



SNS COLLEGE OF TECHNOLOGY
(AN AUTONOMOUS INSTITUTION)
COIMBATORE-35

III YEAR CIVIL ENGINEERING
19CEO304-BUILDING MAINTENANCE



UNIT II

SERVICEABILITY AND DURABILITY OF CONCRETE

Concrete Properties

- Strength
- Permeability
- Thermal Properties



CONCRETE PROPERTIES

Strength

- ❖ Strength of concrete is one of the most important factors. Concrete is used as a structural element, and all structural uses are associated with its compressive strength. Strength of concrete is defined as the resistance that concrete provides against load so as to avoid failure.
- ❖ It depends on the water-cement ratio, quality of aggregates, compaction, curing etc. The primary factor that affects the strength of concrete is the quality of cement paste, which in turn, depends on the quality of water and cement used.
- ❖ Sometimes it is economical to add pozzolana or use Portland pozzolana cement instead of ordinary cement concrete.
- ❖ Pozzolanas are materials that have little cementing value but rich with calcium hydroxide to form compounds that are cementitious. This reaction contributes to the ultimate strength and watertightness of concrete.



Strength

Pozzolanas also increases the plasticity and workability of concrete. Excessive addition of pozzolanas affects durability. So it should be used along with cement as a partial replacement or in small percentage.

Generally construction industry needs faster development of strength in concrete so that the projects can be completed in time or before time.

This demand is catered by high early strength cement, use of very low W/C ratio through the use of increased cement concrete and reduced water content. But this result in higher thermal shrinkage, drying shrinkage, modulus of elasticity and lower creep coefficients.

With higher quantity of cement content, the concrete exhibits greater cracking tendencies because of increase in thermal and during shrinkage. As the creep coefficient is low in such concrete there will not be much slope for relaxation of stresses. Therefore high early strength concretes are more prone to cracking than moderate or low strength concrete.



Strength

Of course, the structural cracks in high strength concrete can be controlled by use of sufficient steel reinforcement. But this practice does not help the concrete durability, as provision of more steel reinforcement; will only results in conversion of the bigger cracks to smaller cracks.

And these smaller cracks are sufficient to allow oxygen, carbon dioxide and moisture get into the concrete to affect the long term durability of concrete. Field experience have also corroborated that high early strength concrete are more cracks-prone.

According to a recent report, the cracks in pier caps have been attributed to use of high cement content in concrete.



Strength

Contractors apparently thought that a higher than the desired strength would speed up the construction time, and therefore used high cement content. Similarly, report submitted by National Cooperative Highway Research Programme(NCHRP) of USA during 1995, based on their survey showed that more than, 100000 concrete bridge decks in USA showed full depth transverse cracks even before structures were less than one month old.

The reasons given are that combination of thermal shrinkage and drying shrinkage caused most of the cracks. It is to be noted that deck concrete is made of high strength concrete. These concrete have a high elastic modulus at an early age.

Therefore, they develop high stresses for a given temperature change or amount of drying shrinkage. The most important point is that such concrete creeps little to relieve the stresses.



Permeability

Concrete is a permeable and a porous material. The rates at which liquids and gases can move in the concrete are determined by its permeability. Permeability affects the way in which concrete resists external attack and the extent to which a concrete structure can be free of leaks.

The permeability is much affected by the nature of the pores, both their size and the extent to which they are interconnected. There can therefore be no one measure of porosity which fully describes the way in which the properties of concrete or of hardened cement paste are affected.



Permeability:

The high permeability of concrete in actual structures is due to the following reasons:

- The large microcracks with generated time in the transition zone.
- Cracks generated through higher structural stresses.
- Due to volume change and cracks produced on account of various minor reasons.
- Existence of entrapped air due to insufficient compaction.



Thermal Properties:

Concrete is a material used in all climatic regions for all kinds of structures. Thermal properties are important in structures in which temperature differentials occur including those due to solar radiation during casting and the inherent heat of hydration.

Knowledge of thermal expansion is required in long span bridge girders, high rise buildings subjected to variation of temperatures, in calculating thermal strains in chimneys, blast furnace and pressure vessels, in dealing with pavements and construction joints, in dealing with design of concrete dams and in host of other structures where concrete will be subjected to higher temperatures such as fire, subsequent cooling, resulting in cracks, loss of serviceability and durability.



Thermal Properties:

The thermal properties of concrete are more complex than those of most other materials because these are affected by moisture content and porosity.

To study about the thermal properties of concrete the following properties needs to be known,

- Coefficient of thermal expansion Thermal conductivity
- Thermal diffusivity
- Specific heat



Cracking

Plastic shrinkage cracks

Water from fresh concrete can be lost by evaporation, absorption of sub grade, formwork and in hydration process. When the loss of water from the surface of concrete is faster than the migration of water from interior to the surface dries up.

This creates moisture gradient which results in surface cracking while concrete is still in plastic condition. The magnitude of plastic shrinkage and plastic shrinkage cracks are depending upon ambient temperature, relative humidity and wind velocity.



THANK YOU...