

Modified  
USN

# CBCS SCHEME

BCV601

Sixth Semester B.E./B.Tech. Degree Examination, June/July 2025  
**Design of RCC Structures**

Time: 3 hrs.

Max. Marks: 100

- Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.  
2. Use of IS456:2000, SP- 16 is permitted  
3. M: Marks, L: Bloom's level, C: Course outcomes.*

Module - 1			M	L	C
Q.1	a.	Compare Working Stree method and limit state method of design.	08	L2	CO1
	b.	Explain the stress block parameters with a neat sketch and derive the expression	12	L2	CO1
OR					
Q.2	a.	Explain the terms: i) under reinforced section ii) balanced section ii) Over reinforced section	06	L2	CO1
	b.	A simply supported beam has a rectangular section and carries a uniformly distributed load of 20KN/m over a clear span of 5m. The cross - section is 300mm x 650mm and is reinforced with 4 numbers of 20mm diameter bar. Assume cover = 25mm and bearing = 300mm. Assuming M20 grade concrete and Fe415 steel, compute short and long term deflection of the beam.	14	L3	CO1
Module - 2					
Q.3		Determine the moment of resistance of T section having the following section properties: Width of flange = 2500mm, Depth of flange =150mm, Width of rib = 300mm, Effective depth = 800mm, Area of steel = 8 bars of 25 mm diameter. Use M20 concrete and Fe415 HYSD bar.	20	L3	CO2
OR					
Q.4		A doubly reinforced concrete beam having a rectangular section 250mm width and 540mm overall depth is reinforced with a 2 bars of 12mm diameter in the compression side and 4bars of 20mm diameter in the tension side. The effective cover to bars is 40mm. Using M20 grade concrete and Fe415 HYSD bars, estimate the flexural strength of the section using IS456:2000 code recommendations.	20	L3	CO2
Module - 3					
Q.5		Design a rectangular beam of section 230mm x 600mm of effective span 6m and effect cover for reinforcement = 50mm. Imposed load on the beam is 40KN/m. Use M20 concrete and Fe415 steel.	20	L4	CO2
OR					
Q.6		Design a simply supported beam of span 5m carries a characteristic live load of 12 KN/m. Use M20 grade of concrete and Fe 415 steel.	20	L4	CO2
Module - 4					
Q.7	a.	Explain one way and two way slab with examples.	04	L2	CO3,4
	b.	Design a slab over a room of internal dimension 4m x 5m on 230mm thick brick wall. All edges are simply supported ( corner of the slab are held down). Use live load 3KN/m <sup>2</sup> , floor finish 1KN/ m <sup>2</sup> . Use M20 and Fe415. Apply check for deflection with the reinforcement details.	16	L4	CO3,4
1 of 2					

OR

Q.8	Design a dog legged staircase for an office building in a room measuring 2.8m x 5.8m clear. Vertical distance between the floors is 3.6m. width of flight is 1.25 m. Allow a live load of 3KN/ m <sup>2</sup> , sketch the reinforcement details. Use M20 and Fe415. Assume the stairs are supported on 230mm wall at the end of outer edges of landing slabs.	20	L4	CO3,4
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Module – 5

Q.9	Design a square footing for a short axially loaded column of size 300mm x 300mm carrying 600 KN load. Use M20 concrete and Fe415 steel. SBC of soil is 180 KN/ m <sup>2</sup> . Sketch the details of reinforcement.	20	L4	CO1
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OR

Q.10	Design a isolated footing for a rectangular column of 300mm x 500mm supporting an axial load of 1000 KN factored. Assume SBC of soil as 1KN/ m <sup>2</sup> . Use M20 and Fe415. Sketch the reinforcement and perform the necessary checks	20	L4	CO3,4
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Module - 1.

Q. 1 a. Working Stress & Limit State method.

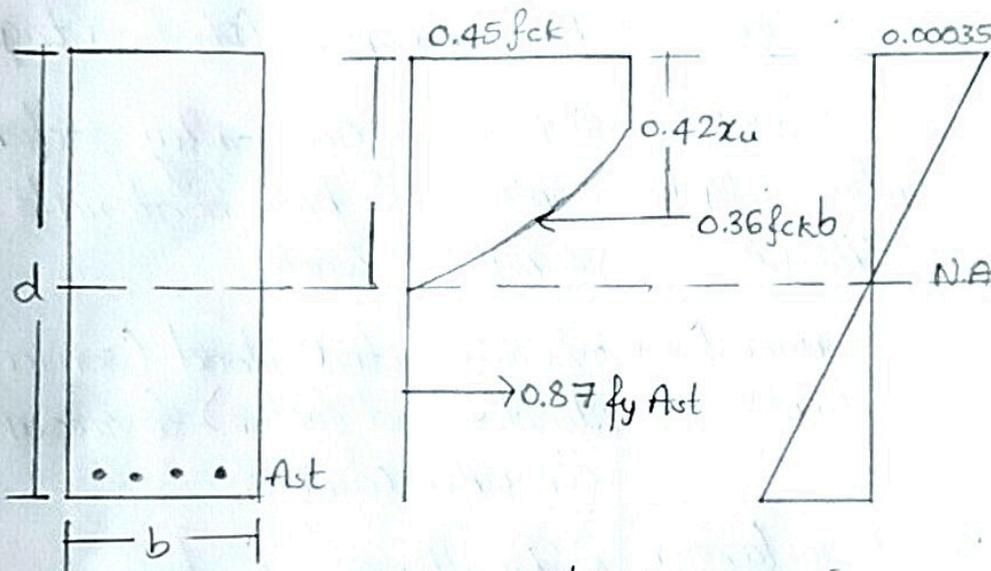
Working stress method	Limit state method.
<p>i). Based on linear elastic theory. Assumes materials behave elastically under service loads.</p> <p>ii). Uses a single factor of safety (Fos) applied only to the material strength.</p> <p>iii). Uses actual service loads (Dead load), (Live load).</p> <p>iv). Generally result in larger sections &amp; more reinforcement (less economical).</p> <p>v). Safety &amp; Serviceability are handled.</p> <p>vi). Safety &amp; Serviceability are handled by the same Fos.</p>	<p>i). Based on actual behavior of materials at the ultimate breaking point (Plastic stage).</p> <p>ii). Uses partial safety factors applied to both materials strength &amp; loads.</p> <p>iii). Uses factored load (Service load <math>\times</math> load factor) to account for uncertainties.</p> <p>iv). Results in slender, optimized sections (more economical).</p> <p>v). Result in slender, optimized sections (more economical).</p> <p>vi). Distinctly checks for ultimate limit state (collapse), serviceability (deflection/cracks).</p>

