

HARDENED CONCRETE

The compressive strength of concrete is one of the most important and useful property of concrete, in most structural applications concrete is employed primarily to resist compressive stress, in some conditions the tension, shear stresses are placed an important role in structural construction.

In these cases the compressive strength of concrete is taken into consider to design, or to satisfy the other stresses developed in structural members.

What are the factor effecting strength of concrete (Harden concrete)?

Water cement ratio and Degree of compaction.
Ratio of cement to Aggregates (both fine & coarse Agg).

Grading, surface texture, shape, strength and stiffness of Agg.

Max size of Aggregate used.

These are important factors which influencing the strength of concrete.

Water cement Ratio:

The strength of concrete primarily depends on the strength of cement paste.

It has been shown that the strength of cement paste depends upon the dilution of the ~~paste~~ water.

In other words the strength of the concrete increases with the increasing of cement content and also it is decreases with increasing the air voids and water content.

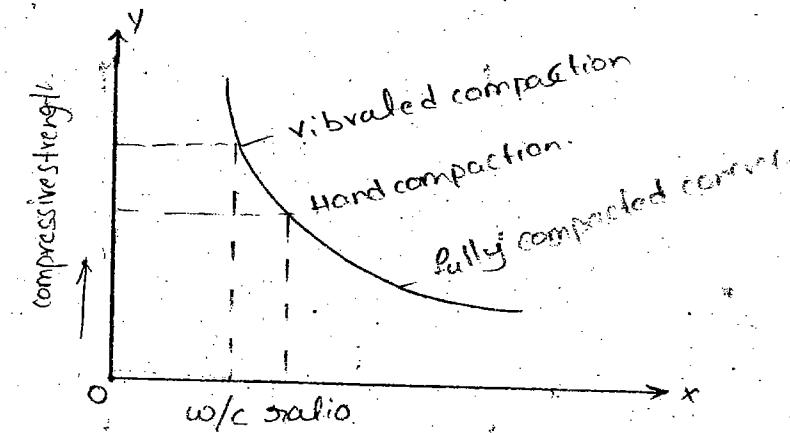
In 1918 Duff Abrams proposed a statement that assuming fully compacted concrete or cement at a given age in normal temperature.

The strength of concrete mix is inversely proportional to water cement ratio.

He proposed a formula

$$S = \frac{A}{Bx}$$

where S is strength of concrete.
x = water cement ratio by volume for 28 days.
The constants A & B are 96N/mm^2 & 2N/mm^2



Note The water cement ratio is typical from $0.35 - 0.45$.

The low water cement ratio gives strong concrete.

The French proposed a formula to calculate the strength of concrete in early of 1982.

$$S = k \left(\frac{c}{c + \alpha} \right)^2$$

where S is strength of concrete in

The concrete is a brittle material, so, the compressive is predominantly influences the strength of concrete.

The compressive strength of concrete is severely decreased due to the increase of ϕ_s , porosity of concrete is affected by the gel space ratio. The ϕ_s ratio is the surface area of the solid products to the available space. A higher ϕ_s ratio produces the porosity and hence hydration products. For the strength of concrete increases after its addition. The gel space ratio decreases the porosity of the concrete and hence the strength of concrete.

The above expression indicates the involvement of air and air.

where $x = \frac{Gel}{Space}$ ratio
 $s = 3H(x)^3$

The proposed a formula to calculate the effective fiber volume space ratio.

The process except shows that the strength of concrete becomes a specific relationship with the gel.

This is due to less ϕ_s ratio the porosity of concrete is increased. Here by the decreasing of strength of concrete is a result.

The higher water cement ratio gives less gel-space ratio.

After its addition, affected by larger cement concrete after its strength.

The gel space ratio decreases the porosity and hence hydration products.

The ϕ_s ratio is the surface area of the solid products ratio in concrete mix.

The porosity of concrete is affected by the gel space ratio in concrete mix.

The concrete is a brittle material, so, the

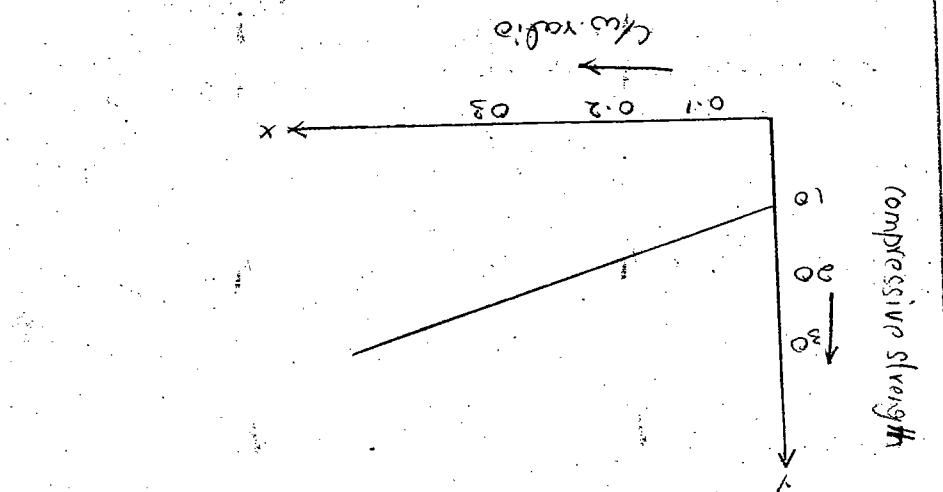
above expression indicates the involvement of air and air.

The above expression indicates the involvement of air and air.

So, the degree of compaction plays an important role in compressive strength (or) strength of concrete.

By the increasing of water cement ratio in concrete, concrete surface we can achieve less strength. The smaller cement surface is decreased with increasing compression.

With increasing high strength concrete correct.



To calculate the Gel/space ratio for fully hydrated cement.

$$x_f = \frac{0.657 \times c}{0.319c + w_0}$$

where c = wt. of cement in gms
 w_0 = volume of mixing water in mm.

To calculate the Gel/space ratio for partially hydrated cement.

$$x_p = \frac{0.657 \times \alpha \times c}{0.319 \times c + w_0}$$

α = % of hydration.

i) calculate Gel/space ratio and the theoretical strength of sample of concrete made with 500gm of cement and 0.5 water/cement ratio. For fully hydrated & 25% of hydration.

For Fully hydrated cement:

Given
wt of cement (c) = 500gms

$$\alpha = 25\% = \frac{25}{100} = 0.25$$

$$w/c = 0.5$$

$$\frac{w}{500} = 0.5$$

$$w = 0.5 \times 500$$

$$w = 250 \text{ gms}$$

$$\text{Volume of water} = 250 \text{ ml}$$

$$250 \text{ ml}$$

$$\frac{1000 \text{ ml}}{x} = 90 \text{ gms}$$

$$x = 250 \text{ gms.}$$

$$x = 274.32 \text{ ml}$$

$$x_f = \frac{0.657 \times 500}{0.319 \times 500 + 274.32}$$

$$x_f = 0.2565$$

Theoretical strength for fully hydrated cement

$$S = 240 (x)^3$$

$$= 240 (0.2565)^3$$

$$S = 101.25 \text{ N/mm}^2$$

For partially Hydrated cement:

$$x_p = \frac{0.657 \times 500 \times 0.25}{0.319 \times 500 + 0.25 + 274.32}$$

$$x_p = 0.62$$

Theoretical strength for partially hydrated cement

$$S = 240 x^3$$

$$= 240 (0.62)^3$$

$$= 52.19 \text{ N/mm}^2$$

calculate G/s ratio and theoretical strength of sample of concrete made with 680 gm of cement & 0.48 w/c ratio on fully hydrated and at 25% of hydration.

so

Gel/space ratio of fully hydrated cement

$$x_f = \frac{0.657 \times c}{0.319c + w_0}$$

The weight of cement used $c = 680 \text{ gms.}$

Volume of water used in mix $w_0 = ?$

Given data,

$$w/c = 0.48$$

$$w = 0.48 \times c$$

$$= 0.48 \times 680$$

$$= 326.4 \text{ gms}$$

Volume of water used in mix

$$= 292.1 \text{ ml}$$

While dealing with curing and strength development of concrete, we have to consider only the time aspect but the strength development of the concrete is not only dependent on time, it is also dependent on the temperature during the early period of hydration and the influence of gain of strength of the concrete.

