

RCC Syllabus - GATE + ESE

- 1- Basic Properties
- 2- Working stress Method - SRB
- 3- Limit state Method - SRB, DRB, T-Beams
- 4- Design of Beam - Deflection
- 5- Shear, Bond and Torsion
- 6- Design of slab & stair case
- 7- Design of column
- 8- Design of Foundation
- 9- Pre-stressed concrete

ONLY For ESE :-

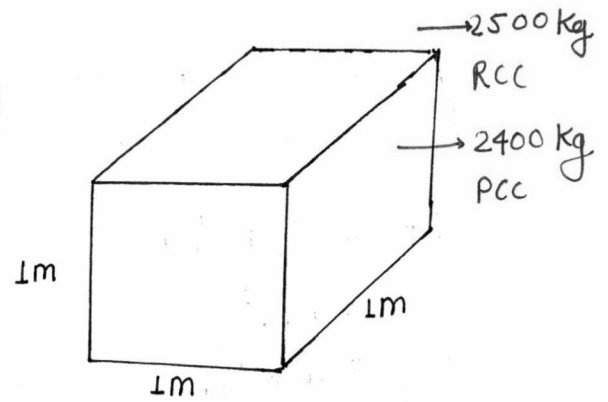
- 10- Design of Retaining wall
- 11- Design of water Tank
- 12- Masonry structure
- 13- Earthquake Engineering

Important IS codes / Handbooks

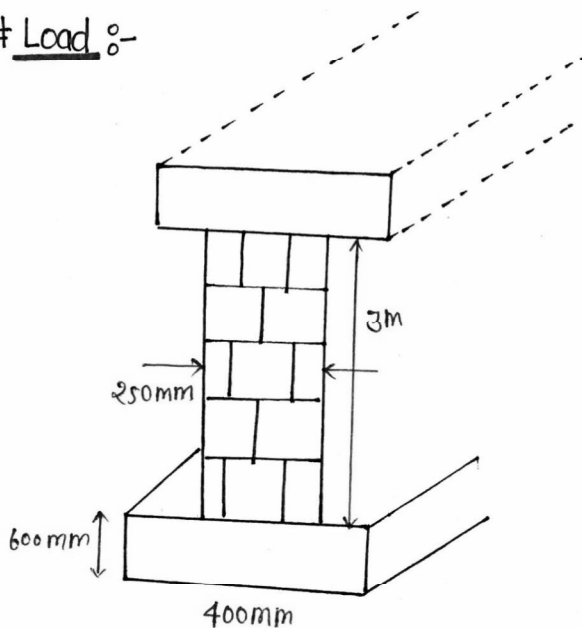
- 1- IS 456-2000 - Plain and Reinforced Concrete
(including Amendment No-6, issued in June 2024)
- 2- IS 1343-2012 - Pre-Stressed Concrete
(including Amendment No-1)
- 3- IS 1893-2016 - Earthquake Resistance Design
(including Amendment No-2, issued in November 2020)
- 4- IS 13920-2016 (Ductile Design & Detailing of Reinforced concrete structures)
- 5- IS 3370:2021 (concrete structure For Retaining Aqueous Liquids) Water Tank
- 6- IS 1905:1987 (code of practices for structural use of unreinforced Masonry)

Unit weight per cubic Meter :-

PCC	24 KN/m ³
RCC	25 KN/m ³
Flooring	24 KN/m ³
Brick Masonary	20-22 KN/m ³
Earth Filling	18-19 KN/m ³
Steel	78.5 KN/m ³
Stone	28-29 KN/m ³
Cement Mortar	20.8 KN/m ³
Grass	25.30 KN/m ³



Load :-

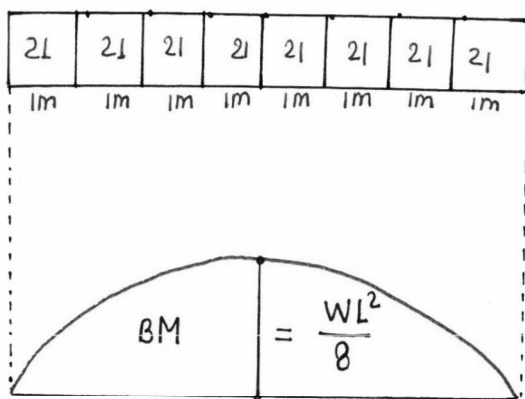
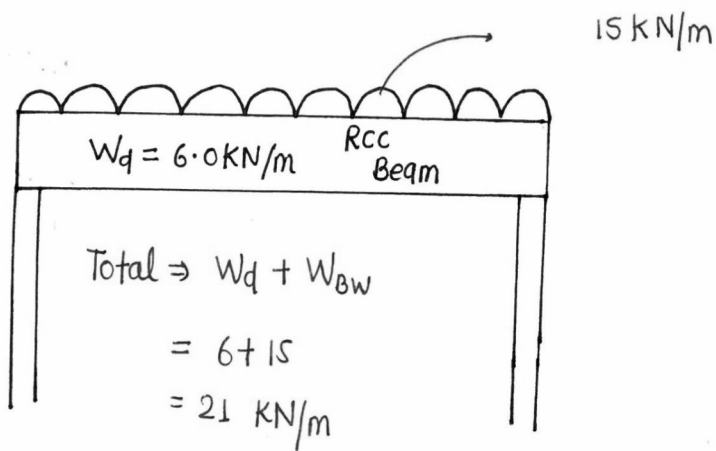


