HARDENED CONCRETE

The compressive strength of the 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 plays an important role in structural Construction

In these cases the Compressive strength of concrete is take into Consider to design (or) to satisfy the other stresses developed in structural members.

Factors Effecting the Strength of Concrete (Hardened Concrete)

1. Water - cement ratio and degree of Compaction Ratio
2. Ratio of cement to aggregate (both fine & coarse Agg)
3. Grading, surface Texture, shape, strength and stiffness of the Agg
4. Max size of Agg used

These are the important factors which are influencing the strength of concrete.

Water Cement Ratio & Degree of Compaction :—

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 cement paste (or) in the other words the strength of the cement paste Increases with the Increase of cement content & also It is decreases with Increasing the air voids & Water content

In 1918 Duff Abrams proposed a statement that assuming fully compacted concrete. (8)

Gel Space Ratio : w/c ↑ G/s ↓ por ↑ strength ↓,

the concrete is a Brittle material so the porosity is primarily influences the strength.

The compressive strength is severely decreases due to the Increasing of its porosity

the porosity of the concrete which governs the strength of the concrete is affected by the Gel space ratio in concrete mix

the G/s ratio is the ratio of the solid products of Hydration to the space available for these Hydration products

A Higher Gel space ratio reduces the porosity and therefore strength of the concrete is Increases

The Gel Space ratio governs the porosity of the Concrete after its strength effected by water cement Ratio.

the Higher Water cement ratio gives less G/s ratio due to less G/s ratio the porosity of concrete is Increases there by ~~strene~~ the decrease of strength of Concrete is occurs W/c ↑ G/s ↓ por ↑ str ↓.

"THE POWERS" Experiment shows that the strength of the concrete Bears a Specific relationship with the G/s

He proposed a formula to calculate the theoretical Strength of concrete

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

where x = Gel/space ratio

the value 240 represents the Inherent strength of the Gel

For the type of cement is specifically used

To calculate the G/S ratio in fully Hydrated cement is

$$x_f = \frac{0.657C}{0.319C + W_o}$$

C = Weight of cement (in gms)
W_o = Volume of Mixing Water (in ml)

To calculate the G/S ratio for partially Hydrated cement

$$x_p = \frac{0.657 \times C \times \alpha}{0.319 \times C \times \alpha + W_o}$$

α = % of Hydration

Problem :

1. Calculate the Gel/space ratio and theoretical strength of sample of concrete made with 500 gms of cement and 0.5 W/c ratio. For Fully Hydrated & at 75% of Hydration

A) For fully Hydrated cement :

Given C = 500 gms

$\alpha = 75\% = \frac{75}{100} = 0.75$

$w/c = 0.5$

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

W = 250 gms of water

W_o = ~~250~~ 274.72 ml

1000 ml → 910 gms
? → 250 gms
274.72

$\rho = \frac{m}{V}$

$1440 = \frac{500}{V}$

$S = 240(x)^3$

$= 240(0.75)^3$

Th = 101.25 N/mm

$$x_f = \frac{0.657 \times 500}{0.319 \times 500 + 274.72}$$

$x_f = 0.75$

$$x_p = \frac{0.657 \times 500 \times 0.75}{0.319 \times 500 \times 0.75 + 274.7}$$

$x_p = 0.62$

Th $S = 240(x)^3 = 240 \times (0.62)^3 = 57.19$ N/mm²

1. Calculate the G/S ratio and theoretical strength of a sample of concrete made with 500 gms of cement and having with the W/C ratio 0.5 on fully Hydration & 60% of Hydration?

A/- Given, Weight of cement used for sample C = 500 gms

MID PROBLEM (2M)

W/C ratio = 0.5

The weight of water used W = 0.5×C

= 0.5×500

= 250 gm

for water
1lit → 1kg
1gm → 1ml

Vol of water used W_o = 250 ml

For fully Hydrated concrete

G/S ratio $$X_f = \frac{0.657 \times C}{0.319 \times C + W_o}$$

$$X_f = 0.8021 \sim 0.8$$

theoretical strength for fully Hydrated cement

$$S = 240(X_f)^3$$
$$= 240(0.8)^3$$
$$S \approx 123 \text{ N/mm}^2$$

For 60% Hydration

$$X_p = \frac{0.657 \times C \times \alpha}{0.319 \times C \times \alpha + W_o}$$

$$= \frac{0.657 \times 500 \times 0.6}{0.319 \times 500 \times 0.6 + 250}$$

$$\therefore X_p = 0.57$$

theoretical strength for Partial Hydrated cement

$$S = 240 \times (0.57)^3$$
$$S = 44.44 \text{ N/mm}^2$$

Calculate the G/S ratio & theoretical strength of a sample of concrete 680 gms of cement and having with w/c ratio 0.48 on fully hydrated & at 72 % of Hydration

