4CE2A

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B.Tech. (Sem. IV) MID TERM EXAMINATION, Civil Engg.

4CE2A Concrete Technology

Time : 2 Hours] [Total Marks: 20]

Problem 1 Identify the correct response(s) in the following questions. Please note that there may be more than one 'right' response.

1. Which of the following is/are hydration product of OPC.

(a) *Alite* **(b)** *Ettringite*

(c) *Monosulphate* **(d)** *Calcium hydroxide*

Solution. *Apart from alite, all are hydration products.Hence the correct response is* ***B, C and D.***

2. Which of the following is/are a constituent(s) of OPC.

(a) C_3A **(b)** *Portlandite*

(c) Na_2O **(d)** *Gypsum*

Solution. *Portlandite (calcium hydroxide) is a hydration product. All the others are a part of the OPC. Whereas* C_3A *is one of the complexes,* Na_2O *is an alkali oxide present as an impurity. Gypum is added to the clinker at the time of grinding the clinker to produce OPC and is hence an integral part of the OPC. Indeed, gypum is NOT a part of the clinker !!*
Hence the correct response is ***A, C and D.***

3. False set occurs in a cement when

(a) *High gypsum and high aluminate content*

(b) *Low gypsum and high aluminate content.*

(c) *Low gypsum and low aluminate content*

(d) *High gypsum and low aluminate content.*

Solution. *Hence the correct response is* ***D.***

4. If in an application, higher ultimate strength is desired, which of the cements is the most suitable.

(a) *One that has a high* C_3S *content*

(b) *One that has a high* C_2S *content*

(c) *One that has a high* C_3A *content*

(d) *One that has very little gypsum.*

Solution. C_3A *contributes to strength in the initial part of the hydration, whereas both* C_3S *and* C_2S *contribute to strength in the later period. Among the latter two,* C_2S *continues to hydrate over a longer period and is a preferred constituent in high strength concrete.*

*Hence the correct response is **B.***

Problem 2. The specific gravity and bulk density of a coarse aggregate is found to be 2.7 and 1500 kgs/m^3. Estimate the void content in the sample used to determine the bulk density.

Solution. The sp gr of 2.7 means that the weight of solid 1000 liters of the coarse aggregate = 2700 kg Given that the weight of measured sample = 1500 kg It is clear that a volume of aggregate missing = 1200/2.74 = 438 liters Percentage of voids = 43.8%
Alternatively, it can be found that the solid volume from the bulk density is only 1500/2.74 = 562 liters, which also gives the void content to be 1000 – 562 = 438 liters

Problem 3. Write a short note defining 'porosity' of a material and how it is different from 'permeability'.

Solution. Porosity basically is a measure of the amount of pores in a material and can therefore be expressed a volume percentage (wrt total volume, or solid volume, etc.). In absolute terms, it can be measured in terms of cc/cc etc. on the other hand permeability is the ability of a 'fluid' to pass through a medium (or a material). It is easy to understand that, in simple terms, the amount of material that flows through a barrier would depend upon factors such as the extent of the pores, the area through which the flow occurs and thickness of the barrier, apart from the difference in concentration or pressure on the two sides of the barrier, besides the properties of the fluid involved. For example, it will be more difficult for a more viscous fluid to flow than a low viscous one, and so on. The latter idea is captured in 'permeability'.

Problem 4. Give reasons for design and quality control measures sometimes allow upto 91 days to determine if the concrete reaches strength (instead of the more common 28days) in cases when blended cements or mineral admixtures are used in concrete construction.

Solution. It is because the presence of mineral admixtures (separately or as a part of the cement, as in the case of using blended cements) implies that strength development will continue for a longer period. This is because there is evidence to suggest that the secondary hydration reaction involving the silica from the mineral admixture and the calcium hydroxide from the primary hydration reaction (reaction of water with the constituents of cement) is a slower reaction. Thus, a greater time is 'allowed' for strength development in such cases. It should also be borne in mind that in several cases where concrete is used, the structure is subjected to full load (service load) only much later than 28 (or even 91 day for that matter), and hence there is reason to 'allow' more time for strength development.

Problem 5. Give reasons for strength of concrete reduces as the water-cement ratio is increased, in the normal range of operations

Solution. The water-cement ratio may be taken to be between 35-40% and 50-55% in the normal range of operations. Now in this range, the water added is clearly higher than that that can be 'fully' consumed in the hydration of cement. It may be noted that the amount of water for complete hydration may be seen to be in the range of 18-22% in the literature, depending upon the characteristics of the cement involved. Now, the water added to the concrete over and above the requirement from the point of view of hydration remains in the concrete and evaporates over a period of time leaving behind pores of different sizes. This phenomenon is at the root of the porosity in concrete, and it is clear that as the water-cement ratio increases, this excess water is more, given that the amount of water required for and consumed during hydration is more or less constant. Independently, it is intuitively clear that the strength of a material would be inversely proportion to the porosity, i.e. higher the porosity lower the strength. Thus, higher the water-cement ratio, lower the strength of concrete in the normal range of operations.