Brickwork Load :-

$$\begin{aligned}
 &\Rightarrow \text{Thickness} \times \text{Height} \times \text{Length} \times 20 \text{ (KN/m}^3\text{)} \\
 &= 0.25 \times 3 \times 1 \times 20 \\
 &= 15 \text{ KN/meter of length}
 \end{aligned}$$

Load of RCC Beam :- (For 1m Length)

$$\begin{aligned}
 &\Rightarrow B \times D \times L \times \gamma_{\text{RCC}} \\
 &= 0.4 \times 0.6 \times 1 \times 25 \\
 &= 6.0 \text{ KN/m} \quad \{ \text{Dead Load} \}
 \end{aligned}$$



$W = \text{Load over 1m length of Beam}$

$$= 21 \text{ kN/m}$$

$$BM = \frac{WL^2}{8} = \frac{21 \times 8^2}{8} = 168 \text{ kN-m}$$

$$R_1 = R_2 = \frac{WL}{2} = \frac{21 \times 8}{2} = 84 \text{ kN}$$

Design Ideas As per WSM :-

⇒ Concrete M30

⇒ Steel Fe 500

$$\underbrace{f_{ck} = 30 \text{ N/mm}^2}_{\text{characteristic compressive strength}} \longrightarrow \text{Failure strength}$$

$$\text{Design strength} = \frac{f_{ck}}{\text{FOS}} = \frac{30}{3.0} = 10 = \underbrace{\sigma_{cbc}}_{\text{concrete in bending in compression}}$$

Permissible stress

$$\text{Stress} \Rightarrow \text{Actual developed stress} = \frac{\text{Load}}{\text{Area}}$$

$$\underbrace{f_y = 500}_{\substack{\text{yield strength} \\ \text{tensile strength}}} \longrightarrow \text{Failure strength}$$

$$\text{Design strength} = \frac{f_y}{\text{FOS}} = \frac{500}{1.8} = 277 = 275 = \underbrace{\sigma_{st}}_{\text{steel in Tension}}$$

Permissible stress

$$\# \text{ Bending stress} = \frac{BM}{I} y = C_a$$

(Actual stress developed in steel
Concrete in compression)

$$C_a \leq \sigma_{cbc}$$

$$8 \leq 10 \rightarrow \text{safe}$$

$$12 > 10 \rightarrow \text{Not safe}$$

$$t_a \leq \sigma_{st} \quad (\text{Actual stress develop in steel in tension})$$

$$240 < 275 \rightarrow \text{safe}$$

$$325 > 275 \rightarrow \text{Not safe}$$

#

Testing

①

For Design of
Proportion of
Mix

For 1 cum (100)
water = 150 kg
cement = 360 kg
sand = 700 kg
stone Agg = 1400 kg
Admixture =

calculation Made As per
IS code 10262

Make cube using Actual Material brought From site :-

1

2

3

→ Test After 28 days After casting

$$f_{avg} = \frac{35 + 37 + 38}{3} = 36.6 \text{ N/mm}^2 \rightarrow \text{Not OK}$$

