INTERNAL ASSESMENT TEST - 2.
Design of RC Structural Elements.
October - 2018

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Question Number	Solution	Marks.
Q.1.	* Dimension: b = 300mm, l/d = 20, d' = 30mm, D = d + d'	01 mark.
	* Effective length: 6.3m.	01
	* load calculation: DL+LL = 14.3 KN/m & Wu = 21.45 KN/m	02
	* BM & SF: Mu = 104.06 KN-m SF = 66.81 KN	02
	* Check for depth: d = 362.13m < dprovi	01
	* Check for Section: Mulim = 126.96 KN-m > Mu	01
	* Ast: 850.83 mm^2	02
	Ast_{min} = 188.43 mm^2 Ast_{max} = 7048 mm^2	} 01
	no. of #'s = 5 # of 16 ϕ	01
	Ast provid. = 1005 mm^2	01
	* Detailing:	02
Q.2.	* Dimension: ly/lx l/d , b = 1000mm, d' = 30mm, D =	02.
	* Effective length: Leff =	01
	* load calculation:	02
	* Mu & SF:	02
	* Check for depth:	01
	* Area of Steel: Ast.	02
	Ast_{min}. — Distribution Steel —	01
	Spacing: main Steel. : Distribut Steel.	02
	Ast_{prov}:	
	* Check for Shear:	02

Question number	Solution

Q. 3

Dimension: $b_f = 2186.6$ mm.

$D = 500$ mm.

Effective length: $l_{eff} = 7.3$ m.

load calculation: $w = 29.2$ KN/m

$w_u = 43.68$ KN/m

SF & Mu: $M_u = 296.96$ KN-m.

$V_u = 159.43$ KN

Check for depth:

Check for Section: $M_{ulimit} = 1003.17$ Mpa.

$M_{uf} = 736.7$ Mpa.

$\therefore M_{uf} > M_u$ $\quad D_f > x_u$. → Rectangular Section.

Ast calculation: $A_{st} = 607.44 mm^2$.

$A_{st\,min} = 2065.50 mm^2$

$A_{st\,max} = 43732 mm^2$

no. of #'c = 5 no.

Check for Shear: $\tau_v = 1.18$ Mpa.

$\tau_c = 0.759$ Mpa.

$S_v = 280$ mm c/c.

Check for deflection: $15.5 < 16$. OK.

1a) Given: $l = 6m$

$W_{LL} = 12\ KN/m$

$f_{ck} = 25\ Mpa$

$f_y = 415\ Mpa$

Step 1: Fixing dimensions

$\frac{L}{d} = 20$

$d = 300mm + 100mm = 400mm$

Assume $d' = 50mm$

$\therefore D = 450mm$

Assume $b = 230mm$

Step 2: Lateral stability

$60b = 60 \times 230 = 13800$

$\frac{250b^2}{d} = \frac{250 \times 230^2}{400} = 33062.5$

Step 3: Effective length

1) $l = L + d = 6 + 0.4 = 6.4m$

2) $L = L + \frac{1}{2} ts + \frac{1}{2} ts = 6 + \frac{0.23}{2} + \frac{0.23}{2} = 6.23m$

$\therefore L_{eff} = 6.23m$

Step 4: Load Calculation

$DL = b \times D \times \delta = 0.23 \times 0.45 \times 25 = 2.58 \ kN/m$

$LL = 12 \ kN/m$

Total load $w = 14.58 \ kN/m$.

$W_u = 14.58 \times 1.5$

$= 21.87 \ kN/m$

Step 5: BM and SF

$$M_u = \frac{W_u l^2}{8} = \frac{21.87 \times 6.23^2}{8} = 106.10 \ kN.m$$

$$V_u = \frac{W_u l}{2} = \frac{21.87 \times 6.23}{2} = 68.12 \ kN$$

Step 6: Check for depth.

$M_{u_{lim}} = 0.138 f_{ck} b d^2$

$$d_{req} = \sqrt{\frac{M_{u_{lim}}}{0.138 f_{ck} b}} = \sqrt{\frac{106.10 \times 10^6}{0.138 \times 20 \times 230}}$$

$d_{req} = 408.82 \ mm$ $\therefore$ $d = 410 \ mm$.