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## b) Stress block parameters

At the ultimate limit state, the actual non-linear stress-strain curve of concrete in compression is replaced an equivalent rectangular stress block to simplify analysis & design.



(a) Cross-section details (b) Stress distributions (c) Strain distribution.  
resultant force

## Stress block parameters.

- i) Maximum compressive stress =  $0.45f_{ck}$
- ii) Resultant compressive force =  $0.36f_{ck} b x_u$
- iii). Location of resultant force =  $0.42x_u$  from the extreme compression fiber

## Derivation of expressions.

i) Compressive force in concrete

a) Area of compression zone

$$= A = b \times x$$

b) Equivalent rectangular stress intensity =  $0.45f_{ck}$

c) Resultant compressive force

$$= C = 0.36f_{ck} b x_u$$

ii) Lever arm: if  $d$  is effective depth of the beam  $z = d - 0.42x_u$

iii) Moment of resistance =  $M_u = C \times z$

$$\text{Substituting for } C = M_u = 0.36f_{ck} b x_u (d - 0.42x_u)$$

## Q.2. a) i) Under reinforcement Section.

- Definition: A section where the area of tensile steel is less than the balanced amount.
- Behavior: The steel yields before the concrete crushes.
- Failure mode: Ductile (large deflection, cracking, giving warning).
- Synonyms / Related terms: Ductile section, safe design.
- Usage: Recommended for structural design to ensure safety.

## ii) Balanced Section.

- Definition: A section where the maximum stress in concrete  $-c$  & the yield stress in the steel are reached simultaneously.
- Behavior: The concrete crushes at the exact same time the steel yields.
- Failure mode: A mix of ductile & brittle, but treated as a limit.
- Synonyms / Related terms: Critical section, balanced reinforcement.
- Usage: Used as a reference point for comparing under/over reinforced sections.

## iii) Over reinforced Section:

- Definition: A section where the amount of tensile steel exceeds the balance amount.
- Behavior: The concrete reaches its maximum compressive strain (crushes) before the steel yields.
- Failure mode: Brittle (sudden collapse mode without warning).
- Synonyms / Related terms: Compression failure section, unsafe design.
- Usage: Avoided in design due to lack of warning before failure.

b)  $w = 20 \text{ kN/m}$ ,  $L = 5 \text{ m}$ , bearing width = 300 mm

$L_{\text{eff}} = \text{Clear span} + \text{bearing width} = 5.3 \text{ m}$

Cross Section:  $b = 300 \text{ mm}$ ,  $D = 650 \text{ mm}$

$$A_{\text{st}} = 4 \times \frac{\pi \times 20^2}{4} = 1256.64 \text{ mm}^2, \text{ Cover} = 25 \text{ mm}$$

$$d = D - \text{Cover} - \frac{\text{Dia of bar}}{2} = 615 \text{ mm}$$

Concrete,  $f_{\text{ck}} = 20 \text{ N/mm}^2$ , Steel,  $f_y = 425 \text{ N/mm}^2$

i) Moment of resistance (m).

$$M = \frac{wL^2 l_f}{8} = 70.225 \text{ kNm} = 70.225 \times 10^6 \text{ N}\cdot\text{mm}$$

ii) Gross moment of inertia ( $I_g$ )

$$I_g = \frac{bD^3}{12} = 6.8656 \times 10^9 \text{ mm}^4$$

iii) Modular ratio ( $m$ ):  $E_c = 5000 \sqrt{f_{\text{ck}}} = 22360.68 \text{ N/mm}^2$

$$E_s = 2 \times 10^5 \text{ N/mm}^2$$

$$m = E_s / E_c = 8.94 \approx 9$$

iv) Neutral axis depth ( $x_u$ )

$$x = 220.6 \text{ mm}$$

v) Cracked moment of inertia ( $I_{\text{cr}}$ )

$$I_{\text{cr}} = \frac{bx^3}{3} + m A_{\text{st}} (d-x)^2 = 3.03 \times 10^9 \text{ mm}^4$$

vi) Effective moment of inertia ( $I_{\text{eff}}$ )

$$I_{\text{eff}} = \min(I_{\text{cr}}, I_g) = 3.03 \times 10^9 \text{ mm}^4$$

vii) Short time deflection:  $\Delta_{\text{st}} = \frac{5wl^4}{384 E_c \times I_{\text{eff}}} = 9.52 \text{ mm}$

viii) Long term deflection:  $\Delta_{\text{lt}} = \Delta_{\text{st}} \times 2$

$$\alpha = \left[ \frac{2.0}{1+0 \text{ (no compression reinforcement)}} \right] = 2.0$$