Because

Target Mean strength :-

$$f_m = f_{ck} + 1.65 \sigma$$

$$\Rightarrow 30 + 1.65 \times 5.0 = 38.25 \text{ N/mm}^2$$

Target strength

#

Testing

②

To check
Quality of
concrete casted
At site

day to day Testing

group 1

Sample = 4 & cubes = 12

$$f_{avg} \Rightarrow \left[\frac{4 \text{ sample}}{12 \text{ cubes}} \right]$$

f_{avg} For 12 Cubes

$$= 32 \text{ N/mm}^2$$

$$< 34.125$$

NOT OK,
Because

Target strength (At 28 day)

$$f_{Target} = f_{ck} + 0.825 \sigma$$

$$= 30 + 0.825 \times 5 = 34.125$$

= No's of samples :-

1-5 cum [cubic Meter M^3] $\rightarrow$ 1 Sample

6-15 cum $\rightarrow$ 2 Sample

16-30 cum $\rightarrow$ 3 Sample

31-50 cum $\rightarrow$ 4 Sample

Further :-

or every 50 cum $\rightarrow$ +1

Example:- For 230 cum

$\Rightarrow$ 50 cum $\rightarrow$ 4 sample

+50 cum $\rightarrow$ +1

+50 cum $\rightarrow$ +1

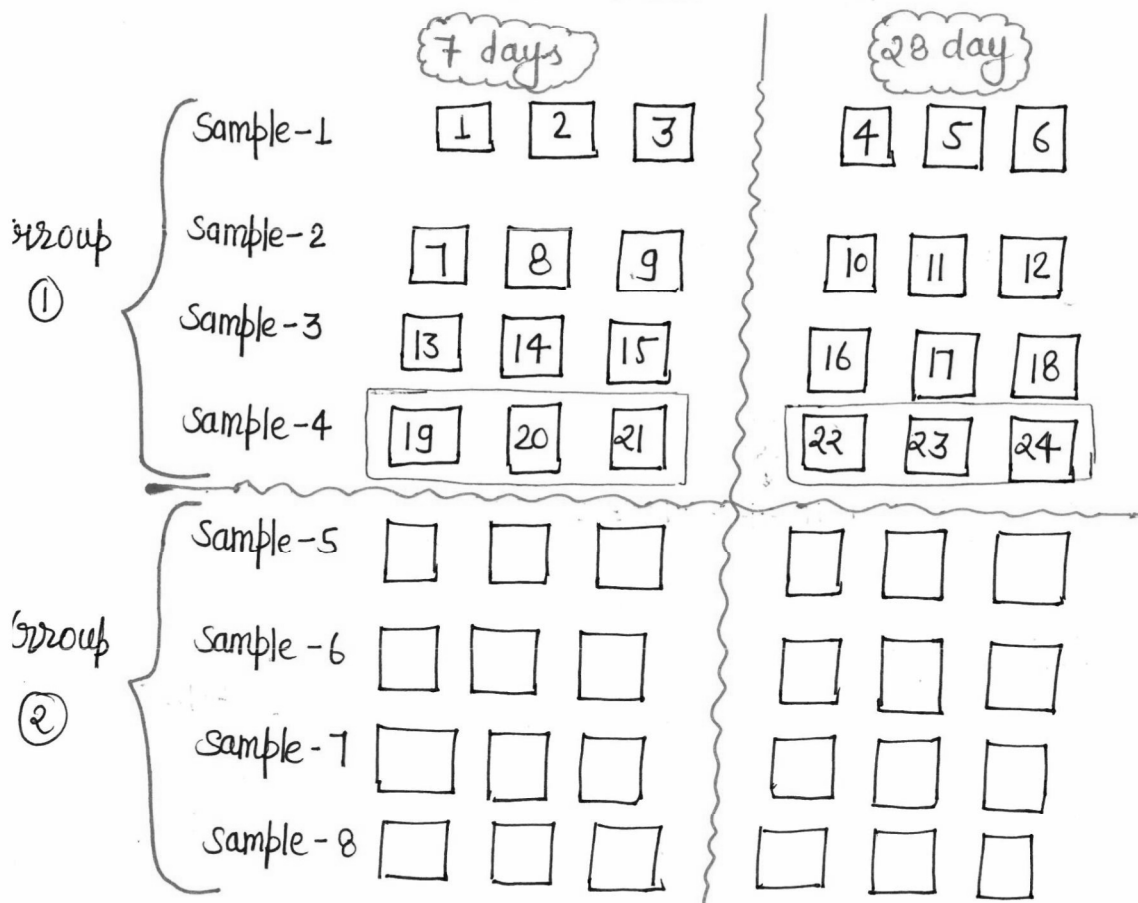
+50 cum $\rightarrow$ +1

+30 cum $\rightarrow$ +1

8 sample

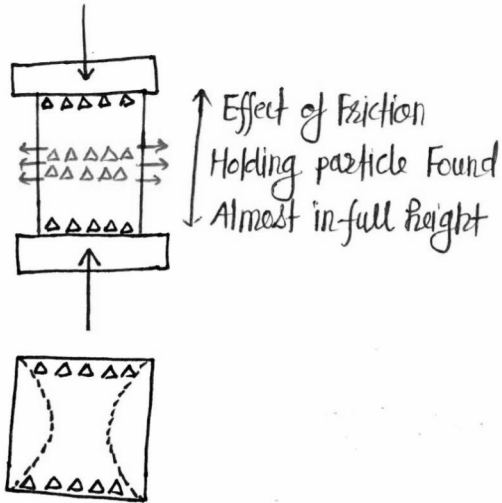
1 Sample = 6 cubes

8 sample $\Rightarrow 8 \times 6 = 48$ cubes

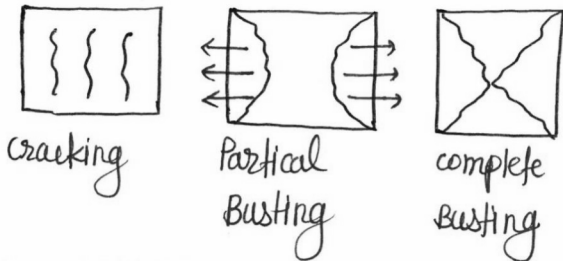


compressive strength Test of concrete

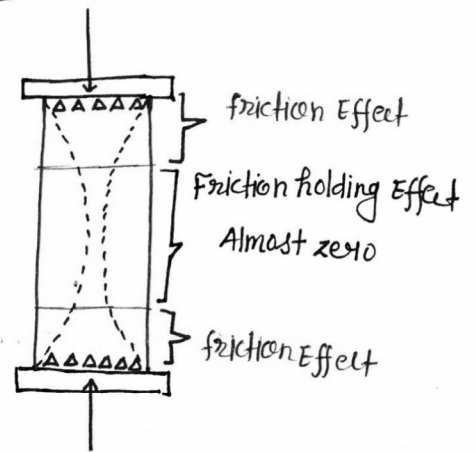
Cube :-



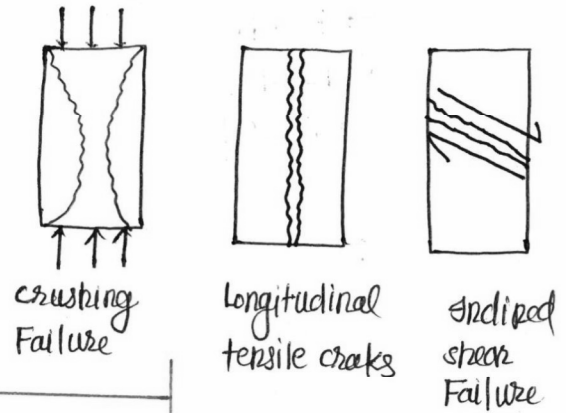
