - Coefficient of the thermal expansion is defined as the change in unit length per degree change in the temperature. It depends upon
   - Composition of mix
   - Coefficient of expansion of cement concrete paste.
   - Coefficient of expansion of aggregate.
   - The coefficient of thermal expansion of Portland cement concrete (PCC) ranges from about 8 to 12 micro-strains/°C.
   - The range of coefficient of thermal expansion values for different concretes reflects the variation in coefficient of thermal expansion of concrete's component materials.
   - For example, concrete containing limestone aggregate has a lower coefficient of thermal expansion than concrete containing siliceous aggregate. Because aggregate comprises about 70% of the concrete, aggregate type has the greatest effect on the coefficient of thermal expansion of concrete.

Q3)

1) (Ans) Normal strength concrete
   - It is also called normal weight concrete or normal strength concrete. It has a setting time of 30 - 90 minutes depending upon moisture in atmosphere, fineness of cement etc. The development of the strength starts after 7 days the common strength values is 10 MPa (1450 psi) to 40 MPa (5800 psi).
2) Reinforced concrete
   - Reinforced concrete (RC) (also called reinforced cement concrete or RCC) is a composite material in which concrete's relatively low tensile strength and ductility are counteracted by the inclusion of reinforcement having higher tensile strength or ductility.
3) Pre-stressed concrete
   - Prestressed concrete is concrete that has had internal stresses introduced to counteract, to the degree desired, the tensile stresses that will be imposed in service. The stress is usually imposed by tendons of individual hard-drawn wires, cables of hard-drawn wires, or bars of high strength alloy steel.

Q3)

B.(Ans) Interfacial transition zone in concrete.

- Concrete is considered to be two phase material
    1) Paste phase
    2) Aggregate phase
- At microscopic level, the concrete have complexities, particularly in the area of large aggregate particles.
- This area is considered as a third phase called the transit zone, which represents, the inter facial region zone between the particles of coarse aggregate and hardened paste.
- This transition zone is a plane of weakness and therefore has great influence on mechanical behavior (strength) of concrete.