$$\therefore \Delta_{\text{lt}} = 19.04 \text{ mm}$$

Permissible deflection as per IS 456: 2000

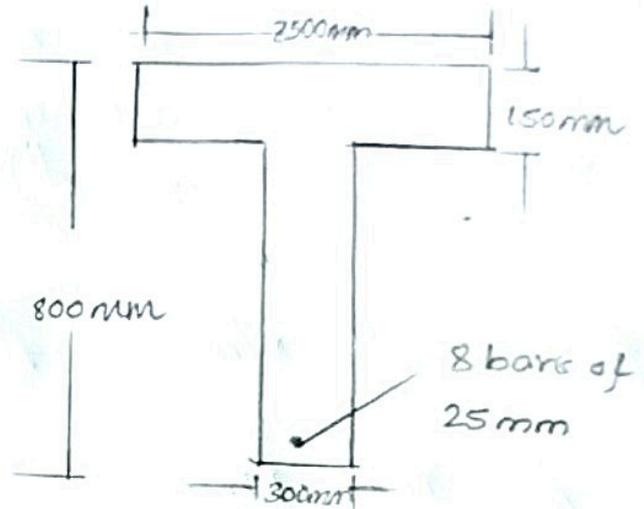
$$\frac{L}{250} = 21.2 \text{ mm}$$

Module - 2

Q. 8.

$$b_f = 2500 \text{ mm}, d = 800 \text{ mm}, b_w = 300 \text{ mm}, D_f = 150 \text{ mm}$$

$$f_{ck} = 20 \text{ N/mm}^2, f_y = 415 \text{ N/mm}^2$$



As given N.A lies in flange ( $x_u < d_f$ )

$$0.36 f_{ck} b_f x_u = 0.87 f_y A_{st}$$

$$x_u = 78.76 \text{ mm} > D_f (150 \text{ mm})$$

$$x_{u \text{ lim}} = 0.48 d = 384 \text{ mm}; x_u < x_{u \text{ lim}}$$

Section is under reinforcement

$$M_u = 0.87 f_y A_{st} (d - 0.42 x_u)$$

$$M_u = 10.87 \text{ kN-m}$$

OR

$$M_u = 0.87 f_y A_{st} d \left( 1 - \frac{A_{st} f_y}{b_f d f_{ck}} \right) = 10.88 \text{ kN-m}$$

Q. 4

$$b = 250 \text{ mm}, D = 540 \text{ mm}, d = \text{D-effective cover} = 500 \text{ mm}$$

$$f_{ck} = 20 \text{ N/mm}^2, f_y = 415 \text{ N/mm}^2$$

$$A_{sc} = 226.29 \text{ mm}^2, A_{st} = 1256.63 \text{ mm}^2$$

$$x_{ulim} = 0.48 d = 240 \text{ mm}$$

$$E_{sc} = \frac{0.0035 (x_{umax} \cdot d)}{x_{umax}} = 0.00291$$

$$f_{sc} = 353.11 \text{ N/mm}^2 \quad A_{st2} = \frac{A_{sc} f_{sc}}{0.87 f_y} = 221.21 \text{ mm}^2$$

$$A_{st} = 1035.41 \text{ mm}^2$$

$$0.36 f_{ck} b x_u = 0.87 f_y A_{st2}$$

$$x_u = 207.68 \text{ mm}$$

$$x_u < x_{ulim}, 207.68 < 240 \text{ mm}$$

Section is under reinforced

$$\text{moment of resistance} = C_1 LA_1 + C_2 LA_2$$

$$= 0.36 f_{ck} b x_u (d - 0.42 x_u) + f_{sc} A_{sc} (d - d')$$

$$= 191.04 \text{ kN.m}$$

### Module - 3

Q. 5

$$b = 230 \text{ mm}, D = 600 \text{ mm}, d = 50 \text{ mm}, L_{\text{eff}} = 6 \text{ m}, d' = 550 \text{ mm}$$

$$I.L = 40 \text{ kN/m}, f_{ck} = 20 \text{ N/mm}^2, f_y = 415 \text{ N/mm}^2 \quad M_u = ?$$

$$D.L = 3.45 \text{ kN/m}$$

$$I.L = 40 \text{ kN/m}$$

$$\text{Total load (w)} = 43.45 \text{ kN/m}, \quad W_u = 66.175 \text{ kN/m}$$

$$M_u = \frac{W_u L^2}{8} = 293.28 \text{ kN.m}$$

$$V_u = \frac{W_u L}{2} = 195.52 \text{ kN}$$

For Fe 415 limiting moment.

$$M_{u\text{lim}} = 0.138 b d^2 f_{ck} = 192.027 \text{ kN.m}$$

$M_u > M_{u\text{lim}}$ , Section is doubly reinforced beam.

$$A_{sc} = \frac{d'}{d} = 0.090$$

$$f_{sc} = 353.4 \text{ N/mm}^2 \quad (\text{From Sp-16})$$

$$M_u - M_{u\text{lim}} = f_{sc} A_{sc} (d - d') \quad (\text{From IS 456-2000})$$

$$A_{sc} = 573.02 \text{ mm}^2 \quad \text{provide } 16 \text{ mm } \phi \text{ bars.}$$

$$a_{sc} = 202.06 \text{ mm}^2$$

$$\text{No. of bars} = \frac{A_{sc}}{a_{sc}} = 2.85 \approx 3 \text{ bars}$$

Provide 3-16mm  $\phi$  bars as compression reinforcement

$$x_{u\text{lim}} = 264 \text{ mm}$$

$$0.36 f_{ck} b x_{u\text{lim}} = 0.87 f_y A_{st2}$$

$$A_{st2} = 1210.86 \text{ mm}^2 \quad A_{st2} = 560.87 \text{ mm}^2 \quad A_{st} = 1771.73 \text{ mm}^2$$