The strength development of concrete can be explained as function of summation of fine and temperature. The function of summation is called modulus of concrete. It is defined as summation of (time multiplied with temperature) + (time multiplied with strength). Modulus = summation of (time multiplied with strength) is called modulus of concrete. The strength development of concrete can be expressed as follows:

$S = S_0 \cdot e^{(X_p \cdot t - X_f \cdot t^2)}$

where S = Strength at time t , S_0 = Strength at time zero, X_p = Proportionality constant, X_f = Factor of final strength, t = time in days.

By experiments it is found that the hydration of concrete continues to take place up to above 11°c. The modulus of concrete is called at 18°c in 88 days.

The modulus is measured in terms of N/mm^2 .

∴ 11°c is taken as a datum line for calculating the modulus of concrete to take place up to above 11°c from an origin lying between 12° to 16°.

The temperature is established by no. of calculations $E = (\text{time} * \text{temperature})$

Modulus = summation of (time multiplied with strength) + (time multiplied with strength).

The theoretical strength for fully hydrated concrete can be calculated as follows:

$$S_0 = 89.82 \text{ N/mm}^2$$

$$X_p = 0.43$$

$$X_f = 0.43$$

$$\frac{S_0}{X_p} = 210 \text{ (A)}$$

$$\text{Theoretical strength}$$

$$X_p = 0.43$$

$$X_f = 0.43$$

$$S_0 = 653.680 \text{ N/mm}^2$$

$$S = 653.680 \cdot 0.43$$

$$S = 279.42$$

$$\text{For partially hydrated cement}$$

$$S = 123 \text{ N/mm}^2$$

$$= 240 (A)$$

$$S = 240 (A)$$

The theoretical strength for fully hydrated concrete

$$X_p \approx 0.8$$

$$= 0.822$$

$$S = 653 \cdot 680$$

$$S = 439.680 + 326.4$$

1. The type of aggregate influences the relationship between compressive and flexural strength.

2. The crushed stone having higher flexibility, higher flexural strength than the compressive strength.

3. The bonded materials used in concrete mix increases the strength of concrete.

Note :-

$$Y = \text{compressive strength}$$

where $X = \text{flexural strength}$

For human maximum size of natural grave

$$4.Y = 9.8X - 2.52$$

For human maximum size of crushed stone aggregate

$$5.Y = 9.9X - 0.66$$

For sand maximum size of natural grave

$$2.Y = 14.1X - 10.4$$

For sand maximum size of a aggregate (cubed stone)

$$1.Y = 15.3X - 9$$

Strengths

The CRT developed some experimental formulas to calculate (1) to estimate the tensile and compressive

compression and flexural strength.

So, we need to design the pavements slabs in both consider due to the changing of vehicle moving load

The flexural strength of concrete is taking into

pavement slabs in road construction works.

ignoring the tensile stress. But in some cases like

strength of concrete plays an important role & we can

resist. So, all structural construction the compressive

membrane is strong in compression and it is weaker in

compression and tensile stresses. i.e., the concrete under

stress :-

1. Strength of identical concrete for natural

At 5% a temperature the identical concrete must be cured in 52 days to achieve full, durability

= 52 days

$$= 51.56$$

$$\frac{24(5-1)}{19800}$$

Gaining full durability $\frac{24(5-1)}{H}$

No. of days for

strength of given temperature is

so, the many days is required to get full

so, we could remove the form work in 5 days

$$31.90 < 35$$

less than the applying stress

the strength of concrete achieved in 15 days of curing

applying stress = 26 Hpa

From given data

$$= 31.9 \text{ Hpa}$$

The strength of identical concrete for 15 days is

$$= 63.38\%$$

$$= 31 + 61 \log_{10} \left(\frac{100}{53.66} \right)$$

$$= A + B \log_{10} \left(\frac{100}{\text{Maturity for 15 days}} \right)$$

$$= 53.66 \text{ Hpa}$$

for more calculations & research oriented we are considered the full maturity of concrete mix is $19,800^{\circ}\text{C hrs}$

The maturity concept is usefull for estimating the strength of concrete at any other maturity value, as a percentage of strength of concrete at known maturity value.

The percentage of strength of identical concrete at any other maturity value is equal to

$$= A + B \log_{10} \left(\frac{\text{Maturity}}{10^3} \right)$$

where A and B are Powlman's coefficients

- 1) The strength of a sample for fully matured concrete is 40 MPa. Find the strength of identical concrete at the age of 7 days. When cured at an average temperature during the day time is 20°C and night time is 10°C

Given data:

Strength after 28 days at 18°C & maturity of level is $19800^{\circ}\text{C hrs}$	Coefficients	
	A	B
< 12.5	10	.68
12.5 - 35.0	21	61
35.0 - 52.5	32	54
52.5 - 70.0	42	46.5

Given Datum temperature = -11°C

concrete at fully matured

strength of sample = 40 MPa

The concrete is falls under zone-III

$$\therefore A = 32, B = 54$$

No. of days for curing
time + 2 days

temperature
day time = 20°C
night time = 10°C

Maturity of concrete

$$M = \sum (\text{time} \times \text{temperatures})$$

$$= (2 \times 24 \times (20^{\circ} - (-11))) + (2 \times 12 \times (10^{\circ} - 11^{\circ})) \\ = 4368^{\circ}\text{C hrs}$$

2. Strengths of identical concrete for maturity of

4368°C hrs is

$$= A + B \log_{10} \left(\frac{\text{Maturity for } 2 \text{ days}}{10^3} \right)$$

$$= 32 + 54 \log_{10} \left(\frac{4368}{1000} \right)$$

$$= 66.54$$

The strength of identical concrete for 2 days is

$$= 40 \times \frac{66.5}{100} = 26.6 \text{ MPa}$$

- 2) A laboratory experiment is conducted at pune: on a particular mix showed a strength of 32.5 MPa for fully matured concrete. find whether a formwork can be removed for an identical concrete placed at sunroo at the age of 15 days when an average temperature of 5°C if the concrete is likely to be subjected to stripping stress of 25 MPa