Cube Failure :-



Cylinder :-



Cylinder failure :-



$$\# \text{ strength After } T \text{ days } f_T = \frac{T}{4.7 + 0.833T} \times f_{ck}$$

T = No. of days

$$f_{T=7\text{day}} = \frac{7}{4.7 + 0.833 \times 7} \times f_{ck} = 0.67 f_{ck}$$

$$f_{T=10\text{day}} = \frac{10}{4.7 + 0.833 \times 10} \times f_{ck} = 0.77 f_{ck}$$

$$f_{T=28\text{day}} = \frac{28}{4.7 + 0.833 \times 28} \times f_{ck} = 1 f_{ck}$$

† Testing of concrete cubes - For (Table-11) day to day Testing At site :-

Test 1 :-

The Average strength of one group

(group of 4 sample = $4 \times 3 = 12$ cubes)



consecutive & Non-overlapping

$$\Rightarrow f_{(avg)} \geq \left[f_{ck} + 0.825 \sqrt{\quad} \right]$$

→ 4 sample
→ 12 cubes
→ 1 Group

rounded to Nearest 0.5

Consecutive → Nothing is left {कातर}

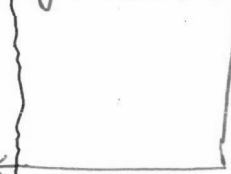
Non-overlapping → Nothing to be repeated

:-

G1-1
S1
S2
S3
S4

G1-2
S5
S6
S7
S8
S9

If Invalid, then



Test-2: Individual Test Result [ITR]

OF each & Every cube of Every sample [in group]

$$\text{ITR} \leq (f_{ck} - 3)$$

Standard Deviation :-

$$\begin{aligned} \sigma &= 3.5 \longrightarrow M_{10}/M_{15} \\ &= 4.0 \longrightarrow M_{20}/M_{25} \\ &= 5.0 \longrightarrow M_{30} \text{ \& Above} \end{aligned}$$