$$\text{Shear } V_u = 195.52 \text{ kN}$$

$$C_v = \frac{V_u}{bd} = 1.645 \text{ N/mm}^2 \quad (P_t = 1.4\%)$$

$$\tau_v > C_c \quad V_{uc} = 88.55 \text{ kN} \quad V_{us} = 106.97 \text{ kN}$$

$$V_{us} > -S_v = 186.62 \text{ mm} \quad S_v = 190 \text{ mm}$$

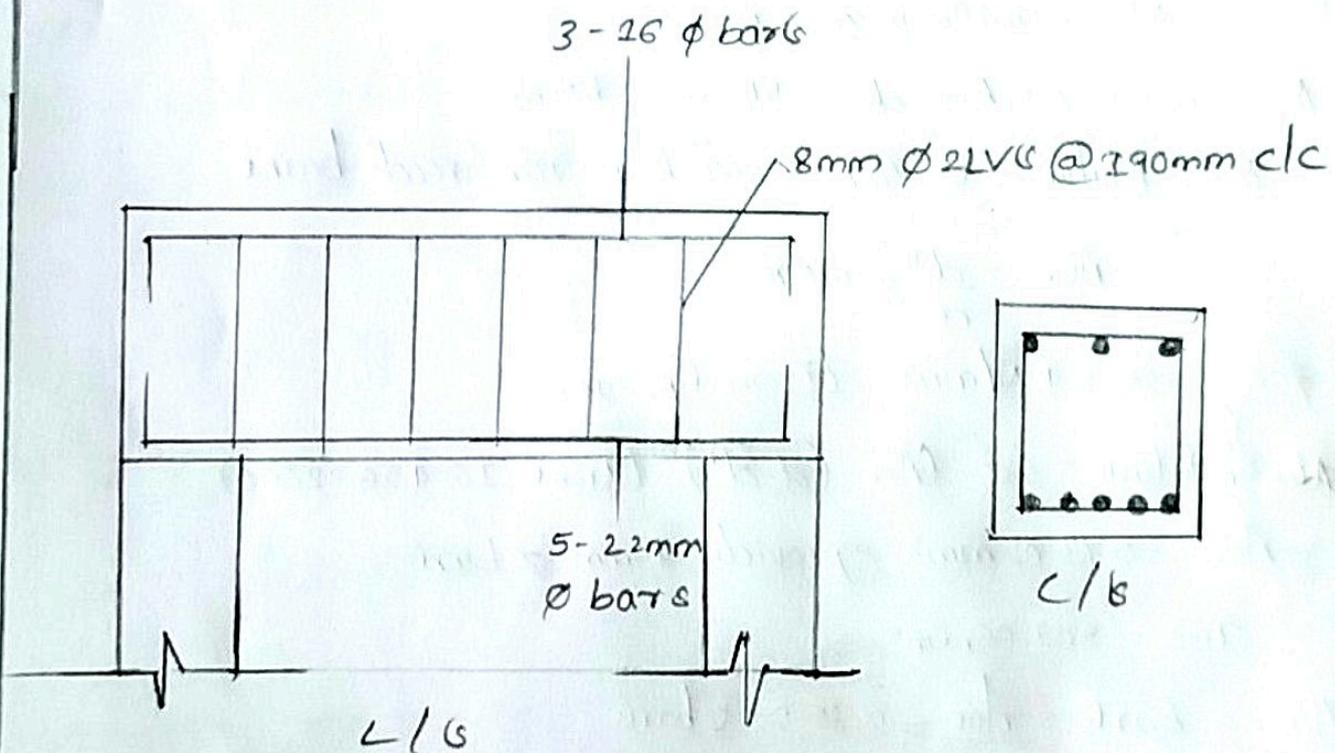
Check for deflection,  $P1 = 1.4\%$

$$f_c = 0.58 f_y \times \frac{A_{st \text{ req}}}{A_{st \text{ prov}}} = 224.37 \text{ N/mm}^2$$

$$P_c = \frac{100 A_{sc}}{bd} = 0.453\%$$

$$\left(\frac{l}{d}\right)_{\text{max}} = 22.59, \quad \left(\frac{l}{d}\right)_{\text{prov}} = 10.90$$

$\left(\frac{l}{d}\right)_{\text{prov}} > \left(\frac{l}{d}\right)_{\text{max}}$  Hence safe against deflection.



Q 6

$L = 5\text{m}$   $L.L = 12\text{ kN/m}$ ,  $f_{ck} = 20\text{ N/mm}^2$ ,  $f_y = 415\text{ N/mm}^2$

$\frac{L}{d} = 12\text{ to }25$ ,  $d = 420\text{mm}$ ,  $D = 460\text{mm}$

$b = \frac{1}{2}D\text{ to } \frac{1}{3}D = 230\text{mm}$ ,  $l = 5230\text{mm}$

Self weight =  $2.645\text{ kN/m}$

$w = 14.645\text{ kN/m}$ ,  $w_u = 22.967\text{ kN/m}$

$$M_u = \frac{wl^2}{8} = 75.08 \times 10^6\text{ N.mm}$$

$$V_u = \frac{wl}{2} = 57.4 \times 10^3\text{ N}$$

$$M_u = 0.138 bd^2 f_{ck}; d = 343.90\text{mm}$$

$$M_u = 112.97\text{ kN.m}$$
  $A_{st\text{ req}} = 563.26\text{mm}^2$

$$\text{No of bars} = 2\text{ bars}$$
,  $A_{st\text{ prov}} = 603.18\text{mm}^2$

$$\tau_v = 0.594\text{ N/mm}^2$$
,  $P_L = 0.624\%$ ,  $\tau_c = 0.526\text{ N/mm}^2$

$\tau_v > \tau_c$  Shear reinforcement is provided.

$$f_s = 224.76\text{ N/mm}^2$$

$\left(\frac{d}{a}\right)_{\text{req}} > \left(\frac{d}{a}\right)_{\text{prov}}$  beam is safe reinforcement details.