Step 7: Ast calculation

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

$$106.10 \times 10^6 = 0.87 \times 415 \ A_{st} \times 410 \left[1 - \frac{415 \ A_{st}}{20 \times 230 \times 410}\right]$$

$6.10 \times 10^6 = 148030.5\, A_{st} - 32.57\, A_{st}^2$

$A_{st,1} = 3653.31\ mm^2 \qquad A_{st,2} = 891.68\ mm^2$

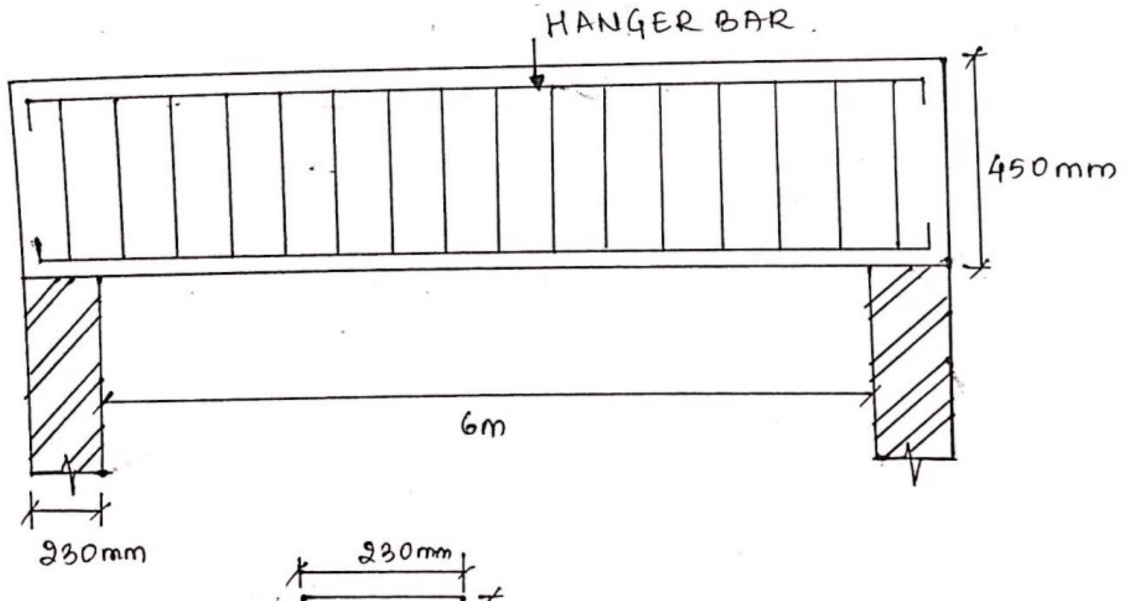
$A_{st\,max} = 0.04bD = 0.04 \times 230 \times 450 = 4140\,mm^2$

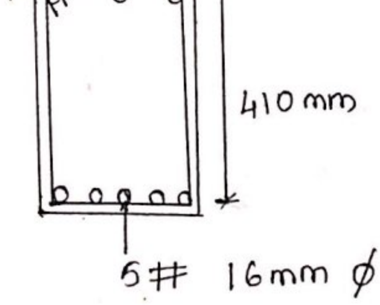
$A_{st\,min} = \dfrac{0.85bd}{f_y} = \dfrac{0.85 \times 230 \times 410}{415} = 193.14\,mm^2$

$A_{st\,req} = 892\,mm^2$.

$\text{No of \# 'C} = \dfrac{A_{st\,req}}{\pi/4 \times \phi^2} = \dfrac{892}{\pi/4 \times 16^2} = 4.4 \approx 5\ \text{No's}$

$\therefore$ Provide 5 # - 16 mm ϕ as tension steel.





2) Design a RG slab supported of 6m X 3m. Live Load acting is 2 kN/m² and the floor finish is 0.6 kN/m². Use M20 grade concrete and 415 grade steel.

Given:-

$l_x = 3m$

$l_y = 6m$

$f_{ck} = 20\ kN/m^2$

$f_y = 415\ kN/m^2$

$FF = 0.6\ kN/m^2$

$L.L = 2\ kN/m^2$.

step 1:-

$\frac{l_y}{l_x} = \frac{6}{3} = 2$ ..

One wa slab.

∴ Given slab is

step :-2:- Fixing dimensions.

L/d ratio $= 20 \times 1.3$ ∴ $l = 3m$

$\frac{3000}{d} = 20 \times 1.3$

∴ $d = 115.38mm \simeq \underline{120mm}$

$d' = 20mm$

$D = d + d' = 120 + 20 = \underline{140mm}$

step 3:- Eaffective length.