Test ① } Both Pass $\longrightarrow$ OK

Test ② } Any one Fail $\longrightarrow$ Not Accepted

Test-3: Individual Variation in Any sample :-

Sample 28 34 39 $\longleftarrow$ Sample Invalid

$$f_{\text{avg}} = \frac{28+34+39}{3} = 33.67$$

$$\text{Variation in Minimum} = \frac{28-33.67}{33.67} \times 100 = -16.84\% > 15\%$$

$$\text{Variation in Maximum} = \frac{39-33.67}{33.67} \times 100 = +15.83\% > 15\%$$

$\uparrow$
Invalid

$\Rightarrow$ Individual Variation From Average of 3 cubes Sample $\nrightarrow \pm 15\%$ of f_{average}

if More than 15% $\longrightarrow$ Sample is Invalid

Ques For M40 concrete :-

Sample	Cube 1	Cube 2	Cub 3	Avg of sample	variation in Minimum	variation in Maximum	Test 3
1	41	47	53	47	$\frac{41-47}{47} = -12.77\%$	$\frac{53-47}{47} = +12.77\%$	✓ ok
2	40	40	50	46	$\frac{40-46}{46} = -13.04\%$	$\frac{50-46}{46} = +8.7\%$	✓ ok
3	38	42	49	43	$\frac{38-43}{43} = -11.62\%$	$\frac{49-43}{43} = 13.95\%$	✓ ok
4	42	42	53	49	$\frac{42-48}{48} = -12.5\%$	$\frac{53-48}{48} = 10.41\%$	✓ ok

Test-1 :-

$$f_{avg} = \frac{47+46+43+40}{4} = 46$$

Test-2

All value $> f_{ck}-3$
 > 37 ✓ ok

$$f_{avg} \geq f_{ck} + 0.625 \sigma$$

final conclusion :-

Accepted for concrete

$$46 \geq 40 + 0.625 \times 5$$

$$46 > 44.125 \text{ } \} \text{ Rounded to } 0.5$$

$$46 > 44 \Rightarrow \text{ok}$$

Group 2	Sample	Cube 1	Cube 2	Cube 3	f _{avg}	variation in Minimum	variation in Maximum	Test 3
5		44	48	55	49	$\frac{44-49}{49} = -10.2\%$	$\frac{55-49}{49} \times 100 = +12.24\%$	OK
6		39	43	53	45	$\frac{39-45}{45} = -13.33\%$	$\frac{53-45}{45} \times 100 = +17.78\%$	Invalid
7		43	47	54	48	$\frac{43-48}{48} = -10.42\%$	$\frac{54-48}{48} = 12.5\%$	OK
8		42	46	53	47	$\frac{42-47}{47} = -10.64\%$	$\frac{53-47}{47} = 12.77\%$	OK
9		47	48	55	50	$\frac{47-50}{50} = -6\%$	$\frac{55-50}{50} = +10\%$	OK

Test-1

f_{avg} + sample :-

$$= \frac{49 + 48 + 47 + 50}{4}$$

$$= 48.5$$

$$f_{ck} + 0.825 \sigma :-$$

$$40 + 0.825 \times 5 = 44$$

$$48.5 > 44 \Rightarrow OK$$

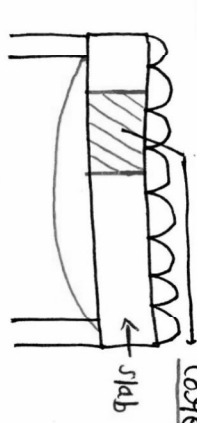
Test :- 2

ITR :-

All value > 37
 $> f_{ck} - 3 \} \Rightarrow OK$

if cube Test Result $\rightarrow$ failed

then :- (in Actual Member)



Cube cutting sample test

Pass $\rightarrow OK$
 Fail $\rightarrow$ Load Test

Load Test :- $DL + 1.25LL$ (सामान्य) 24 hours से पहले :- $\delta_1 = H_1 - H_2$

deflection

Removal of Load (Recovery) $\delta_2 = H_3 - H_2$

if $\delta_2 > 0.75 \delta_1 \rightarrow$ Accept

Repeat the test

After 3 days

$\delta_4 =$ निम्नलिखित

if Not $\delta_4 > 0.8 \delta_3 \rightarrow$ Accept

completely Reject

At site - 4 Sample - 12 cubes

Design Mix - 1 Sample - 3 cubes

Target For Design Mix $\Rightarrow$

$$f_m = f_{ck} + 1.65\sigma$$

Target At site

$$f_m = f_{ck} + 0.85\sigma$$

standard
deviation

Weighted average of variation each from Mean value.

