

4. Elasticity, Creep, & Shrinkage

Modulus of elasticity:-

The modulus of elasticity of a material is the strength against unit deformation of the specimen when the body is subjected to stress the energy dissipated for elastic (or) plastic (or) elastoplastic.

The stress-strain response under monotonic loading is used to determine the modulus of elasticity.

Note:-

The modulus of elasticity of the concrete is the initial tangent modulus of the stress-strain response of the concrete.

What are the methods to determine modulus of elasticity:-

There are 2 ways to determine modulus of elasticity

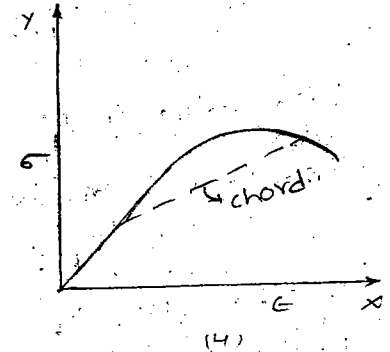
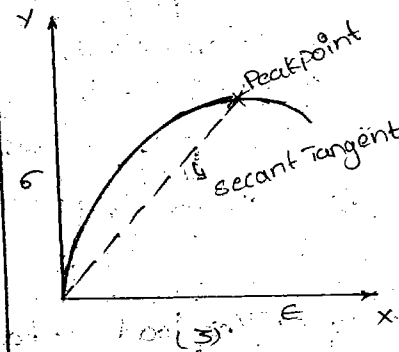
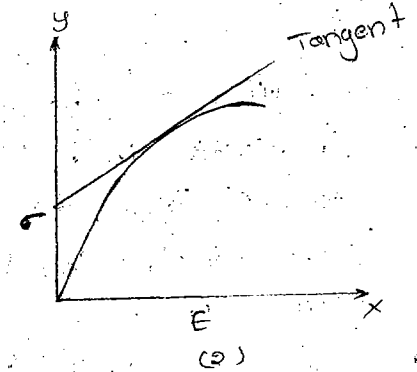
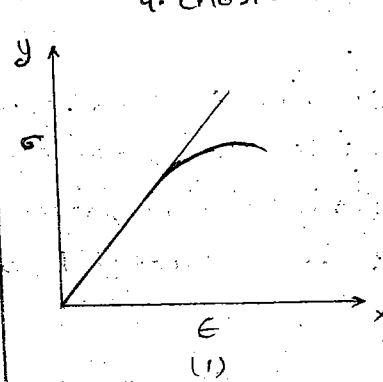
1. Axial stress method
2. Beam Deflection Method.

→ The axial stress method specimens are compressed (or) pulled axially and the stress-strain response is prepared.

→ In Beam deflection Method the deflection corresponding to various stages of loading in the beam is determined and the load-deflection response in bending is prepared.

Types of Modulus of Elasticity
There are 4 different types of determining the modulus of Elasticity

1. Initial Tangent Modulus.
2. Tangent Modulus.
3. Secant Modulus.
4. Chord Modulus.



Dynamic Modulus of Elasticity:-

It is also known as complex modulus of the elasticity.

Def:-

It is the ratio of stress to strain under vibration conditions. It is calculated from data obtained from either free (or) forced vibration test in shear, compression & elongation.

Creep Coefficient

It is the ratio of ultimate creep strain to the elastic strain at the age of loading, is termed as creep quotient coefficient.

The assumed data of creep quotient is for

For 7 days : value is 2.2

For 28 days : value is 1.6

For 1 year : value is 1.1

Factors Influencing Creep of Concrete:-

1. Water/cement ratio.
2. Humidity
3. Age of concrete structure.
4. Aggregates
5. Add mixture
6. Other influencing factors.

Water - Cement Ratio

The rate of creep increases due to the increasing of w/c ratio in concrete. Why because the w/c ratio increases the bond strength between the particles are decreases.

Humidity

The factor humidity influencing the creep depending upon the environment conditions of structure locality.

Age of Concrete Structure:-

The rate of creep is rapidly decreases with time. The time taken by a concrete structure to be attain creep is 5 years.

Aggregates:-

The rate of creep generally decreases with the size of aggregate.

The agg with moisture moment and low elastic modulus causes a large amount of creep.

Add mixture:

The admixture is also responsible for increase (or) decreasing the rate of creep value. because more using of add mixture exhibits more fluidity (or) quick setting of concrete mixture.

Other Factors

1. Type of cement
2. Entrained Air
3. strength of concrete.
4. Improper curing.

Shrinkage of concrete:-

The volumetric changes of concrete structure due to loss of moisture by evaporation is known as shrinkage of concrete.

It is a time dependent factor. It deforms the volume of concrete is reduces without the impact of external forces.

1. Plastic shrinkage.
2. Drying shrinkage.
3. Carbonation shrinkage.
4. Autogenous shrinkage.

Plastic shrinkage:-

The plastic shrinkage occurs very soon after pouring the concrete in the formwork. The hydration of cement results in reduction of the volume of concrete due to evaporation from the surface of concrete. It leads to cracking. i.e., (Air line cracks)

Drying shrinkage:-

The shrinkage that appears after the setting & hardening of concrete mixture due to loss of capillary water. It is known as drying shrinkage.

Drying shrinkage is generally occurs in first few months then after it decreases with time.

Carbonation shrinkage:-

The carbonation shrinkage is occurs due to the reaction of carbon dioxide with hydrated cement material. The carbonation process in structural members.

Ca(OH)_2 is turns into CaCO_3 . The carbonation is slowly penetrates in to the outer surface of concrete structure. This type of shrinkage is mainly occurs in medium humidity & it results in decrease of permeability.