Given

Strength of concrete of fully matured = 32.5 MPa

The concrete is falls under zone-II

$$\therefore A = 21, B = 61$$

No. of days for curing = 15 days

temperature = 5°C

Maturity of concrete for 15 days

$$M = \sum (\text{time} \times \text{temperatures})$$

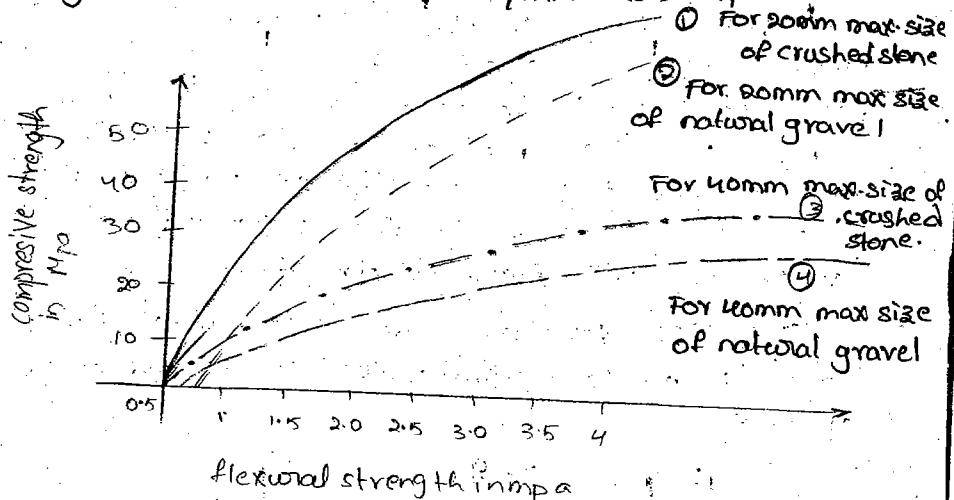
$$= (15 \times 24 \times (5^{\circ} - 11^{\circ})) + (15 \times 12 \times (5^{\circ} - 10^{\circ}))$$

$$= 5760^{\circ}\text{C hrs}$$

As a general relationship b/w flexural and compressive strength is established by CRRI is

$$Y = 11X - 3.4$$

In all these formulae the compressive and flexural strength are in terms of N/mm² (or) MPa



The flexural strength of concrete is 8-11% of the compressive strength of concrete for higher ranges of concrete strength which means the strength of concrete is greater than 25 MPa

9-12.8% for lower ranges of concrete strength which means the strength of concrete is less than 25 MPa

From the codal provision the flexural strength of concrete is $0.7 f_{ck}$

Where f_{ck} is characteristic compressive strength of concrete.

According to IS 456-2000

Non-Destructive Test

By using these NDTs, we are estimating the surface hardness, tensile strength and quality of concrete approximately.

While using these NDTs we are following some experimental readings (or) charts to find the required results.

They are three major tests per Non destructive Analysis.

1. Rebound Hammer Test
2. Pull out Test
3. Ultrasonic pulse velocity Test (UPV Test)

Note:-

The limitations for determining the quality of concrete by using UPV IS 13311 - Part - I

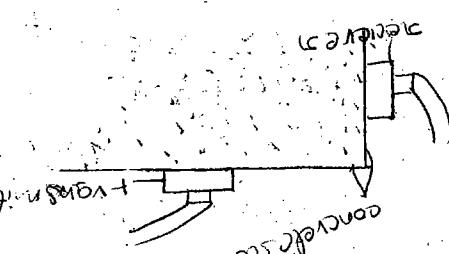
S.NO	Pulse velocity in km/s	concrete quality
1.	> 4.5	Excellent
2.	3.5 - 4.5	Good
3.	3.0 - 3.5	Medium
4.	< 3.0	Doubtful

Factors affecting the measurement of pulse velocity through concrete
 The measurement of pulse velocity through concrete members
 is affected by following parameters:
 - smoothness of the contact surface under the
 effect of the applied pressure
 - influence of pulse length
 - temperature of concrete
 - moisture condition of concrete
 - presence of reinforcement steel.
 The natural camber for cement and building
 material prepared the quality of concrete with
 the pulse velocity.

N.C.B.M	S.N.Q	Pulse Velocity	Bulk density of concrete
Good	3.	$3.0-3.5$	>3.5
Medium	4.	$3.0-3.5$	$2.0-2.5$
Bad	5.	$2.0-2.5$	poor

Methods of transmission of pulse wave in concrete member
 There are 3 methods of transmission.

1. Direct Transmission:
- 
- Diodes
- ← Time taken by the pulse wave between the two pulse velocity $v = \frac{d}{t}$
- These are the three ways of measuring pulse velocity through concrete.
- SWI face transmission.

2. Indirect Transmission:
- 
- Diodes
- ← Distance d
- Pulse velocity v
- Concave face SWI face

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.

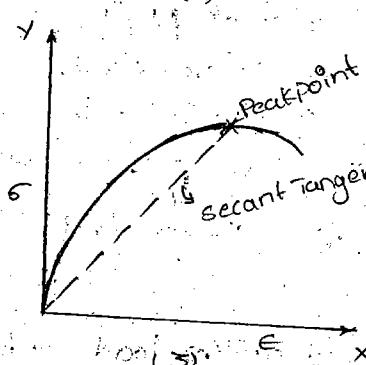
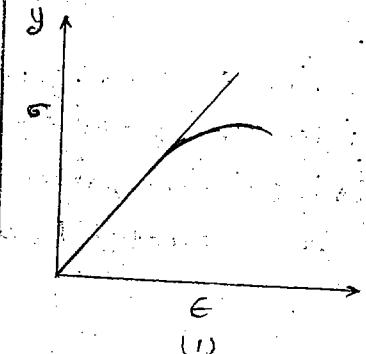
→ The axial stress method specimens are compressed (or) pulled axially and the stress-strain response is prepared.

→ 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.

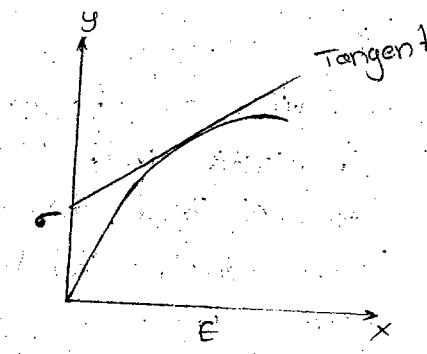
Types of Modulus of Elasticity:-

There are 4 different types of determining modulus of elasticity:

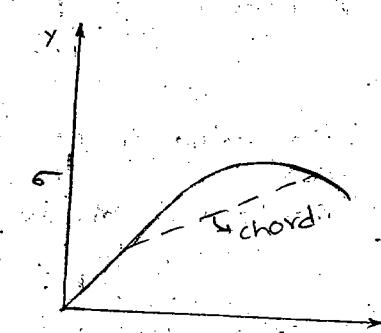
1. Initial Tangent Modulus:
2. Tangent Modulus:
3. Secant Modulus:
4. Chord Modulus.



Graph (3): E



Graph (2): E



Graph (4): E

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 forced or forced vibration test in shear, compression & elongation.

Elastictiy characterisitics. They are called viscous elastic.
 The materials that are each both viscous and elastic have
 the property of returning back to their original shape
 when a load is applied. Eg:- rubber.
 In this condition we can apply a compressive load having
 a compressive dimension ϵ in the longitudinal direction.
 And we can observe that there is an increase in lateral
 dimensions ϵ and decrease in longitudinal dimension.
 This is because when a compressive load is applied there is an
 increase in lateral dimension due to lateral contraction.
 And the strain will be true and linear strain will be -ve.
 Longitudinal dimension decrease which indicates the lateral
 strain will be true and linear strain will be -ve
 Creep of concrete:—
 Creep can be defined as the long and long
 term deformation of concrete under a continuous
 load. Generally a long term plastic change the shape
 of concrete structure and the deformation occurs.
 When the continuous load is removed the strain
 along the direction of the applied load.
 When the concrete load is removed the strain
 is decreased immediately.
 The amount of decrease of strain is equal to the
 elastic strain at the given age. The bulk stress
 is then released by a continuous decreasing
 strain is known as creep of concrete.