G/S ratio of fully Hydrated cement

$$x_f = \frac{0.657 \times C}{0.319 \times C + W_o}$$

The weight of cement used $C = 680$ gms

volume of water used in mix $W_o = ?$

$$\frac{W}{C} = 0.48 \Rightarrow W = 0.48 \times 680$$
$$= 326.4 \text{ gms}$$

Vol of water $W_o = 326.4$ ml

For fully hydrate $x_f = \frac{0.657 \times 680}{0.319 \times 680 + 326.4}$

$$x_f = 0.822$$

theoretical strength for fully Hydrated cement

$$S = 240 (x_f)^3$$
$$S = 240 (0.8)^3 \Rightarrow S \approx 123 \text{ N/mm}^2$$
$$S = 122.88 \text{ N/mm}^2$$

For 72 % Hydration

$$x_p = \frac{0.657 \times C \times \alpha}{0.319 \times C \times \alpha + W_o}$$
$$= \frac{0.657 \times 680 \times 0.72}{0.319 \times 680 \times 0.72 + 326.4}$$

$$x_p = 0.6$$

Theoretical strength for partially Hydrated cement

$$S = 240 (x_p)^3$$
$$S = 51.8 \text{ N/mm}^2$$
$$S \approx 52 \text{ N/mm}^2$$

Maturity Concept of Concrete :

While dealing with curing & strength development we have so far consider only the time aspect but the strength development of the concrete is not only depend on time It also depends on the Temperature during the Early period of Hydration that influences the the rate of gain of strength of the concrete

The strength development of the concrete can be explain a function of summation of the product of Time & Temperature.

the Function of summation is called maturity of the concrete

$\therefore$ Maturity $M = \sum$ (Time * Temperature)

The Temperature is Established by No. of calculations from an origin laying b/w $-12^\circ c$ to $10^\circ c$

By Experimentally It is found that the Hydration of concrete continous to takes place upto about $-11^\circ c$.

$\therefore$ $-11^\circ c$ is taken as a datum Line for computing the Maturity of concrete

The Maturity is Measured in terms of °c hrs (or) °c d

Note :

A sample of concrete is cured at $18^\circ c$ in 28 days The Full Maturity of the Concrete is

$$M = \Sigma \text{(time * Temperature)}$$

Datum line temp $= -11^\circ c$

Given Temp $= 18^\circ c$

$$M = 28 \times 24 (18 - (-11))$$

$$= 19{,}488 \ ^\circ c \text{ hrs}$$

The Full Maturity of concrete mix for 28 days at 18°curing Temperature is. 19,488 °c hrs

For more calculations and Research Oreinted We are Considered the Full maturity of the concrete mix is 19,800 °c hrs

The Maturity concept is useful for Estimating the strength of concrete at any other Maturity value as a percentage of strength of the concrete at no maturity value

The % of strength of Identical concrete at any other Maturity value $= A + B\log_{10}\left(\frac{\text{Maturity}}{10^3}\right)$ A & B {Powlmans 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 avg temperature during the day time is 20°c and night time 10°c.

A:- Given data

Strength after 28 days at 18°c and Maturity of concrete is 19800°ch	Coeffcients	
	A	B
< 17.5	10	68
17.5 - 35.0	21	61
35.0 - 52.5	32	54
52.5 - 70.0	42	46.5

S = 40 Mpa → For 28 days

Age = 7 days

Night temperature = 10°c

Day Temperature = 20°c

Maturity $M = \Sigma(\text{Time} * \text{Temperature})$

$= \Sigma((7\times12\times(20-(-11)) + 7\times12\times(10-(-11)))$

$= 4368\ ^\circ c\ hrs$

The concrete is falls under zone III

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

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

$= 32 + 54\log_{10}\left(\frac{4368}{10^3}\right)$

$= 32 + ~~35.46~~\ 34.57$

$= ~~67.46~~\ 66.57\ \%$

The strength of Identical Concrete for 7 days

$= \frac{66.57}{100}\times40$

$S = 26.6$ mpa

2. A Labaratory experiment is conducted at pune on a particular mix showled a strength of 32.5 mpa. For Fully matured concrete. Find whether a form work can be removed for an Identical concrete placed at Srinagar at age of 15 days when an avg temperature of 5°c. If the concrete is likely to be subjected to a stripping stress of 25 mpa