## Module - 4.

Q. 7 a. i) One way slab      ii) Two way slab

i) One way slab.

A slab is called a one way slab when the load is mainly carried in one direction (shorter span direction).

Condition:-

- If the ratio of longer span ( $L$ ) to shorter span ( $B$ ) is greater than 2 ( $L/B > 2$ ) it is a one way slab.

Example:-

- Verandah slab
- Corridor slab
- Slab resting on two opposite walls.

ii) Two way slab.

A slab is called a two way slab when the load is carried in both directions.

Condition:-

- If the ratio of longer span ( $L$ ) to shorter span ( $B$ ) is less than or equal to 2 ( $L/B \leq 2$ ). It is a two way slab.

Example:-

- Room slab in two way direction
- Square or nearly square slab panels.

b)  $\frac{l_y}{d} = 1.25 < 2$  Hence two way slab

$\frac{l_x}{d} = 28, d = 140 \text{ mm}, d^2 = 20 \text{ mm}, D = 160 \text{ mm}$

$d_{\text{eff}} = 4.4 \text{ mm}$

① Load calculation:  $DL = 4 \text{ kN/m}$

$LL = 2 \text{ kN/m}$

$EF = 1 \text{ kN/m}$

$W = 7 \text{ kN/m}$

$W_u = 10.5 \text{ kN/m}$

② Bending moment calculation

$M_x = \alpha_x W_u l_x^2, \alpha_x = 0.0885 \quad M_x = 25.92 \text{ kN/m}$

$M_y = \beta_y W_u l_y^2, \beta_y = 0.057 \quad M_y = 10.256 \text{ kN/m}$

$M_x = 0.138 \phi d^2 f_{ck}, d_{\text{req}} = 75.76 \text{ mm}$

$d_{\text{prov}} > d_{\text{req}} \therefore$  Simply reinforced

$M_x = 0.87 f_y A_{st} d \left( 1 - \frac{f_y A_{st}}{f_{ck} b d} \right), A_{st} = 331.34 \text{ mm}^2$

$\phi = 10 \text{ mm} \quad C_r = 230 \text{ mm} \quad A_{st} = 209.4 \text{ mm}^2$

③ Check for shear:  $V_u = 21.73 \text{ kN} \quad \tau_c = 0.045 \text{ N/mm}^2$

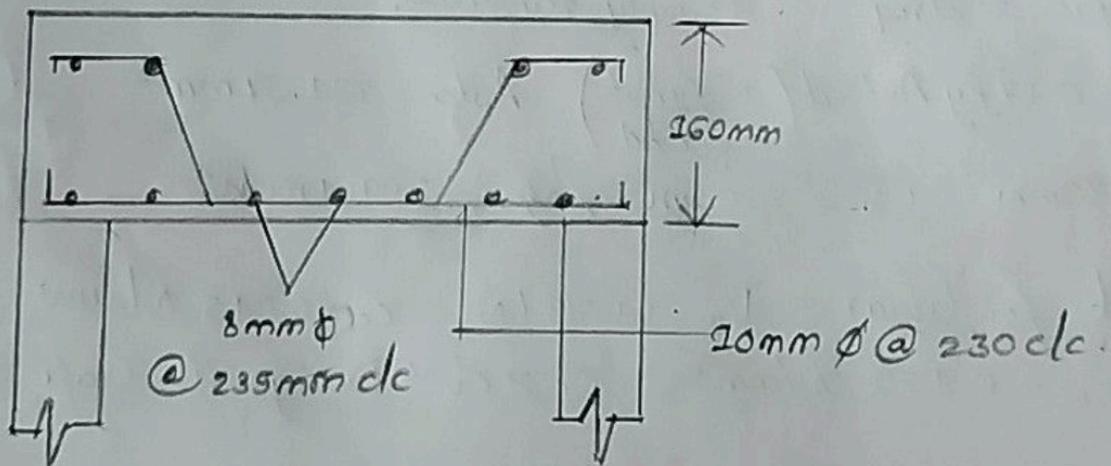
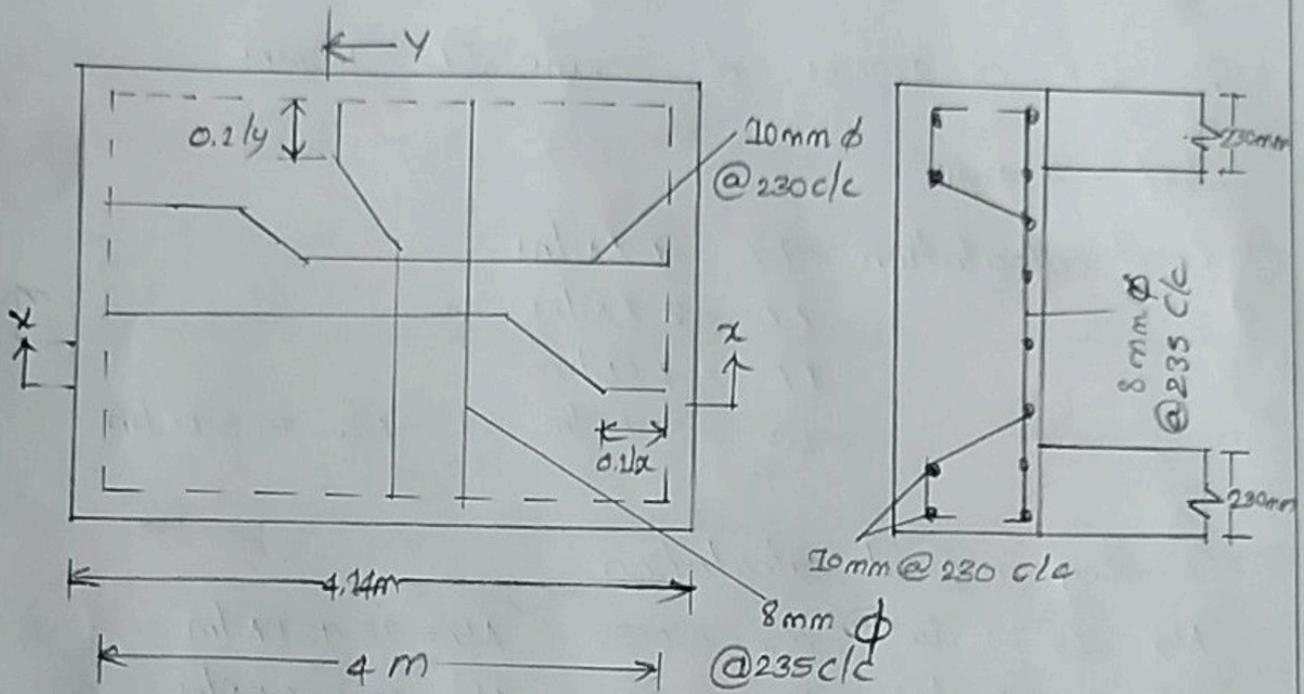
$\tau_v = 0.155 \text{ N/mm}^2 \quad \tau_c > \tau_v$  Design is safe