It is a property where the material has the ability and
 the materials that are each both viscous and elastic have
 the property of returning back to their original shape
 when a load is applied. Eg:- rubber.
 These materials are called viscous elastic.
 These have their dimensions initially with
 a stress when a stress is applied.
 In this case changing their dimensions initially with
 the strain is constant and it is denoted by a
 to the linear strain. It is called passes strain.
 When a load is subjected to loading with
 a lateral dimension ϵ is affected to loading with
 a mathematical formula to calculate μ is

$$\mu = \frac{\epsilon}{\epsilon_L}$$

 A mathematical formula to calculate μ is
 the value of passes ratio μ lies between 0.1-0.5
 Note:—
 The lateral strain is less than linear strain.
 When you are applying a putting load on body
 having ϵ , as lateral dimension ϵ is longitudinal dimension.
 In this position condition ϵ is parallel to length.
 The charge in dimension is calculated as
 called the length of body of the load.
 The positive value in linear dimension side
 is possible to length.

The materials that are exhibit both viscosity and elasticity characteristics. They are called visco-plastic materials. Eg :- Water.

These materials are resist the shear flow & these are changing their dimensions linearly with time when a stress is applied.

Poisson's Ratio:

When a material is subjected to loading within elastic limit. Then the ratio of lateral strain to the linear strain is called poisson's ratio.

It remains constant and it is denoted by a letter μ .

A mathematical formula to calculate μ is

$$\mu = \frac{-e_L}{e}$$

e_L = lateral strain
 e = linear strain.

The value of poisson's ratio varies between 0.1 - 0.5

Note : The lateral strain is less than linear strain.

$$e_L < e$$

When you are applying a pulling load on body having 'd' as lateral dimension & 'L' is longitudinal dimension.

In this particular condition 'L' is called the length of body & the load is parallel to length.

The change in dimension is occurred or positive value in linear dimensional side.



the decreasing of lateral dimension 'd' so, the obtained lateral strain will be -ve.



In this condition we are applying a compressive load on the subjected body having linear dimension 'L' & lateral dimension 'd' and we are observed that there is an increase in lateral direction & decrease in longitudinal direction which indicates the lateral strain will be +ve and linear strain will be -ve

$$\mu = \frac{e_L}{-e}$$

Creep Of Concrete:

Creep can be defined as the elastic and long term deformation of concrete under a continuous load.

Generally a long term pressure changes the shape of concrete structure and the deformation occurs along the direction of the applied load.

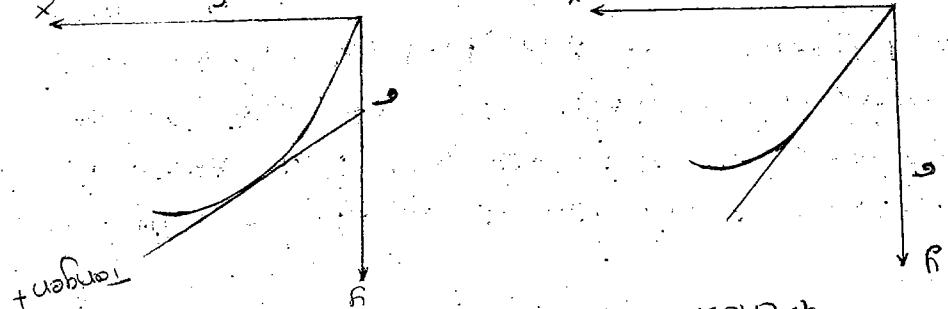
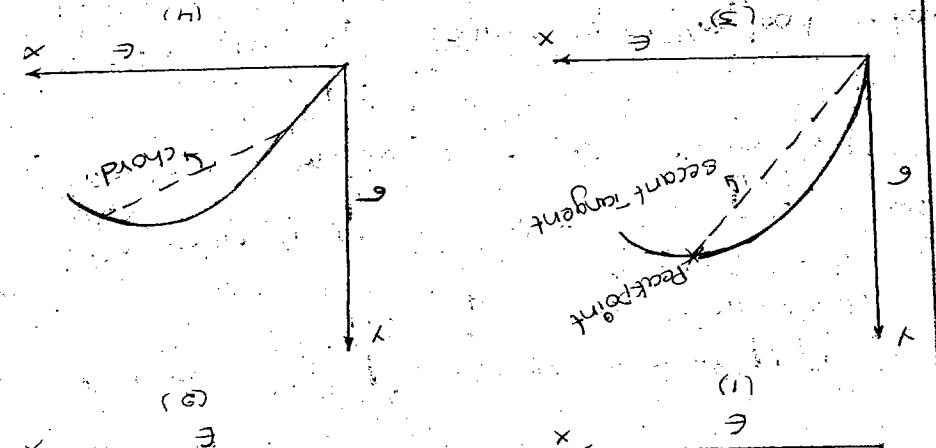
When the continuous load is removed the strain is decreased immediately.

The amount of decreased strain is equal to the elastic strain at the given age. The quick recovery is then followed by a continuous decreasing in strain is known as creep recovery of total creep strain suffered by concrete member.

In shear, compression, & elongation
deflected from after force (or) forced vibration test.
vibration condition. It is calculated from deflection test.
Deflection condition of stress to strain under
elasticity.

It is also known as complex modulus.

Dynamical Modulus of Elasticity



1. Tangent Modulus
2. Tangent Modulus
3. Second Modulus
4. Chord Modulus

There are different types of determining the modulus of elasticity.

- The axial stress method specimens are compressed (or) pulled axially and the stress-strain response is measured to determine the deflection method.
- Axial stress method.
- Beam deflection method the deflection is prepared.
- In beam deflection the deflection corresponding to various stages of loading in the beam is determined and the load-deflection response is measured.
- Beam bending is prepared.

The figure shows two ways to determine modulus of elasticity:

Method 1: The methods to determine modulus of elasticity are the methods to determine the stress-strain response of the concrete.

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

Note:- The modulus of elasticity of concrete is used to determine the modulus of loading.

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

The energy dissipated for elastic work plastic work when the body is subjected to stress is called elastic modulus.

The modulus of elasticity of a material is the strength against unit deformation of the specimen.

Modulus of elasticity is the measure of the ability to resist shape change.

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 and 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 content and low elastic modulus causes a large amount of creep.

Add mixture

The add mixture is also responsible for increasing (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 deform the volume of concrete it reduces without the impact of external forces.

1. Plastic sheathing.

2. Drying sheathing.

3. Combination sheathing.

4. Autogenous sheathing.

Plastic sheathing →

The plastic sheathing consists of polyvinyl chloride (PVC) or polyethylene (PE). It is a flexible, waterproof material that can be applied directly to the concrete surface. This type of sheathing is commonly used in marine environments where it is exposed to saltwater. It is also used in construction projects where there is a risk of water damage. The combination sheathing is a composite of PVC and PE, providing better protection against water damage. It is often used in marine environments where it is exposed to saltwater. The combination sheathing is a composite of PVC and PE, providing better protection against water damage. It is often used in marine environments where it is exposed to saltwater.

1. Water-vapour control sheathing
2. Enviroseal membrane system
3. Time
4. Type of aggregate
5. Additive
6. Other factors

Factors influencing sheathing of concrete:

The autogenous sheathing allows concrete to do its best. It is a minor problem of concrete that it can be removed from concrete paste. And it is constant term.

The concrete mix must be able to withstand the sheathing because the sheathing factor of concrete increases because there is a chance of cracking segregation due to the segregation of concrete. Segregation is due to the mixing of concrete in batches because the sheathing factor of concrete is one of the major factors that affect the final volume of sheathing.

The sheathing is mostly affected due to the drying out of sheathing. The concrete mix must be able to withstand the sheathing factor of concrete due to the drying out of sheathing.

The surface of sheathing is rapidly degraded due to the drying out of sheathing.

As increases with the decreasing of humidity.

The concrete mix must be able to withstand the sheathing factor of concrete due to the drying out of sheathing.

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The concrete mix must be able to withstand the sheathing factor of concrete due to the drying out of sheathing.

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 sandstone 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.