A- For fully matured strength = 32.5 mpa

age = 15 days

Temp = 5°c

Maturity $M = \Sigma(\text{Time} * \text{Temperature})$

$= 15\times24\times(5-(-11))$

$M = 5760\ ^\circ c\ hrs.$

The concrete is falls under zone II

$A = 21,\ B = 61$

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

$$= 21 + 61 \cdot \log_{10}\left(\frac{5760}{10^3}\right)$$

$$= ~~128.38~~\ 67.38\ \%$$

The strength of Identical Concrete for 15 days

$$= \frac{~~128.38~~\ 67.38}{100} \times ~~32.5~~\ 32.5$$

$$S = 21.89 \text{ mpa}$$

Stripping stress = 25 mpa
↑
From the given data

The strength of the concrete acheive in 15 days of curing is less than this stripping stress $21.90 < 25$

So we couldn't remove the form work in 15 days.

So How many days is req to get (or) to gain fully maturity strength at given curing Temperature is

$$\frac{M}{24\left[t-(-11)\right]} = \text{No. of days} \qquad t \rightarrow \text{curing Temp of Identical Concrete}$$

$$\text{i.e.}\quad \frac{19{,}800}{24\left[5-(-11)\right]} = 51.5$$

$$\sim 52 \text{ days}$$

At 5°c temp the Identical concrete must be cured in 52 days to acheive full Maturity strength

Relationship between Flexural strength & Compressive strength:

We are all know the behaviour of the concrete under compression and Tensile stresses i.e., the concrete member is strong in compression and it is weak in Tension so in all structural construction the compressive strength of the concrete plays an impotant role and we are Ignoring the Tensile stress. But in some cases like pavement slabs in road construction works.

The Flexural strength of the concrete is taking into consider due to the changing of vehicular moving Load

So we need to design the pavement slabs in both compression and Flexural strength

CRRI Develops some experimental formulas to calculate (or) to estimate the tensile and compressive strengths

1. $Y = 15.3X - 9$

For 20 mm maximum size of Agg

2. $Y = 14.1X - 10.4$

For 20 mm maximum size of Natural gravel

3. $Y = 9.9X - 0.55$

For 40 mm maximum size of crushed stone Agg

4. $Y = 9.8X - 2.52$

For 40 mm maximum size of Natural gravel

Where

$X \rightarrow$ Flexural strength

$Y \rightarrow$ Compressive strength

Note :

The Type of the Agg influences the relationship between compressive and flexural strengths

