



# **SNS COLLEGE OF TECHNOLOGY**

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**An Autonomous Institution**

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## **DEPARTMENT CIVIL ENGINEERING**

**19CEE409 – REPAIR AND REHABILITATION OF STRUCTURES**

**III YEAR / V SEMESTER**

**Unit 1 : SERVICEABILITY AND DURABILITY OF CONCRETE**

Topic 2- Strength of Concrete & Permeability and thermal properties of  
Concrete



# 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.
- 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.

# Permeability of concrete



Permeability of concrete is defined as the property that controls the rate of flow of fluids into a porous solid. It largely depends on the size of pores, connectivity of pores, and how tortuous the path is for the permeating fluid.

## **Factors Influencing Concrete Permeability**

There are three major factors that influence the permeability of concrete :

### 1. Water to Cement ratio

Water to cement ratio influences concrete permeability to a great extent. The higher the w/c ratio the greater the concrete permeability. In this case, not only does sizable free water remain in concrete after completion of cement hydration but also particles of cement and aggregate would not be as compact as in the case of low water to cement ratio.



## 2. Compaction of Concrete

When concrete is adequately compacted, air-voids and trapped bleed water in concrete are eliminated. As a result, pores and more importantly interconnected pores are avoided and eventually concrete permeability is declined.

Therefore, it is crucial to select and use proper and suitable compaction equipment during concrete placement and supervise the work to achieve the desired compaction.

## 3. Curing of Concrete

It is obvious that curing of concrete substantially influences the permeability of concrete. Sufficient curing allows proper cement hydration. Subsequently, pores in concrete would be filled with hydration product.





# Thermal properties of concrete

Thermal properties of concrete to understand the behavior of concrete to heating and cooling. The study of thermal properties of concrete is an important aspect while dealing with the durability of concrete.

Concrete is a material used in all climatic regions for all kinds of structures. The important properties that will be discussed are:

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



## 1. Thermal Conductivity

This measures the ability of material to conduct heat. Thermal conductivity is measured in joules per second per square meter of area. Conductivity of concrete depends on type of aggregate and body when the temperature difference is 1 degree C per meter thickness of the body.

The conductivity of concrete depends on type of aggregate moisture content, density and temperature of concrete. When the concrete is saturated, the conductivity ranges generally between about 1.4 to 3.4 J/S/m<sup>2</sup>

## 2. Thermal Diffusivity

Diffusivity represents the rate at which temperature changes within the concrete mass. Diffusivity is simply related to the conductivity by the following equation:

$$\text{Diffusivity} = \text{Conductivity} / CP$$

Where C is the specific heat, and P is the density of Concrete. The range of diffusivity of concrete is between 0.002 to 0.006 m<sup>2</sup>/h



### 3. Specific heat

It is defined as the quantity of heat, required to raise the temperature of a unit mass of a material by one degree centigrade. The common range of values for concrete is between 840 to 1170 j/kg<sup>3</sup>/C

### 4. Coefficient Thermal Expansion

It is defined as the change in unit length per degree change of temperature. In concrete, it depends upon the mix proportions. The coefficient of thermal expansion of hydrated cement paste varies between  $11 \times 10^{-6}$  and  $20 \times 10^{-6}$  per degree C. The coefficient of thermal expansion of aggregates varies between  $5 \times 10^{-6}$  and  $12 \times 10^{-6}$  per degree C. Limestone and Gabbros will have low values and gravel and Quartzite will have high values of coefficient of thermal expansion.





**Thank you !!!**