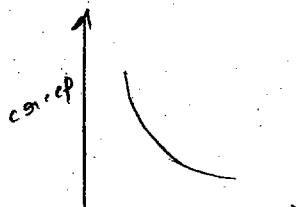
- * Granular & micro biological composition of Agg's

- * Strength of concrete.

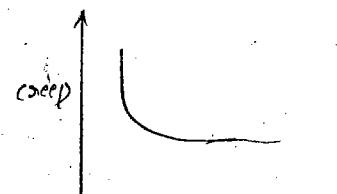
- * Method of curing.

- * Dimensions of the structural elements.

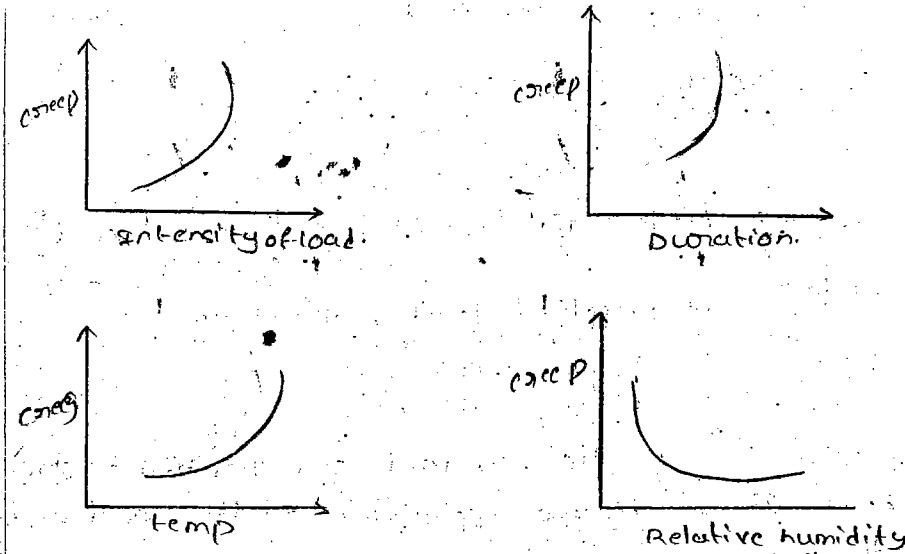
Relation b/w creep & factors influencing deformation



size of member



Age of concrete



Assessment of creep:

The creep deformation (ϵ_c) 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 be creep deformation in the absence of experimental data we are following the creep coefficient to calculate creep strain (ϵ_c) or creep deflection.

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

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

where

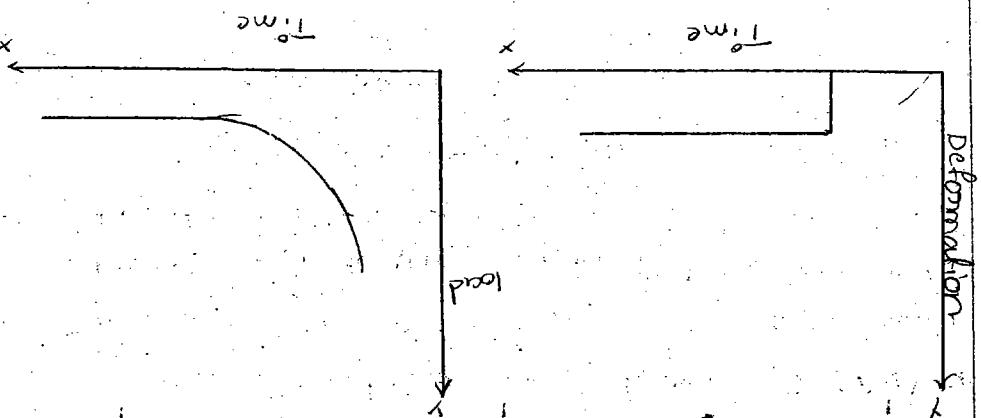
$$\text{stress calculated by} = \frac{\text{Applied load}}{\text{Area}}$$

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

E_e = modulus of elasticity of the concrete

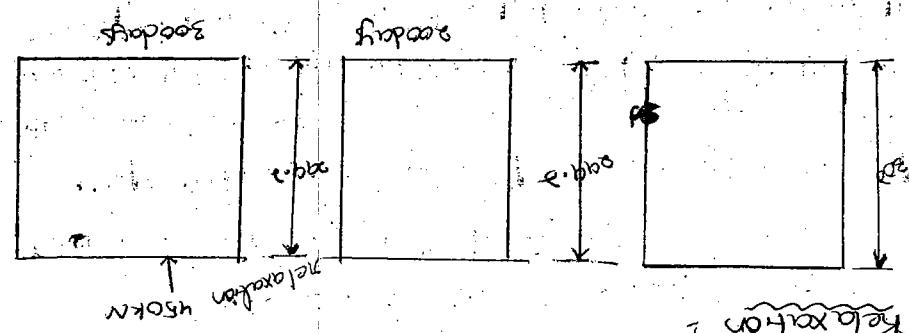
$$E_{ce} = \frac{E_e}{\gamma}$$

is strongly influenced by temperature
rise of casting of member is influenced by the
coefficient of thermal expansion.



The effect of relaxation is reduction of stress in structural member
and redistribution of stresses in structures.

- The factors affecting influence the concept decreases with time.
- The load for continuing with constant determine machines of applying different loads.
- The concrete specimen subjected to constant width time when it is subjected to constant strain.
- Relaxation is the progressive decrease in stress



It is the multiple constant corresponding to structure is verified by the application of the load and the beam end condition.

$$I = H \sigma I \text{ of beam}$$

$$I = (\text{length of beam})$$

where, W = applied load on the beam

$$\text{Creep deflection in beams} = \frac{E \omega d^3}{E_e I} - \frac{E_e I}{E \omega d^3}$$

$$I_{beam} = 1.1$$

$$28 \text{ days} = 1.6$$

$$E \text{ value per day} = 2.2$$

5. MIX DESIGN

To calculate the mix design for a concrete proportion is,

Step I :-

To calculate the target strength (f'_{ck}) of mix proportion we are using IS - 10262 : 2009 table 1 for taking standard deviation and the target strength f'_{ck} is

$$f'_{ct} = f'_{ck} + 1.65 * s \quad \text{from class - 3.2}$$

IS 10262 : 2009

$$= 40 + 1.65 * 5$$

$$= 48.25$$

Step II :-

selection of water cement ratio is taken by from IS 456 : 2000 table 5

$$w/c = 0.40 \text{ and}$$

$$c = 360 \text{ kg/m}^3$$

We are taking data from table 5 IS 456 : 2000 to our required conditions

Step III :-

selection of water content from IS : 10262 : 2009 table 2 . we are assuming the normal size of Agg as 20 mm.

$$W = 186 \text{ lit}$$

for calculating water content we are following table 2 IS 10262 : 2009 clause NO. 4.2

Step IV

calculation of cement content

$$w/c = 0.40$$

$$100/c = 0.40$$

$$c = 360 \text{ kg/m}^3$$

We are calculated the cement content value from w/c ratio and we are checking the appeared value from table -5 is, IS - 456 : 2000.

Step V :-

The proportion of coarse & fine Agg

$$0.40 - 0.60$$

$$0.50 - 0.60$$

$$0.40 - 0.62$$

$$0.40 - 0.62 * 0.9$$

$$= 0.56$$

$$1 - 0.56 = 0.44$$

The volume of coarse Agg can be estimated from table 3 in IS 10262 : 2009

The adjustable values taken from the data i.e., exist in class 4.4

And the reduction of coarse Agg according to placing of concrete can be taken clause 4.11 in IS 10262 : 2009.