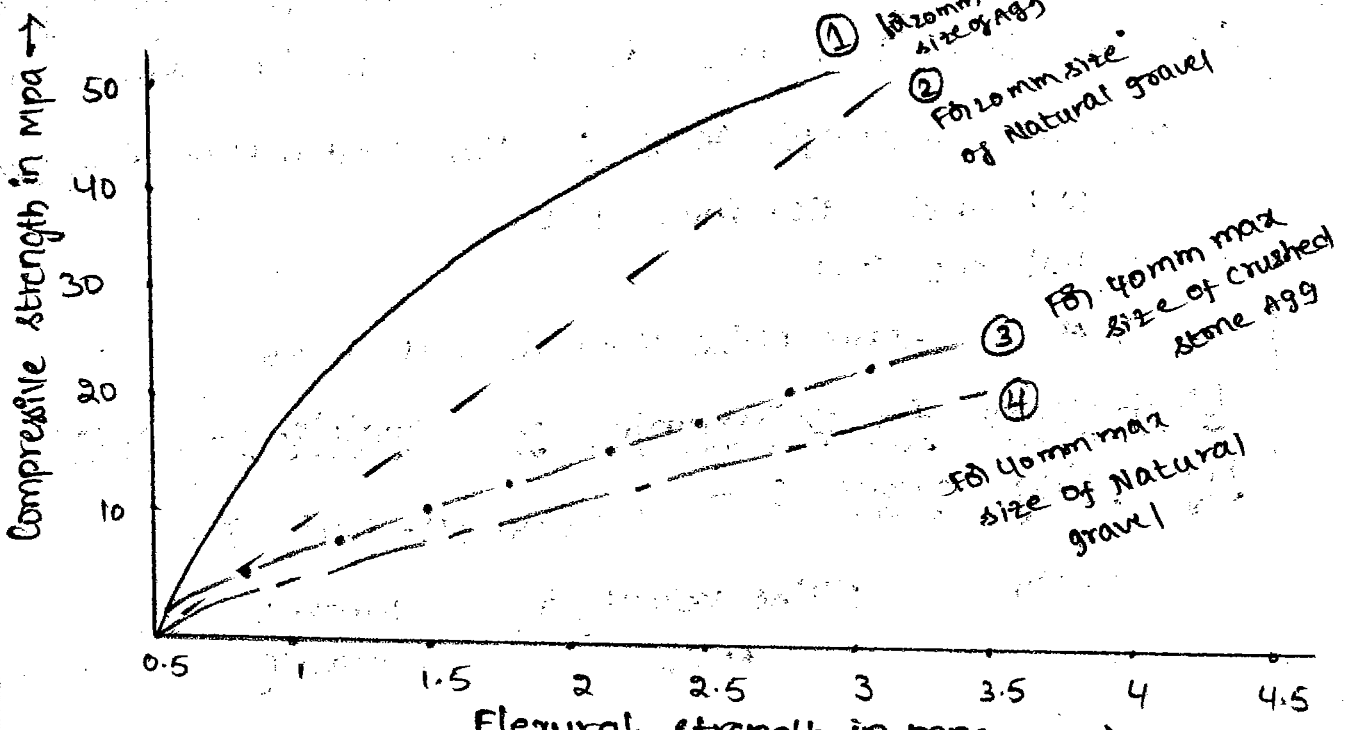
The crushed stone Agg gives relatively Higher Flexural strength than the compressive strength

The pozzolmic materials used in concrete mix increases the Tensile strength of the concrete

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

$$Y = 11x - 3.4$$

In all these formulas the compressive and Flexural strenghts are in terms of N/mm^2 (or) Mpa



The Flexural strength of concrete is 8 to 11 % of the compressive strength of concrete for higher ranges of the concrete strength which means strength of concrete is greater than 25 Mpa.

9 to 12.8 % for lower ranges of the concrete strength which means the strength of concrete < 25 Mpa.

From the codal provision the Flexural strength of the concrete is $0.7\sqrt{F.C.K}$

Tests:
- central load method (or)
- Two point load method

by U.T.M

F.C.K → Characteristic compressive strength of concrete

According to (IS 456-2000)

Non Destructive Test :

By using these N.D. Tests We are estimating the surface hardness, Tensile strength & quality of the Concrete approximately

While using these N.D.T Test We are following some Experimental Readings & charts to find the req result