$l = L + \frac{1}{2} t_s + \frac{1}{2} t_s$

$l = 3000 + \frac{1}{2} \times 230 + \frac{1}{2} \times 230$

$l = 3230$ mm

(2) $L + d = l$

$l = 3000 + 140 = $ ~~l = 34~~ - 140

$l = 3140$ mm

$\therefore l = $ ~~3230~~ 3230 mm

step 4: Load calculation $\therefore$ assume $b = 1$ m

W_D = Dead load $= d \times \gamma \times b = 0.14 \times 25 \times 1 = 3.5$ kN/m

W_L = Live load $= 2 \times 1 = 2$ kN/m

Floor finish on slab $= 0.6 \times 1 = 0.6$ kN/m

Total working load = 6.1 kN/m

~~step~~

ultimate load = 9.15 kN/m

step 5:- Bending moment & shear force.

$$M_u = \frac{w_u l_{eff}^2}{8} = \frac{9.15 \times 3.23^2}{8} = 11.93 \text{ kN-m}$$

$$V_u = \frac{W_u L}{2} = \frac{9.15 \times 3.23}{2} = 14.77 \text{ kN-m}$$

step 6:- Cheak for depth

$M_u = 0.138 f_{ck} b d^2$

$11.93 \times 10^6 = 0.138 \times 20 \times 1000 \times$ ~~120~~ d^2

$d_{req} = 65.74$ mm $< d_{provd} = 120$ mm Hence Safe.

Step 7:- **Area of steel**

$$M_u = 0.87 f_y A_{st} d \left(1 - \frac{f_y A_{st}}{f_{ck} b d}\right)$$

$$11.93 \times 10^6 = 0.87 \times 415 \times A_{st} \times 120 \left(1 - \frac{415 A_{st}}{20 \times 1000 \times 120}\right]$$

$$A_{st} = 289.88 \text{ mm}^2$$

$$\text{Spacing} = \frac{\frac{\pi \times 10^2}{4}}{289.88} = 270.89 \text{ mm}$$

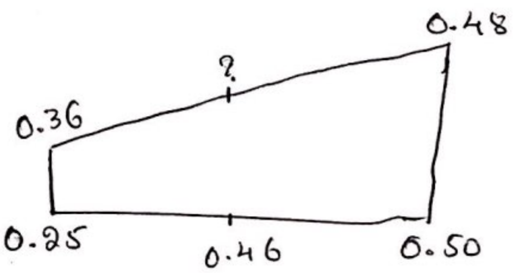
$$A_{st} \text{ Provid} = \frac{\pi \times 10^2}{4 \times 140} \times 1000 = 560.99 \text{ mm}^2$$

Step 8!- **Check for shear:**

$$\tau_v = \frac{V_u}{bd} = \frac{14.77 \times 10^3}{1000 \times 120} = 0.123 \text{ N/}$$

$$P_t = \frac{100 A_{st}}{bd} = \frac{100 \times 560.99}{1000 \times 120} = 0.46$$

τ_c =	p_t
0.48	0.50
?	0.46
0.36	0.25



$$\tau_c = 0.36 + (0.48 - 0.36) \frac{(0.46 - 0.25)}{(0.50 - 0.25)}$$

$$\therefore \tau_c = 0.46 \text{ N/mm}^2$$

$\tau_v = 0.12 < \tau_c = 0.46$

∴ Min shear reinforcement shall be Provaided.

step :- Cheak for deflaction.

$(l/d)_{allow} = (l/d)_{basic} \times k_t \times k_c \times k_f = \underline{53.82}$

$(l/d)_{actual} = \frac{3230}{120}$ ~~= 26.91 × kt × kc × kp~~.

$(l/d)_{actu} =$ 26.91 ~~×2×1×1~~ $= \underline{53.82}$

~~$(l/d)_{allowable} = (l/d) \times k_t \times k_c \times k_p$~~

= ~~20~~ ×

(l/d) ~~allowable~~ = ~~26.91 × 2 × 1 × 1~~

(l/d) ~~allowble = 53.82~~.

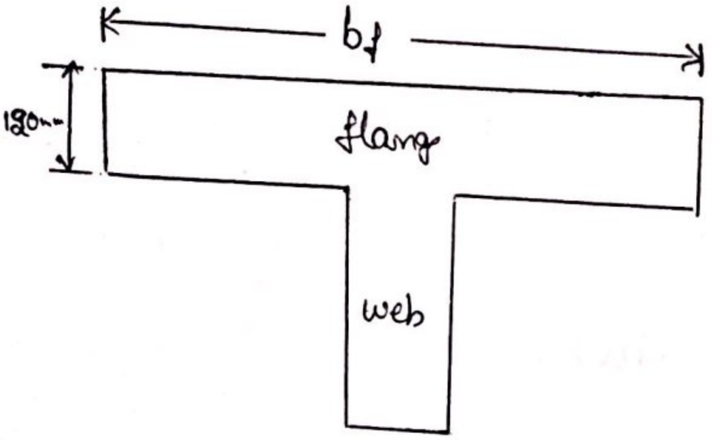
$(l/d)_{actual} < (l/d)_{allowble}$

Hence safe.