The calculations are done according to the IS 10262 : 2009 clause 4.6.

Grade designation - M35

Type of cement - OPC 43 grade.

max. nominal size of Agg - 20 mm.

$$f_{c'k} = 35$$

$$f_{ck} = f_{c'k} + 1.65 \times s$$

$$s = 6 \text{ N/mm}^2$$

$$f_{ck} = 43 - 25 \text{ N/mm}^2$$

Mortar water content = 18.6 l/t For 80 mm agg
water content Ferntoonm column

$$\text{water content} = 19.16 \times 0.81 = 140.6 \text{ l/t}$$

$$= 19.7 \cdot 16$$

$$= 18.6 + \frac{100}{6} \approx 18.6$$

$$\text{W/C ratio} = 0.45$$

$$\text{W/C ratio} = 0.45$$

$$\text{cement content} = \frac{140}{6.45} = 31.11 \text{ kg/m}^3$$

$$\text{For sand} = 0.60$$

$$\text{Volume of coarse Agg} = 0.61 \times 0.9 = 0.54 \text{ m}^3$$

$$\text{Volume of fine Agg content} = 1 - 0.54 = 0.46 \text{ m}^3$$

$$= 0.46$$

$$= 0.46$$

Illustrate the mix design proportion for a concrete grade of M₃₅ —

Concrete mix used in reinforcement at very severe explosive condition. The nominal size of Agg is 20mm. The method of placing of concrete is pumpable and we are using superplasticizer (water reducing agent 1.2%).

It having a specific gravity 1.25. The specific gravity of coarse Agg 2.69. specific gravity of fine Agg 2.58. sp. gravity of cement 3.15 for OPC of 43 grade.

Given data:

Type of cement = OPC of 43 grade

The min. cement content = 340 kg/m³

sp. gravity of cement = 3.15

exposure condition = very severe for reinforcement
cement concrete method of concrete placing is pumpable

Max. w/c ratio = 0.45 [IS 456 : 2000 table-5]

Nominal size of Agg = 20mm

workability = 100mm.

Type of admixture = super plasticizer (1.2%)

Type of Agg = crushed Angular Agg

Test data:

specific gravity of coarse Agg = 2.69

specific gravity of fine Agg = 2.58

Waterability = 100 mm slurry

Cement w/c = 0.46 (for 25-35 mm slurry)
Accordindg to Nominal size of aggregate 30 mm diameter

CS - 10262 : 800 a

Calculation of water/cement content from table - 2

Step 3 :-

0.40

Based on experience we can adopting a value of
(constant)

[For every 5% increase in slurry]

Max. w/c ratio = 0.45 [CS 455 : 2000 table 5]

selection of w/c ratio

Step 2 :-

= 43.25 N/mm²

$f_{ck} = 25 + 166 * \frac{c}{w}$

[CS - 10262 : 800 a table 2]

c = standard deviation.

$f_{ce} = \text{Chokedenistic compressive strength}$

where $f_{ce} = \text{target strength of concrete mix N/mm}^2$

[CS 10262 : 800 a table 2]

$c_k = f_{ce} + 1.66 * s$

calcultate the target strength of concrete mix

Step 4 :-

for a w/c ratio 0.40
for a present mix proportion is designed

$$0.40 = 0.64$$

$$\frac{w}{c} = 0.50 = 0.62$$

Assume fine aggregate 20

From table - 8 CS - 10262 : 2000

calculation of aggregate volume.

Step 5 :-

Hence ok.

$$394.82 > 300 \text{ kg/m}^3$$

$$= 300 \text{ kg/m}^3$$

from table - 5 CS - 455 : 2000 take mix cement content

$$c = 394.82 \text{ kg/m}^3$$

$$0.40 = \frac{c}{250.45}$$

$$\frac{c}{w} = 0.40$$

calculation of cement content

Step 4 :-

$$W = 154.11$$

$$W = 193.16 * \frac{100}{80}$$

$$W = 193.16 : 800 a$$

water content upto 80% from clause 4.1
by using super plasticizer we are reducing the

$$= 193.16$$

$$W = 186 + \frac{100}{9} * 186$$

There is an increase coarse Agg according to the rate of change $\pm 0.50\%$. If change in w/c ratio is respectively change of ± 0.01 .

$$0.40 \rightarrow 0.64$$

From placing 4.41 the concrete is placed by using pumps.

The reduction of coarse Agg content is 10% from table-3, IS-10262: 2009

$$\text{coarse content} = 0.64 \times \frac{90}{100}$$

$$= 0.576$$

$$\text{fine Agg content} = 1 - 0.576$$

$$= 0.424$$

Step-6 :-

calculation of mix design.

volume of concrete = 1m^3

$$\text{volume of cement} = \frac{\text{mass of cement}}{\text{sp.gravity of cement}} \times \frac{1}{1000}$$

$$= \frac{394.32}{8.15} \times \frac{1}{1000}$$

$$= 125.18 \times 0.001$$

$$= 0.125\text{m}^3$$

The design procedure for calculation of mix proportion

Note :-

We need test data for various ingredients which are present in concrete mix. Those are specific gravity of cement, s.p of coarse Agg, s.p of fine Agg, s.p of admixture, the % of adding admixture, transportation procedure (or) method of placing (or) type of cement, grade designation and various concrete test procedure.

Step 1 :-

To calculate the target strength of concrete:

For M40 grade the target strength :

$$f_{ck}' = f_{ck} + 1.65s \quad [\text{From IS-10262-2009 clause 3-2}]$$

where
 $f_{ck}' \rightarrow$ characteristic compressive strength of concrete at 28 days in N/mm^2

$s \rightarrow$ standard deviation in N/mm^2

value is taking from IS 10262 from table I

$$f_{ck}' = 40 + 1.65 \times 5$$

$$= 46\text{N/mm}^2$$

Step 2 :-

selection of water/cement ratio

The water/cement ratio is taking from table no. 5 in IS-456-2000.

Maximum water content i.e.,

water cement ratio = 0.40 [from codal provision]

$$C = \frac{0.0}{186} = 4.65 \text{ kg/m}^3$$

$$\omega = \text{water content} = 18.6\%$$

$$\omega/C = 0.46$$

water is selected from step 2

cement content is calculated from ω/C

selection of cement content.

Step 1 - selection of cement content value.

class 4 we can finally estimating the water. Based on the deduction value (by adding 1% from volume and the usage of super plasticizer (additive) value and the size of super plasticizer (additive) class 4.2 indicates the shape of aggregate clustering selecting the water content value.

We need to check (in) follow the elcucus has for

is 186 (kg/m³)

The corresponding minimum water content from table

Assume the max. nominal size of aggregate is 2mm.

maximum size of aggregate.

The water content is selected based on the Nominal

from Table No: 2

The water content is selected from 55; 1862

selection of water content: —

Step 2:

The water content based on the experience will may reduce

contents based on the experience will may reduce

ω/C ratio

value

that is

present in 55-456: 8000 tonne-5

From table $C = 320 \text{ kg/m}^3$

and tabulated value.

calculation of aggregate proportion.

The coarse aggregate content is to be calculated from

Table-3 form the corresponding value of max. nominal size of aggregate.

The tabulated values are for the water content.

The tabulated values are for the water content.

Water content of 0.50 (from class no. 4.4). 55; 1862 = 2009

so, there is an increase in the decreasing of water

ratio is to be observed in the design procedure

decreasing of water content.

water increasing in above rate of changing.