They are 3 major Tests for Non Destructive Analysis

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

Limitations for Determining the quality of concrete by using U.P.V :—

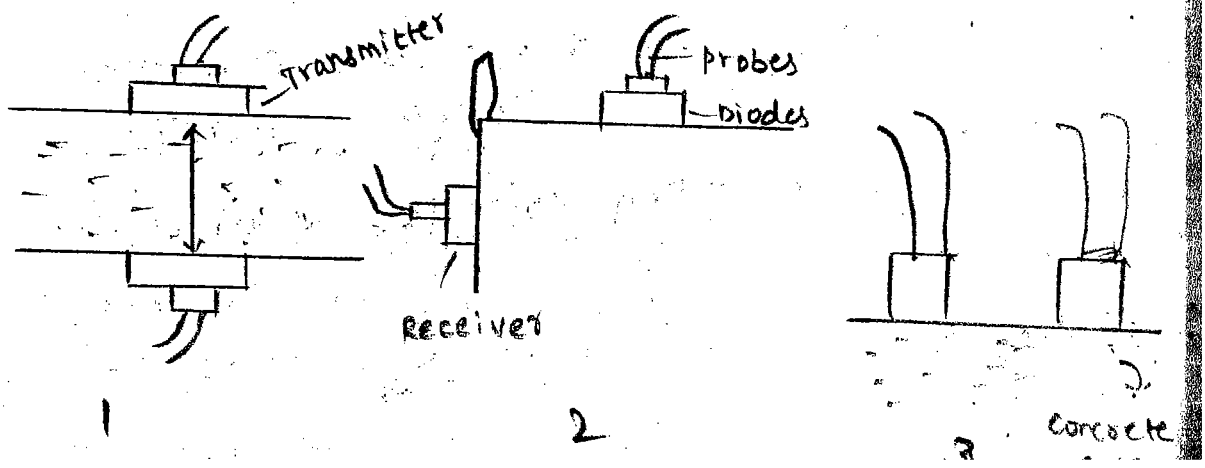
IS : 13-311 - part - I

S.No	pulse velocity in km/s	concrete quality
1	> 4.5	Exellent
2	3.5 to 4.5	Good
3	3.0 to 3.5	Medium
4	< 3.0	Doubtful

Methods of Transmission of pulse wave in Concrete member:

They are 3 methods of Transmission

Direct Transmission
Indirect "
Surface "



These are the 3 ways of measuring pulse velocity through concrete

∴ the pulse velocity $v = \frac{d}{t}$

Where $d \rightarrow$ path length of the pulse wave

$t \rightarrow$ Time taken ~~b/w the~~ of pulse wave b/w Two Diodes

Factors Effecting the measurement of pulse velocity :—

The Measurement of pulse velocity through concrete is effected by following parameters

1. Smoothness of the contact surface under the test
2. Influence of path length
3. Temperature of the concrete
4. Moisture condition of the concrete
5. Presence of Reinforcement steel — 1.2 to 1.5 times to pulse velocity → Plane concrete

Note :

the National Commitee for cement & Building materials proposed the quality of the concrete w.r.t pulse velocity

S.No	Pulse velocity km/s	Quality of concrete
1	> 3.5	Excellent
2	3.5 - 3.0	Good
3	3.0 - 2.5	Medium
4	< 2.5	Poor

↖ Accarding to IS standards IS: 13-311 - part - I

~~S.No~~

HARDNED 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 (Hardned 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 increases with the increasing of cement content and also it is decreases with increasing the airvoids 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 inversly proportional to water cement ratio.

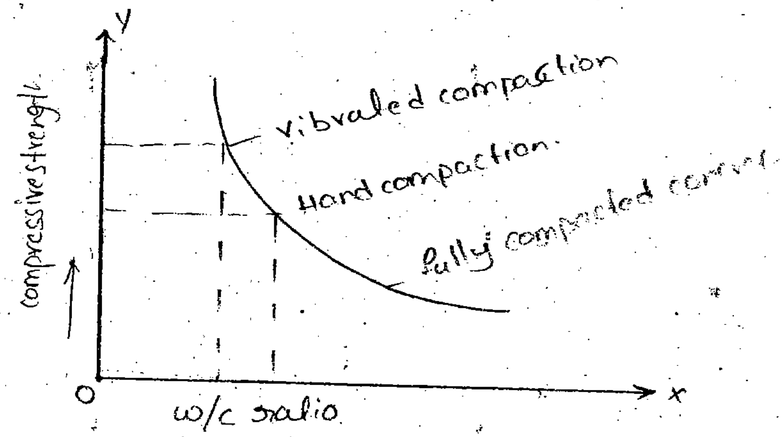
He proposed a formula

$$S = \frac{A}{B^x}$$

where S is strength of concret.

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 ~~Freest~~ proposed a formula to calculat the strength of concrete in early of 1987.

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

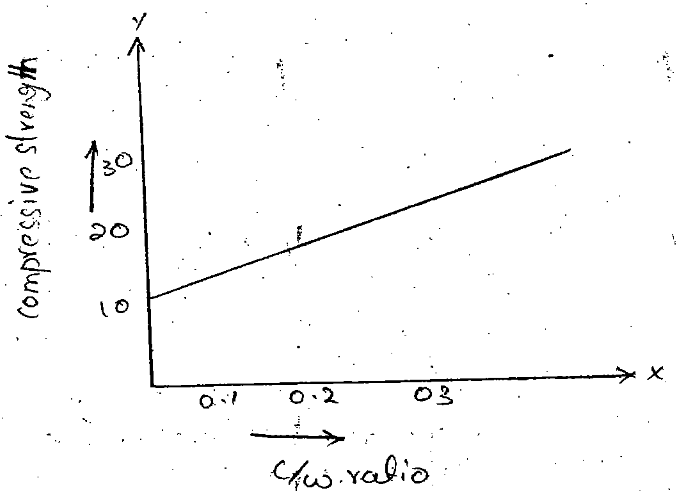
where S is strength of concrete mix

c, e, a are the ... of the ...
and air.

