PROPERTIES OF CONCRETE

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Properties of Hardened Concrete

1. Strength
2. Elastic Property
3. Fatigue
4. Durability
5. Permeability
6. Workability

Strength of Concrete

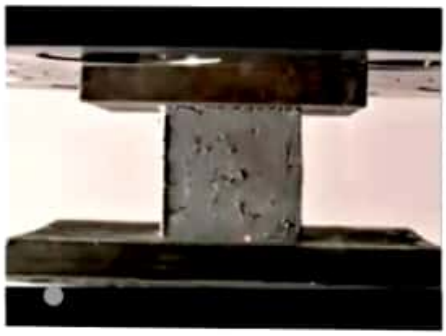
- Strength of concrete is commonly considered its most valuable property, although in many practical cases, other characteristics, such as durability and permeability may in fact be more important
- Strength usually gives an overall picture of the quality of concrete because strength is directly related to the structure of the hydrated cement paste

Types

1. Compressive strength
2. Tensile strength
3. Shear strength
4. Flexural Strength

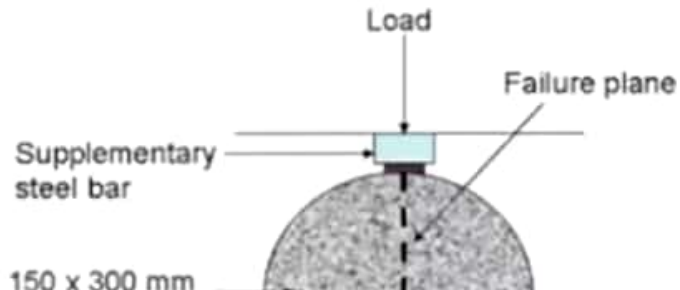
Compressive Strength

- The compressive strength of concrete is defined as the strength of 28 days old specimens tested under monotonic uniaxial compressive load
- Testing of cylindrical samples with 15 cm diameter and 30 cm height is standard
- Cube specimens of 15 cm × 15 cm × 15 cm are also being used



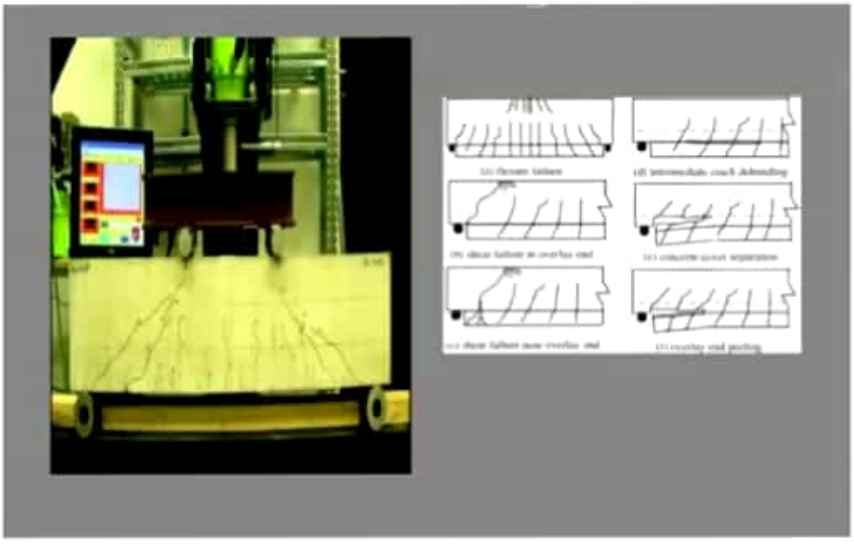
Tensile Strength

- The tensile strength of concrete is much lower than the compressive strength, largely because of the ease with which cracks can propagate under tensile loads
- The tensile strength of concrete is measured in three ways: direct tension, splitting tension, and flexural tension



Shear Strength

Shear strength of concrete is taken approximately equal to **20%** its compressive strength