The correction of coarse aggregate is also depends on

method of placing from clause no. 4.4, 55; 1862: 2009

the correction of coarse aggregate is also depends on

method of placing from clause no. 4.4, 55; 1862: 2009

the correction of coarse aggregate is also depends on

method of placing from clause no. 4.4, 55; 1862: 2009

the correction of coarse aggregate is also depends on

method of placing from clause no. 4.4, 55; 1862: 2009

MIX PROPORTION CALCULATION

For every mix calculations we are preparing the proportion for unit volume of concrete which means the volume of concrete is 1m³.

The calculation for ingredients in mix proportion are to be calculated from clause 4.6. IS:10262:2009.

$$\text{volume of cement} = \frac{\text{mass of cement}}{\text{sp. gravity of cement}} * \frac{1}{1000}$$

$$\text{volume of water} = \frac{\text{mass of water}}{\text{sp. gravity}} * \frac{1}{1000}$$

$$\text{volume of superplasticizer} = \frac{\text{mass of superplasticizer}}{\text{specific gravity}} * \frac{1}{1000}$$

(add mixture)

$$\text{mass of chemical admixture} = \frac{2}{100} * \text{Step 4-(c) kg/m}^3$$

$$\text{sp. gravity of add mixture} = 1.115 \text{ (from IS 383-Part I)}$$

$$\text{Mass of coarse Agg} = \frac{\text{The volume of total Agg} * \text{volume of coarse Agg} * \text{sp. gravity of coarse Agg}}{1000}$$

$$\text{Mass of fine Agg} = \frac{\text{volume of total Agg} * \text{volume of fine Agg} * \text{sp. gravity of fine Agg}}{1000}$$

calculate mix proportion for reinforced concrete construction of moderate exposure condition. consider suitable data from the codal provision.

For moderate exposure condition the minimum grade of concrete should be taken from Table NO.5. IS: 456: 2000.

∴ The min grade of concrete = M25

cedar

step 1:- calculate the target strength of mix proportion

$$\text{For M25 grade of concrete } f_{ck} = 25 \text{ N/mm}^2$$

$$f'_{ck} = f_{ck} + 1.65 * s$$

where s = standard deviation in N/mm²

(s is taking from Table NO.4. IS:10262:2009)

$$s = 4 \text{ N/mm}^2$$

$$f'_{ck} = 25 + 1.65 * 4 \\ = 31.65 \text{ N/mm}^2$$

step 2:- selection of water cement ratio.

From Table NO.5 IS: 456 - 2000

The maximum water cement ratio = 0.50

step 3:- calculation of water content.

Assume the maximum nominal size of aggregate is 20mm. (used in slab construction & beam designed)

The water content for 20mm nominal size of egg is 18.6 lit.

We are assuming the workability of the concrete is 100mm.

$$\text{Volume of concrete} = \frac{\text{mass of concrete}}{\text{specific gravity of concrete}} = \frac{153.6}{1.56} = 98.6 \text{ m}^3$$

$$= 315.2 \times 100 \text{ m}^3$$

$$\text{Volume of cement} = \frac{\text{mass of cement}}{\text{specific gravity of cement}} = \frac{100}{1.56} = 64.0 \text{ m}^3$$

Form factor of
concrete = 0.6

$$\text{Volume of concrete} = 1 \text{ m}^3$$

How calculation?

$$= 1 - 0.558 = 0.442$$

$$= 1 - V_A - C_A - C$$

Volume of fine Aggregate content is

$$\approx 0.558$$

$$= 0.64 \text{ m}^3$$

Volume of coarse Aggregate content is

The method of placing of concrete is pumpable
and need to reduce the coarse agg. content by 10%.

Coarse Agg content is 0.66

For 0.66 water ratio, the volume of the

coarse Agg content provide

According to that Table No. 3 is 102.6 : 200 a portion

maximum nominal size of aggregate is 20mm.

Assume the fine aggregate is belongs to zone 11. The
calculate: Volume of coarse and fine aggregate

$$315.2 \text{ kg/m}^3 > 300 \text{ kg/m}^3 \\ = 300 \text{ kg/m}^3$$

for moderate exposure the min content of cement

$$\text{From Table No. 5 IS:456 : 2000}$$

$$= 315.2 \text{ kg/m}^3$$

$$\therefore C = \frac{315.2}{153.6}$$

$$\frac{C}{153.6} = 0.4$$

$$\therefore water cement ratio = 0.50$$

Step 4: calculation of cement content
= 154.6

$$= 142 \times \frac{80}{100}$$

The water content for adding of super plasticizer
= 142.6

$$= 142.6 \times 0.90 = 128.4$$

There is a reduction of water content due to

$$\text{From clause 4.2 in IS: 10262 : 2009}$$

$$= 142.6$$

$$= 142.6 + \frac{186}{6} = 186$$

The maximum water content for commingling

$$\text{volume of chemical admixture} = \frac{\text{mass of chemical admixture}}{\text{specific gravity of admix} \times 100}$$

$$\text{mass of chemical admixture} = 315.2 \times \frac{2}{100} \\ = 6.304 \text{ kg/m}^3$$

$$\text{volume of chemical admixture} = \frac{6.304}{1.145} \times \frac{1}{1000} \\ = 0.0055 \text{ m}^3$$

$$\text{volume of all aggregates} = \text{volume of concrete} -$$

$$= 1 - [0.600 + 0.1576 + 0.0055] \\ = 0.7324 \text{ m}^3$$

[vol of cement + vol of water
+ vol of chemical admix]

$$\text{The mass of coarse Agg} = \text{vol of all} \times \text{volume of coarse} \times \text{specific grad} \\ \text{in Agg} \quad \text{coarse} \quad \text{agg} \quad \text{of coarse} \\ \times 1000 \quad \text{agg}$$

$$\text{from IS 4026-2009 clause 4.6} \\ = 0.7324 \times 0.1558 \times 2.74 \times 1000 \\ = 492.4 \text{ kg}$$

$$\text{wt. mass of fine Agg} = \text{vol of all} \times \text{vol of fine} \times \text{sp. gravity} \\ \text{agg} \quad \text{fine} \quad \text{of fine} \quad \times 1000 \\ = 0.7324 \times 0.442 \times 2.74 \times 1000 \\ = 893.05 \text{ kg.}$$

The mix proportion for trial mix M45

$$\text{cement} = 315.2 \text{ kg/m}^3$$

$$\text{water} = 157.6 \text{ kg/m}^3$$

$$\text{Fine Agg} = 893.05 \text{ kg/m}^3$$

$$\text{Coarse Agg} = 492.4 \text{ kg/m}^3$$

$$\text{chemical Admix} = 6.304 \text{ kg/m}^3$$

$$\text{w/c ratio} = 0.50$$

$$\text{cement : water : Fine Agg : coarse Agg} \\ 315.2 : 157.6 : 893.05 : 492.4 \\ 315.2 : 315.2 : 315.2 : 315.2$$

$$1 : 0.5 : 2.8 : 3.5$$

slump value = 50, very severe exp.

For very severe exp:

\therefore The min grade of concrete = M35

Step 1: calculate the target strength of mix proportion

For M35 grade of concrete $f_{ck} = 35 \text{ N/mm}^2$

~~$$w/c = f_{ck} = f_{ck} + 1.65 * s$$~~

where s = standard deviation

$$= 35 \text{ N/mm}^2 \quad (\text{Table 1 IS : 4026 2 : 2004})$$

$$s = 4 \text{ N/mm}^2$$

$$f_{ck} = 35 + 1.65 * 5$$

$$= 43.25$$

Step 2: Selection of water cement ration.

From Table No. 5 IS : 456 - 2000

The max. water cement ratio = 0.45

Step 3: calculation of water content.

Assume the maximum nominal size of agg is 20 mm.