The above expression indicates the Involvement of air voids in concrete mix ;

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

* By the increasing of water cement ratio in self compacting concrete we are achiving less strength. The water cement ratio is decreases with vibrating compaction. We are achiving High strength concrete.



The concrete is a brittle material, so, the porosity is primarily influences the strength.

The compressive strength is severely decreases due to the increase of its porosity

The porosity of concrete which governs the strength of concrete is affected by the Gel-space ratio in concrete mix.

The G/s ratio is the ratio of the solid products of hydration to the space available for these hydration production.

A Higher G/s ratio reduces the porosity and there for the strength of concrete increases.

The Gel space ratio Governs the porosity of the concrete after its strength affected by water cement ratio.

The Higher water cement ratio gives less Gel-space ratio due to less G/s ratio the porosity of concrete is increases. there by the decreasing of strength of concrete is occurs.

The power's expt shows that the strength of concrete bears a specific relationship with the Gel-space ratio.

He proposed a formula to calculate the theoritical strength of concrete

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

where x = Gel/space ratio

The value 240 represents the inherent strength of Gel in MPa (or) N/mm^2. for the type of cement is specifically used

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

$$X_f = \frac{0.657 * C}{0.319C + W_0}$$

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.

$$X_p = \frac{0.657 * \alpha * C}{0.319 * C * \alpha + W_0}$$

α = % of Hydration.

1) calculate Gel/space ratio and the theoritical strength of sample of concrete made with 500gm of cement and 0.5 water/cement ratio. For fully hydrated & 75% of Hydration.

For Fully Hydrated cement:

Given

wt of cement (C) = 500 gms

$\alpha = 75\% = \frac{75}{100} = 0.75$

$w/c = 0.5$

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

$w = 0.5 * 500$

$w = 250$ gms

1000 ml = 910 gm

x = 250 gm.

x = 274.72 ml

Volume of water = ~~274.72 ml~~ 250 ml

$$X_f = \frac{0.657 * 500}{0.319 * 500 + 274.72}$$

$X_f = 0.7565$

Theoritical strength for fully hydrated cement

$S = 240 (x)^3$

$= 240 (0.75)^3$

$S = 101.25 \ N/mm^2$

For partially Hydrated cement:

$$X_p = \frac{0.657 * 500 * 0.75}{0.319 * 500 * 0.75 + 274.72}$$

$X_p = 0.62$

Theoritical strength for partially Hydrated cement

$S = 240 x^3$

$= 240 (0.62)^3$

$= 57.19 \ N/mm^2$

calculate G/s ratio and theoritical strength of sample of concrete made with 680 gm of cement & 0.48 w/c ratio on fully hydrated and at 72% of Hydration.

Sol: Gel/space ratio of fully hydrated cement

$$X_f = \frac{0.657 * C}{0.319C + W_0}$$

The weight of cement used C = 680 gms.

Volume of water used in mix W_0 = ?

Given data.

$w/c = 0.48$

$w = 0.48 * C$

$= 0.48 * 680$

$= 326.4$ gms

∴ volume of water used in mix

$= 326.4$ ml

$$x_p = \frac{0.657 * 680}{0.319 * 680 + 326.4}$$

$= 0.822$

$x_p \approx 0.8$

The theoritical strength for fully hydrated concret

$S = 240 (x_p)^3$

$= 240 (0.8)^3$

$= 123 \ N/mm^2$

For partially hydrated cement

$\alpha = 72\% = 0.72$

$$x_p = \frac{0.657 * 680 * 0.72}{0.319 * 680 * 0.72 + 326.4}$$

$x_p = 0.66$

$x_p \approx 0.7$

Theoritical strength

$S_p = 240 (x)^3$

$= 240 (0.7)^3$

$S_p = 82.32 \ N/mm^2$

While dealing with curing and strength development we have so far consider only the time aspect but the strength development of the concrete is not only depend on time. It is also dependent on the temperature during the early period of hydration that influences the rate of gain of strength of the concrete.

The strength development of concrete can be explained a function of summation of the product of time and temperature. The function of summation is called maturity of concrete.

∴ Maturity = summation of (time multiplied with temp

= Σ (time * temperature)

The temperature is established by no. of calculations from an origin lying between − 12° to +10°c.