④ Check for deflection.

$\left( \frac{d}{l} \right)_{\text{max}} = \left( \frac{d}{l} \right)_{\text{basic}} \times k_t \times k_c \times k_f$

$k_t = 1.6, \left( \frac{d}{l} \right)_{\text{max}} = 32 \quad \left( \frac{d}{l} \right)_{\text{act}} = 295.7$

$\left( \frac{d}{l} \right)_{\text{max}} > \left( \frac{d}{l} \right)_{\text{actual}}$  safe



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Q. 8

Ht of one flight = 1800mm. No of ribs = 12, Tread = 11

Effective span = 6.03m,  $t = 250\text{mm}$ ,  $D = 280\text{mm}$

Wt. of waist slab = 7.83 kN/m. Wt of step = 1.87 kN/m

Landing slab wt width total land = 15.37 kN/m

Factored load going /mt horizontal width = 20.25 kN/m

Landing slab /mt width of total land = 15.37 kN/m

Design moment  $\therefore R_A = R_B = 54.40\text{kN}$   $M_u = 87.5\text{kNm}$

$M_{ulim} = 0.36 f_{ck} b x_{ulim} (d - 0.42 x_{ulim}) = 1725 \times 10^6 \text{Nmm} = M_{u\lim}$

Singly reinforced main reinforcement

$$M_u = 0.87 f_y A_{st} d \left( \frac{1 - A_{st} f_y}{b d f_{ck}} \right) \quad A_{st} = 2063 \text{ mm}^2$$

16mm  $\phi$  bars.

$s = 289\text{mm}$ , Provide 16mm bars @ 280mm c/c

Distribution steel  $\therefore A_{st} = 0.12\%$   $b d = 336 \text{ mm}^2$

$s = 233\text{mm}$ , Provide 10mm bars @ 230mm c/c

Plan & sectional elevation sketch.

Module - 5.

Q. 9

$$P = 600 \text{ kN}, f_{ck} = 20 \text{ N/mm}^2, f_y = 415 \text{ N/mm}^2$$

$$\text{SBC} = 120 \text{ kN/m}^2$$

$$\text{Self wt of footing} = 10\% \text{ of 'P'} = 60 \text{ kN}$$

$$\text{Area of footing} = 3.667 \text{ m}^2$$

$$\text{Size of footing} = 1.91 \text{ m} \times 1.91 \text{ m}$$

Provide  $2\text{m} > 2\text{m}$  footing

$$q \frac{P_u}{A} = 225 \text{ kN/m}^2 = 0.225 \text{ N/mm}^2$$

$$V_u = q_u B \left[ \frac{(B-b)}{2} - d \right] = 450 (850 - d)$$

$$P_t = 0.2\% \tau_c = 0.32 \text{ N/mm}^2, d = 360 \text{ mm}$$

$$M_{ulim} = 0.138 b d^2 f_{ck} = 715.39 \times 10^6 \text{ N.mm}$$

$$M_u = q_u B \frac{(B-b)}{8} = 162.563 \times 10^6 \text{ N.mm} < M_{ulim}$$

Check for two way shear reinforcement.

$$M_u = 0.87 f_y A_{st} d \left[ \frac{1 - A_{st} f_y}{b d f_{ck}} \right] = 1299 \text{ mm}^2$$

$$\text{Check for shear} = \tau_v = 0.306 \text{ N/mm}^2 > \tau_c = 0.32 \text{ N/mm}^2$$

Development length,

$$L_d = \frac{\phi \sigma_s}{4 \tau_{bd}} = 564.14 \text{ mm}$$

Q.10:

Size of footing: Self wt: 1100 kN,  $L \times B = 5.5m^2$

$$\frac{d}{b} = \frac{L}{B} = 1.67 \quad L = 3.9m \quad B = 1.9m$$

$$q_0 = 269.8 \text{ kN/m}^2$$

Thickness of footing (D),  $M_{xx} = 243.48 \text{ kN}\cdot\text{m}$

$$M_{yy} = 59.33 \text{ kN}\cdot\text{m} \quad M_u = 225.22 \text{ kN}\cdot\text{m}$$

$$M_{ulim} = 0.138bd^2 f_{ok} \quad d = 280 \text{ mm}, \quad b = 1000 \text{ mm}, \quad D = 339 \text{ mm}$$

From shear consideration double the above value.

$$L \times B \times D = 3.9 \times 1.9 \times 0.68 \text{ m}$$

AGT along longer span direction  $M_{yy} = 225.23 \text{ kN}\cdot\text{m}$

$$M_{uy} = 0.87 f_y A_{st} d \left[ 1 - \frac{f_y A_{st}}{f_{ek} b d^2} \right]$$

$$A_{st} = 961.45 \text{ mm}^2 \quad \phi = 200 \text{ mm c/c} \quad d = 620 \text{ mm}$$

Provide 16mm bars @ 200mm c/c main bars along longer span.