The Autogenous shrinkage occurs due to no moisture moment from concrete paste under constant temp. It is a minor problem of concrete & it can be ignored.

Factors influencing shrinkage of concrete:-

1. Water-cement ratio
2. Environmental condition
3. Time
4. Type of Aggregate.
5. Add mixture
6. Other factors

Water-cement ratio:-

The water-cement ratio increases in the concrete mixture the shrinkage factor of concrete increases because there is a chance of occurring segregation due to the segregation of concrete mix the bond strength will be decreases.

Environmental conditions:-

It is one of the major factor that effect the total volume of shrinkage.

The shrinkage is mostly occurred due to the drying conditions of atmosphere.

It increases with the decreasing of humidity.

Time:-

The rate of shrinkage is rapidly decreases with time. It is found that 14-34% of the 20 years shrinkage occurs in 2-weeks, 40-80% shrinkage is occurs in 3 months & the rest 66-85% shrinkage is occurs in 1 year.

Type of Aggregate

The rate of shrinkage is generally decreases with increasing of size of Aggregate.

It is found that the concrete is made from the sand stone shrinks twice than the concrete of limestone.

The Agg with moisture moment & low elastic modulus cause large shrinkage.

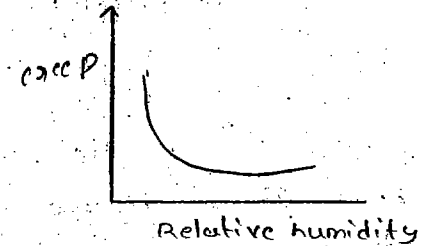
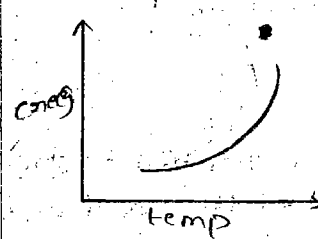
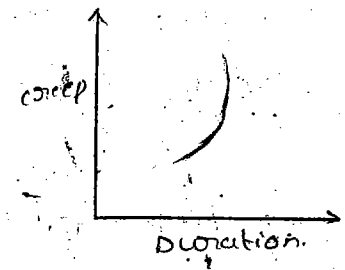
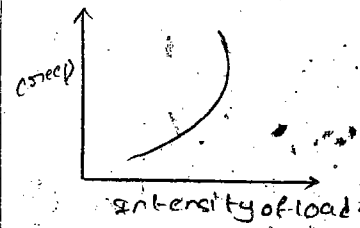
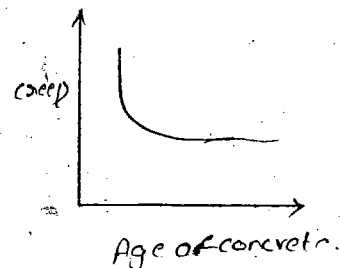
Add mixture

The shrinkage is increases with the addition of accelerating admixtures. Due to the presence of calcium chloride in it and it can be reduced by lime replacement.

Other Factors

- * Type & Quality of cement.
- * Granular & Micro Biological composition of Agg's
- * strength of concrete.
- * Method of curing.
- * Dimensions of the structural elements

Relation b/w creep & factors influencing deformation.



Assessment of creep

The creep deformation (or) strain is assessed based on experimental data.

Many Mathematical models are available to explain the behaviour of creep of concrete and we are considering many influencing factors related to creep deformation in the absence of experimental data we are following the creep coefficient to calculate creep strain (or) creep deflection.

$$\text{creep strain} = \text{Total strain} - \text{elastic strain}$$

$$= \frac{\text{stress}}{E_{ce}} - \frac{\text{stress}}{E_c}$$

where

$$\text{stress calculated by} = \frac{\text{Applied load}}{\text{Area}}$$

E_{ce} = The effective modulus elasticity of the concrete.

E_c = modulus of elasticity of the concrete.

$$E_{ce} = \frac{E_c}{1 + \mu}$$

θ value for. 7 days = 2.2

28 days = 1.6

1 year = 1.1

$$\text{creep deflection in beams} = \frac{kwl^3}{E_c I} - \frac{kwl^3}{E_c I}$$

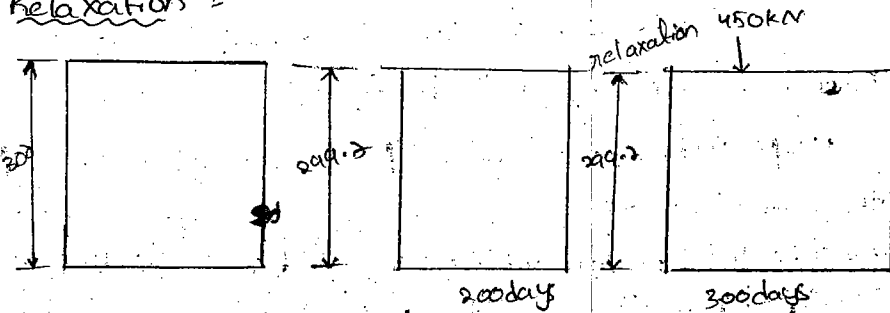
where, w = applied load on the beam

l = length of beam

I = M.O.S of beam

k is the multiple constant corresponding to structure
it is varies by the application of the load and
the beam end condition.

Relaxation :



- Relaxation is the progressive decrease in stress with time when it is subjected to constant strain.
- The concrete specimen is subjected to constant deformation for a long time by using mechanical machines of applying different loads.
- The load for continuing with constant deformation decreases with time.
- The factors that are influencing the creep effect the relaxation of the stresses in concrete members.

is strongly influenced by temperature
* risk of cracking of member is influenced by the
creep relaxation.

→ The effect of relaxation is reduction of the
and redistribution of stress in structural member.