By experimentally it is found that the hydration of concrete continuous to takes place upto above −11°c

∴ −11°c is taken as a datum line for computing the maturity of concrete.

The maturity is measured interms of °c hrs (or) °c days.

Note:

A sample of concrete is cured at 18°c in 28 days. The full maturity of concrete is

M = Σ (time * temperature)

datum line temperature = −11°c t = 18°c

M = (28 * 24 * (18 − (−11))) = 19488 °c hrs

∴ The full maturity of concrete mix for 28 days at 18°c curing temperature is 19488 °c hrs.

% strength of identical concrete for maturity of 5260 °ch

$= A + B \log_{10}\left(\frac{\text{maturity for 15days}}{10^3}\right)$

$= 21 + 61 \log_{10}\left(\frac{5260}{1000}\right)$

$= 67.38\%$

The strength of identical concrete for 15 days is

$= 32.5 * \frac{67.38}{100}$

$= 21.9$ Mpa

From given data

Stripping stress = 25 Mpa

The strength of concrete achieved in 15 days of curing is less than the stripping stress

$21.90 < 25$

So, we couldn't remove the form work in 15 days.

So, How many days is required to get full maturity strength at given temperature is

No. of days for gaining full maturity strength $= \frac{M}{24(t-(-11))}$

$= \frac{19800}{24(5-(-11))}$

$= 51.56$

$= 52$ days

At 5°c temperature the identical concrete must be cured in 52 days to achieve full maturity strength.

Relationship between compressive strength & tensile strength :-

We are all know the behaviour of concrete under compression and tensile stresses, i.e., the concrete member is strong in compression and it is weak in tension. so, In all structural construction the compressive strength of concrete plays an important role & we are ignoring the tensile stress. But in some cases like pavement slabs in road construction works.

The flexural strength of concrete is taking into consider due to the changing of vehicular moving load so, we need to design the pavement slabs in both compression and flexural strength.

The CRRI develops some experimental formulas to calculate (or) to estimate the tensile and compressive strengths

1. $Y = 15.3X - 9$

For 20mm maximum size of a aggregate (crushed stone)

2. $Y = 14.1X - 10.4$

For 20mm maximum size of natural Gravel

3. $Y = 9.9X - 0.55$

For 40mm maximum size of crushed stone Agg

4. $Y = 9.8X - 2.52$

For 40mm maximum size of natural gravel

where X = flexural strength

Y = compressive strength.

Note :-

1. The type of aggregate influences the relationship between compressive and flexural strengths
2. The crushed stone agg give relatively higher flexural strength than the compressive strength
3. The pozzolonic materials used in concrete mix increases the tensile strength of concrete.

for more calculations & research oriented we are considered the full maturity of concrete mix is 19,800°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 Poolman's coefficients

1) The strength of a sample for fully matured concrete is 40MPa. 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°C hrs	coefficients	
	A	B
< 17.5	10	68
17.5 – 35.0	21	61
35.0 – 52.5	32	54.
52.5 – 70.0	42	46.5

Given Datum temperature = – 11°c

strength of sample, concrete at fully matured = 40MPa

The concrete is falls under zone-III

∴ A = 32, B = 54

no. of days for curing time t = 7 days

temperature day time = 20°c

night time = 10°c

Maturity of concrete for 7 days

$M = \Sigma$ (time * temperature)

$= (7 \times 12 \times (20° - (-11°)) + (7 \times 12 \times (10° - (-11°)))$

$= 4368\,°C\,hrs$

% strength of identical concrete for maturity of 4368°C hrs is

$$= A + B\log_{10}\left(\frac{\text{Maturity for 7 days}}{10^3}\right)$$

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

$= 66.5\%$

The strength of identical concrete for 7 days is

$= 40 \times \frac{66.5}{100} = 26.6$ 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 srinagar 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 25Mpa

Given

strength of concrete of fully matured = 32.5Mpa.