$A_{st}$  along shorter direction

$$M_{xx} = 82.50 \text{ kN}\cdot\text{m}, \quad A_{st} = 379 \text{ mm}^2 \quad \phi = 300 \text{ mm c/c}$$

Provide 16mm bars @ 300mm c/c

Check for one way shear:  $SE = 225.46 \text{ kN}$ ,  $V_u = 273.29 \text{ kN}$

$$\tau_v = 0.28 \text{ N/mm}^2, \quad \tau_c = 0.26 \quad \tau_c > \tau_v$$

$\therefore$  Design safe.

Two way shear.

$$L_1 = 1.92 \text{ m} \quad b_1 = 0.92 \text{ m} \quad b^2 = 2(L_1 + b_1) = 4.08 \text{ m}$$

$$V = q_0(L \times B) \leq b_1) = 269.8 \text{ kN/m}^2 \times V = 825.26 \text{ kN}$$

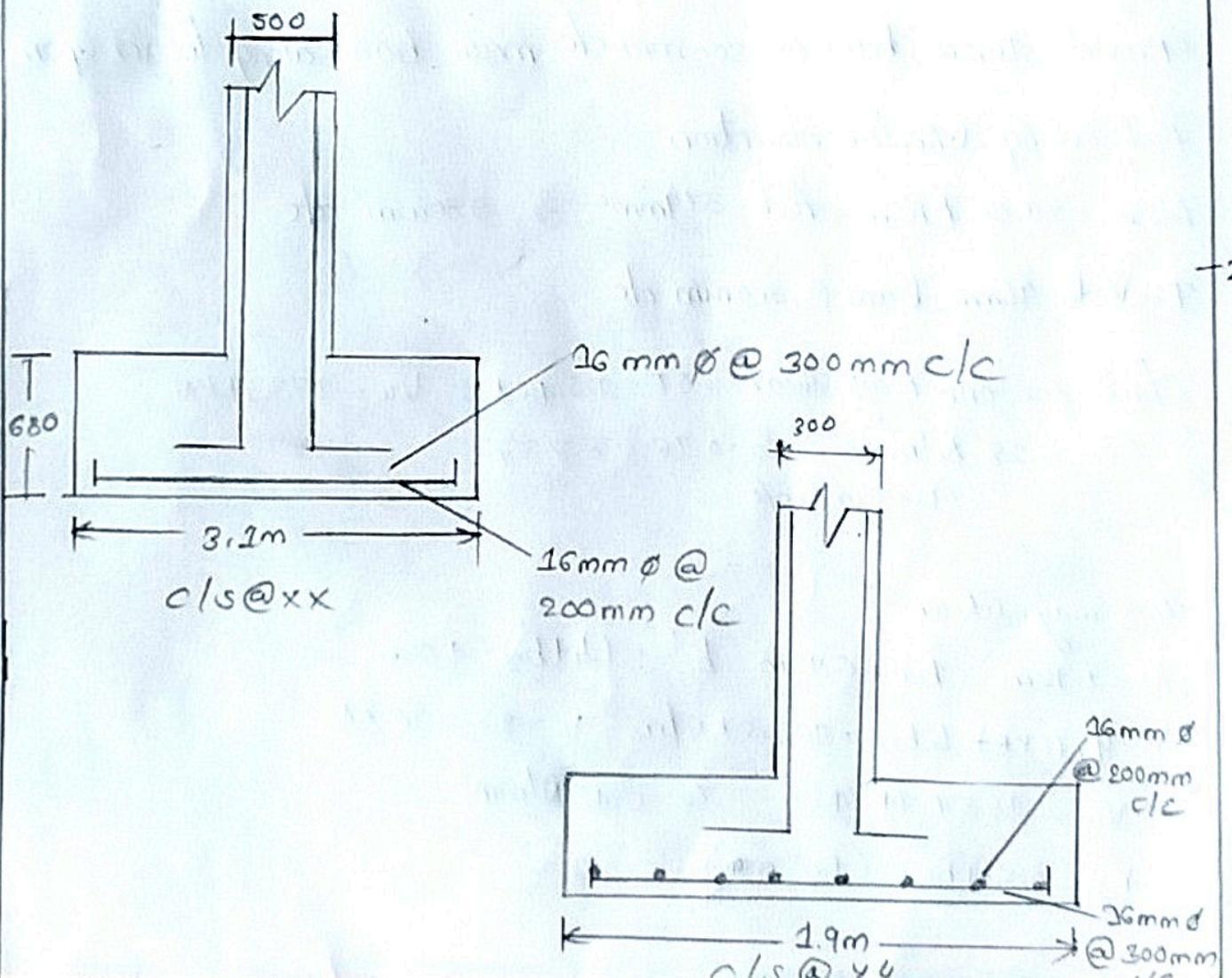
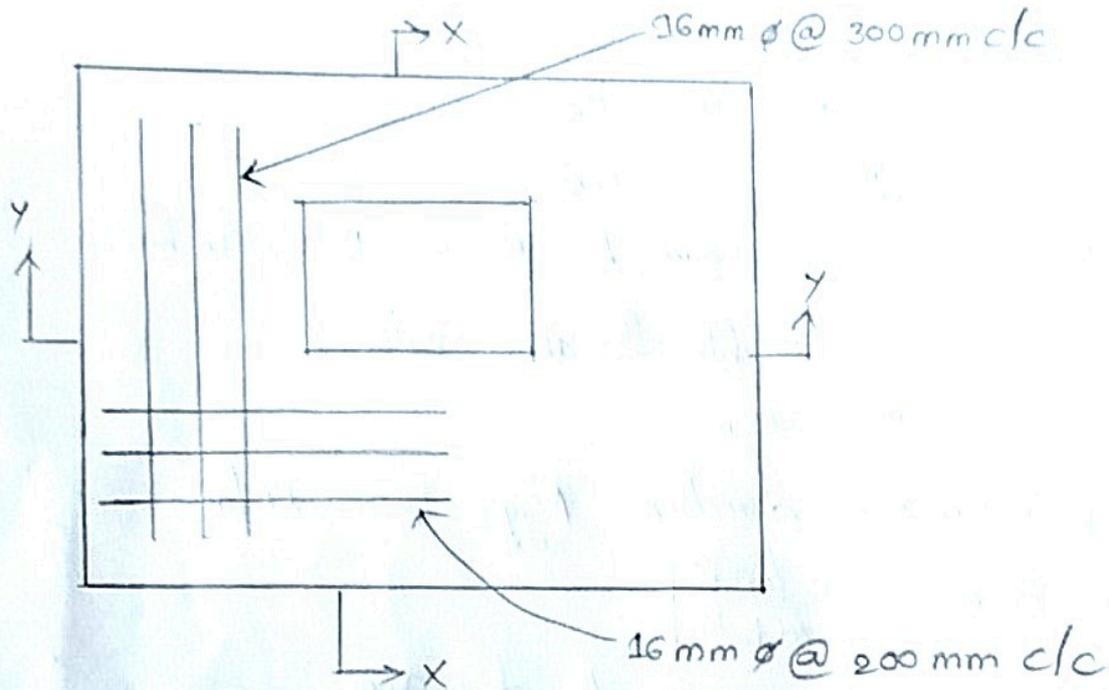
$$V_u = 2237.74 \text{ kN} \quad \tau_v = 0.48 \text{ N/mm}^2$$