The water content for 20mm nominal size is 186 lit.

$$\therefore \text{slump value} = 50 \text{ mm}$$

845-99 - Bane Agg - 00-7575 = 00-3893 + 0.4332 - 2.7416 / 100

$$\text{Mass of cocaine } \text{Agg} = 0.7383 \times 0.587 \times 2.941000 = 0.4383$$

$$(b_{100} \cdot 0 + b_{88} \cdot 0 + b_{0} \cdot 0) - 11 = \text{the sum of all the digits}$$

$$\text{Volume of chemical add mix type} = \frac{1.145}{6.8} \times \frac{1000}{1} = 0.00159$$

$$\text{mass of chromic acid mixture} = 200 \times \frac{2}{100} = 6.8 \text{ mg/L}$$

Volume of chemical adiabatic tube.

sp. g. 0.970-0.974
sp. g. 0.970-0.974

$$\text{Volume of water} = \text{Mass of water} / \text{Density}$$

0001 51.8

$$\text{Volume of concrete (m}^3\text{)} = \frac{\text{Volume of earth (m}^3\text{)}}{\text{Efficiency of earthmoving equipment}} \times \frac{\text{Efficiency of transport}}{\text{Efficiency of storage}}$$

4.1.1 x calculator

= ladder content = 186 ft

where is education after adding

Q01
08*981=

water-cement ratio

Step 4: - calculation of cement; cohesion

$$g_{n=0} = \frac{3}{2}$$

$$c = 330 \text{ km/s}$$

per service expense the mid content of demand

Form Table No. 5 E.S. : 456 : 2000

value of the human resources

so, we can also find

C-3 46 89 1m3

one year ago

କବିତା

For $\alpha = 0.05$ we observe the volume of aging is more than an 0.85 decrease in the solution.

calculate the volume of coarse fine Agg.

$$\frac{63}{100} \times 99 = 62.43 \text{ cubic feet}$$

प्रामाण्य

For, Pumpable & concrete to produce by 10%

Illustrate

Step 1 :- calculation of target strength.

$$f_{ck} = 40 \text{ N/mm}^2$$

$$f'_{ck} = f_{ck} + 1.65 \times S$$

From table No: 2 IS 10262 : 2009] $S = 5.0$

$$f'_{ck} = 40 + 1.65 [5]$$

$$= 48.25$$

Step 2 :- selection of water cement ratio.

From Table No: 5 IS 456 : 2000

$$w/c = 0.45 \text{ and}$$

Step 3 :- calculation of water content

From IS 10262 : 2009 Table 2

$$\text{Wt} = 186.6 + \frac{6}{100} \times 186 = 192.16 \text{ lt}$$

For calculating water content we are following table-2 IS 10262 : 2009 clause NO 4.2

There is reduction of water content upto 20%.

∴ The water content for adding superplasticizer

$$= 192.16 \times \frac{80}{100} = 153.6 \text{ lt}$$

Step 4 :- calculation of cement content

$$w/c = 0.45$$

$$C = \frac{153.6}{0.45} = 340.2 \text{ kg/m}^3$$

$$350.2 \rightarrow 320 \text{ kg/m}^3$$

Hence OLT

cementitious material (cement + flyash) content
 $\frac{153.6}{0.45} = 340.48 \text{ kg/m}^3$

$$340.48 \geq 320$$

Hence OLT

$$\text{cementitious material content} = \frac{340.48 \times 110}{100}$$

$$= 38.5 \text{ kg/m}^3$$

$$\text{water content} = 153.6 \text{ kg/m}^3$$

$$30\% w/c \text{ ratio} = 0.40$$

fly ash @ 30% of total cementitious material content $= 38.5 \times 30\% = 11.55 \text{ kg/m}^3$

$$\text{cement (OPC)} = 38.5 - 11.55 = 269.5 \text{ kg/m}^3$$

saving of cement while using fly ash $= 350.48 - 269.5$

$$= 80.48 \text{ kg/m}^3$$

Flyash being utilized $= 11.55 \text{ kg/m}^3$

Ah

structure in mild exposure condition. Consider
Normal max size of the Agg is 30 mm and
square the suitable test date using code
provision

Step 5: Target strength of the concrete
min grade of concrete = M30

$$f_{ck} = 30 \text{ N/mm}^2$$

$$\text{From table No. } \frac{1}{4} \text{ IS : 1026A : 2009}, S = 4.0 \text{ mm}$$

$$f_{ck} = 30 + 1.65 \times 4.0$$

$$f_{ck} = 36.6 \text{ N/mm}^2$$

Step 2: Calculation of Water Cement ratio

$$\text{From table No. } \frac{1}{4} \text{ IS : 1026 : 2000}$$

But we consider $W/C = 0.45$

$$(Based on experience) \\ W/C = 0.45$$

Step 3: Calculation of water content
From IS : 1026A : 2009 Table 2

Max Nominal size 20 given, $W = 186 \text{ l/c}$
So, $W = 186 \text{ l/c} (\because \text{code provides same value})$
we assume 50 slurry

$$\checkmark \quad 186 \times \frac{80}{100} = 148.8 \text{ l/c}$$

the water content by adding superplasticizer
there is a reduction of water by 20 l/c.
are made by 20 mm slurry

Step 4: Calculation of concrete
Vol of concrete = 1 m^3
Vol of coarse Agg = 0.494 m^3
Vol of fine Agg = 0.506 m^3
Volume of coarse Agg = $0.64 \times \frac{90}{100} = 0.576 \text{ m}^3$
For pumpable concrete reduce by 10%.
 $= 0.64 + 0.09 = 0.63 \text{ m}^3$
Vol of coarse Agg = 0.62 m^3
[From table No. 3 IS 1026 : 2009]
[From IS 44.1.1.1m IS 1026 : 2009]
In Vol of coarse Agg, so we are adding 0.02
for 0.40 W/C ratio there is a decrease of 0.01.
Step 5: Calculation of coarse Agg & fine Agg volume
Hence B_k :
 $342 > 300 \text{ kg/m}^3$
[From table No. 5 IS : 1026 : 2000] min cement = 300 kg/m³
 $C = 342 / 300 = 1.14 \text{ kg/m}^3$
 $W/C = 0.40$
 $\therefore 148.8 = C$

$$\text{Vol of water} = \frac{\text{mass of water}}{\text{s.p.g. of water}} \times \frac{1}{1000}$$

$$= \frac{148.8}{1} \times \frac{1}{1000}$$

$$= 0.1488 \text{ m}^3$$

$$\text{Vol of C. Ad} = \frac{\text{mass of C. Ad}}{\text{s.p.g. of C. Ad}} \times \frac{1}{1000}$$

$$\text{mass of C. Ad} = \text{mass of cement} \times \frac{2}{100}$$

$$= 3.2 \times \frac{2}{100}$$

$$= 0.064 \text{ m}^3$$

$$= \frac{0.064}{1.148} \times \frac{1}{1000} = 0.0064 \text{ m}^3$$

$$\text{Vol of All in Agg} = 1 - [\text{Vol of cement} + \text{Vol of water} + \text{Vol of C. Ad}]$$

$$= 1 - [0.118 + 0.1488 + 0.0064]$$

$$= 0.7268$$

Vol of Coa

$$\text{mass of coarse Agg} = \frac{\text{Vol of all in Agg} \times \text{s.p.g. of coarse Agg}}{\text{Vol of coarse Agg}} \times 1000$$

$$= 0.7268 \times 0.536 \times 2.94 \times 1000$$

$$= 1149.06$$

$$\text{mass of fine Agg} = \frac{\text{Vol of all in Agg} \times \text{s.p.g. of fine Agg}}{\text{Vol of fine Agg}} \times 1000$$

$$= 0.7268 \times 0.424 \times 2.74 \times 1000$$

$$= 844.36$$