The concrete is falls under zone-II

∴ A = 21, B = 61

No. of days for curing = 15 days.

temperature – 5°c

Maturity of concrete for 15 days

$M = \Sigma$ (time * temperature)

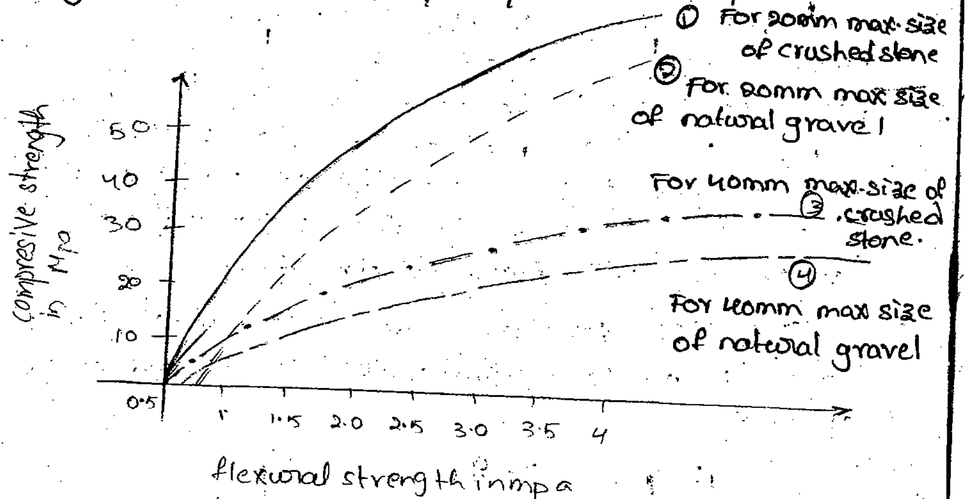
$= (15 \times 24 \times (5° - (-11°)))$

= 5760 °c hrs

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

$$Y = 11X - 3.4$$

In all these formulas the compressive and flexural strength are in terms of N/mm^2 (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 25Mpa

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 $\boxed{0.7\sqrt{f_{ck}}}$

Where f_{ck} is charecteristic compressive strenth of concrete.

According to IS 456-2000

Non-Destructive Test

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

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

They are three major Tests for Non Destructive Analysis.

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

Note:-

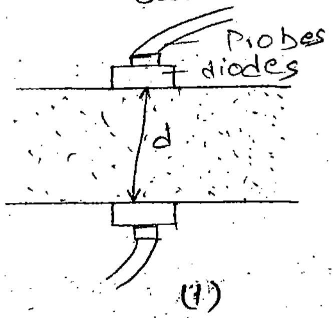
The limitations for determining the quality of concrete by using UPV IS. 13311 -Part-I

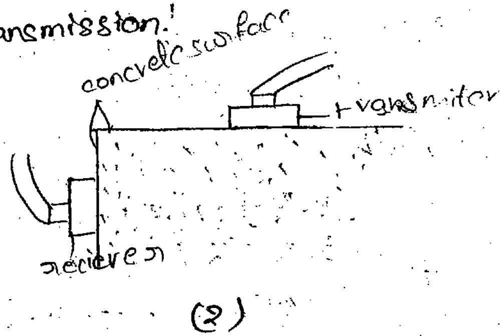
S.NO	Pulse velocity in km/s	concrete quality
1.	>4.5	Excellent
2.	3.5 - 4.5	Good
3.	3.0 - 3.5	Medium
4.	< 3.0	Doubtfull

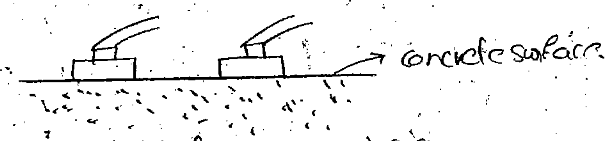
Methods of Transmission of pulse wave in concrete member

There are 3 Methods of Transmission.

1. Direct Transmission.
2. Indirect Transmission.
3. Surface Transmission.







These are the three ways of measuring pulse velocity through concrete.

pulse velocity $v = \frac{d}{t}$

d → path length of pulse wave

t → Time taken the pulsewave b/w two diodes

Factors effecting the measu...

The measurement of pulse velocity through concrete is effected by following parameters.

→ Smoothness of the contact surface under the test

→ Influence of path length — 5% reduction in pulse velocity

→ Temperature of concrete. — 30 to 60 ; <5°C 25% ↑ in pulse velocity

→ Moisture condition of concrete

→ presence of Reinforcement steel.

The National committee for cement and building material proposed the quality of concrete w.r.to the pulse velocity:

NCBM

S.NO	pulse velocity km/sec	Quality of concrete
1.	>3.5	Excellent
2.	3.5 - 3.0	Good
3.	3.0 - 2.5	Medium
4.	<2.5	poor