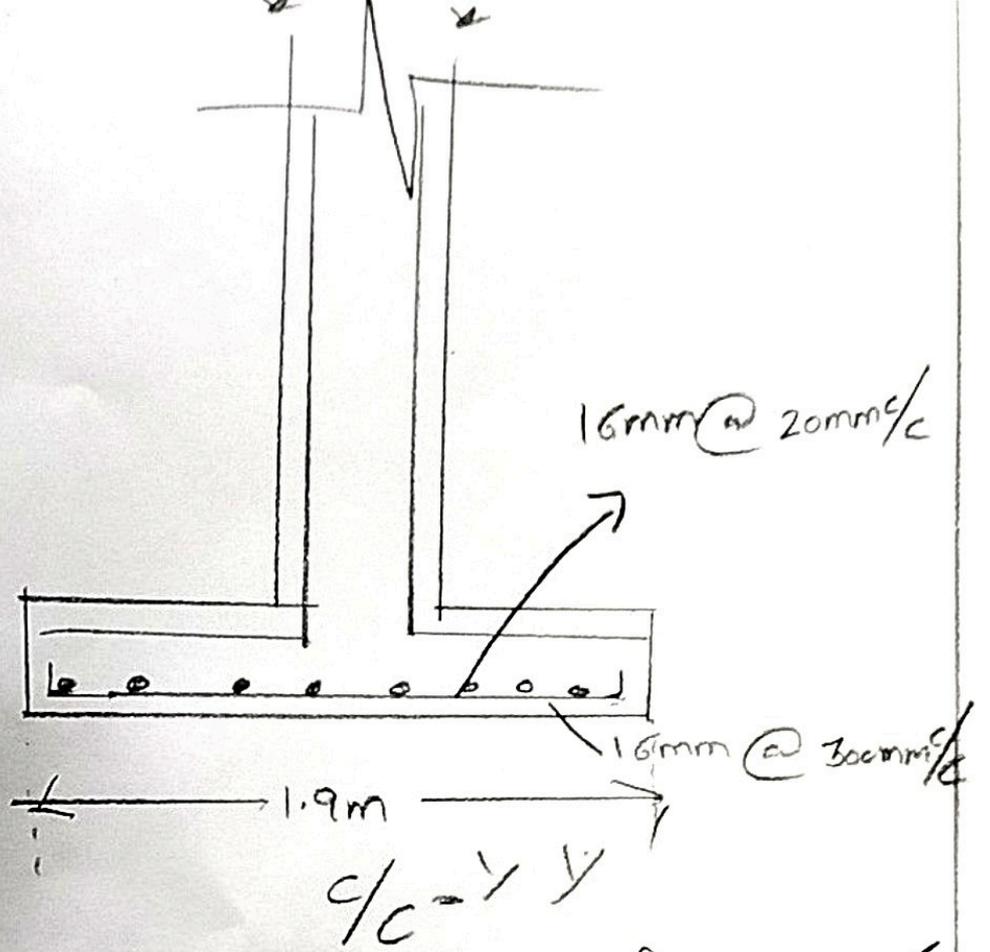
$$k_s = 0.5 + \beta_c \quad (\beta_c = 0.6) \quad k_s = 1.2$$

$$\tau_c = 0.25 \sqrt{f_{ck}} = 1.198 \quad \tau_c = 1.93 \text{ N/mm}^2$$

Permissible shear > Nominal shear,

∴ design of footing is safe





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