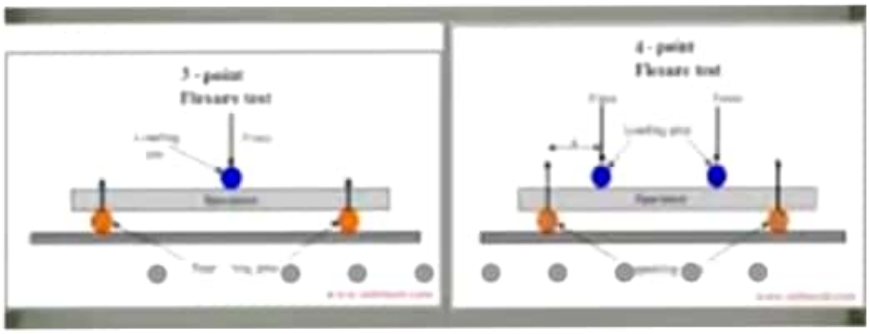


Flexural Strength

Flexural test evaluates the tensile strength of concrete indirectly. It tests the ability of unreinforced concrete beam or slab to withstand failure in bending

According to ASTM the size of the specimen is 150mm width, 150mm depth and the length should not be at least three times the depth of the specimen

Indian standard determined the size of the concrete specimen as 150mm width, 150mm depth, and span of 700mm



Elastic Properties

- It is a stress strain relationship under normal loading and under sustained loading.
- Under normal loading: the first effect of applying a load to concrete is to produce an elastic deformation i.e. as the load increases deformation increases.
- Under sustained loading: the continue application of stress causes a slow deformation known as creep. The increase of deformation is not proportional , as the time passes the deformation is lesser.

Modulus of Elasticity

- Defined as the ratio of load per unit area (stress) to the elastic deformation per unit length (strain).
- The modulus of elasticity for most concretes at 28 days, ranges from 15 – 40 kN/mm^2.

$$E = \frac{stress}{strain} = \frac{\sigma}{\varepsilon}$$

Stress-Strain

- **The "initial tangent modulus" is given by the slope of a line drawn tangent to the stress-strain curve at the origin**
- **The "tangent modulus" is given by the slope of a line drawn tangent** to the stress-strain curve at any point on the curve
- **The "secant modulus" is given by the slope of a line drawn from the origin** to a point on the curve corresponding to a 40% stress of the failure stress
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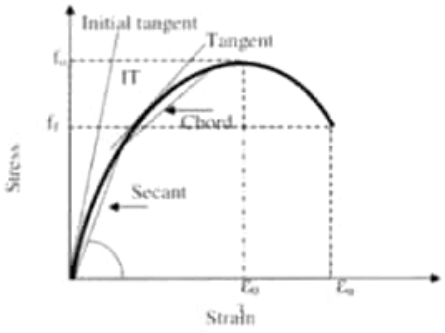

Fatigue

The fatigue process occurring in plain concrete has been under investigation since about 1900 with the majority of the significant work having been done during the past twenty years. This process has been observed in concrete under repeated compressive and repeated flexural loading, and small amounts of experimental work show that it also occurs under reversed flexural loading and repeated tensile loading. It is a loading condition of particular importance in the design of many highway structures.

Durability

- Defined as its resistance to deterioration processes that may occur as a result of interaction with its environment (external) or between the constituent materials or their reaction with contaminants present (internal).
- Ability to with stand the damaging effects of the environment over a long period of time.
- The absence of durability maybe caused either by the environment to which the concrete is exposed i.e. external or internal causes.

Durability

INTERNAL CAUSES	EXTERNAL CAUSES
• The alkali-aggregate reaction, volume changes due to the differences in thermal properties of aggregate and cement paste and the permeability of the concrete.	• physical, chemical and mechanical • weathering, occurrence of extreme temperature, abrasion, electrolytic action. • The common forms of chemical attack : leaching out of cement and action of sulphates

Durability

Permeability

- Concrete has a tendency to be porous due to the presence of voids formed during or after placing.
- Penetration by substance may adversely affect durability e.g. $Ca(OH)_2$ leaches out.
- Ingress of air and moisture resulting in corrosion.
- Important with regards to water tightness of liquid retaining structure.
  - To produce concrete of low permeability, full compaction & proper curing is essential.
  - Low permeability is important in increasing resistant to frost action and chemical attack and in protecting embedded steel against corrosion

Permeability

- The permeability of cement paste varies with the age of concrete or with progress of hydration.
- With age, the permeability decreases because gel gradually fill the original water filled space.
- For the same w/c ratio, the permeability of paste with coarser cement particles is higher than those with finer cement.
- In general, the higher the strength of cement paste, the lower will the permeability.