$D_f = 120mm$

$l = 7m$

$f_{ck} = 20\ mpa$



Assume : $b_w = 300$

Step ① :- Demenecon

Pg No 37 & 38

$D_f = 120mm$

$d = l/d$ ratio

$d = \frac{7000}{20} = 350 \Rightarrow 350 + 100 = 450\ mm$

$d' = $ Assume $= 30$

$b_w = $ Assume $= 300\ mm$

$\therefore D = d + d' = 450 + 30 = 480\ mm$

step ②

$l_{eff} = L + d = 7000 + 450 = 7450\ mm$

$l_{eff} = $ clear span $+ \frac{1}{2}$ thickness of support $+ \frac{1}{2}$ thickness of support

$= 7000 + \frac{1}{2} \times 300 + \frac{1}{2} \times 300$

$= 7300\ mm$

$\therefore l_{eff} = 7300\ mm$

Step ③ :-

1) $b_f = \frac{l_{eff}}{6} + b_w + 6D_f$

$= \frac{7300}{6} + 300 + 6(120)$

$b_f = 2236.66$

2) c/c distance b/w slab (rib) :-

$b_f = 3200$ mm

$\therefore b_f = 2236.66$ mm

Step ④ :- Load calculation :-

Self weight of slab $= D_f \times$ c/c distance $\times \gamma$

$= 0.12 \times 3.2 \times 25 = 9.6$ kN/m

web $= b_w \times (D - D_f) \times \gamma$

$= 0.3 \times (0.48 - 0.12) \times 25 = 2.7$ kN/m

Flooring $= 0.6 \times 3.2 = 1.92$ kN/m

Live load $= 4.6 \times 3.2 = 14.72$ kN/m

$\therefore W = 28.94$ kN/m

8 $\therefore W_u = W \times 1.5 = 28.94 \times 1.5 = 43.41$ kN/m

Step ④ :- $M_u = \frac{W_u l_{eff}^2}{8} = \frac{43.41 \times (7.3)^2}{8} = 289.16$ kN/m

$V_u = \frac{W_u l_{eff}}{2} = \frac{43.41 \times 7.3}{2} = 158.44$ kN/m

Step ⑤ :- $M_{uf} = 0.36 f_{ck} D_f b_f (d - D_f/2)$

$= 0.36 \times 20 \times 120 \times 2236.66 (450 - \frac{120}{2})$

$M_{uf} = 753.66$ kN-m

$\therefore M_u < M_{uf}$ $\therefore$ It is Rectangular Behaviour.

$M_{u\,lim} = 0.138\ f_{ck}\ b_f\ d^2$

$= 0.138 \times 20 \times 2236.66 \times (450)^2$

$M_{u\,lim} = \underline{\underline{1250.06}}\ kN\text{-}m$

$M_u < M_{u\,lim}$ ∴ It is Singly reinforced.

6: Area of steel cal.

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

$39.16 \times 10^6 = 0.87 \times 415 \times A_{st} \times 450 \left(1 - \frac{415 \times A_{st}}{2236.66 \times 450 \times 20}\right)$

$A_{st_{req}} = \underline{\underline{1850.33}}\ mm^2$

Assume dia of bars. = 20 mm

∴ No. of bars $= \frac{A_{st_{req}}}{\pi/4 \times d^2} = \frac{1850.33}{\pi/4 \times 20^2} = 5.88 \simeq \underline{\underline{6\ no.}}$

$\underline{A_{st}\ Max} = 0.04\ b_f\ D = 0.04 \times 2236.66 \times 480 = \underline{\underline{42943.8\ mm^2}}$

∴ Provide # 6 — 20 mm ϕ in Tension zone.

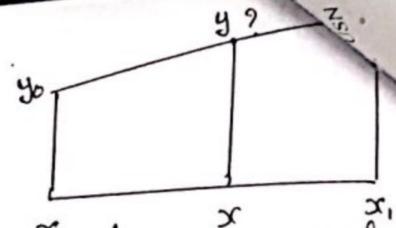
$A_{st\,(prov)} = 6 \times \frac{\pi}{4} \times 20^2 = \underline{\underline{1884.95}}\ mm^2$

Step (7): Check Shear :-

$\tau_v = \frac{V_u}{bd} = \frac{158.44 \times 10^3}{300 \times 450} = \underline{\underline{1.17}}$

$P_t = \frac{100\,(A_{st_{prov}})}{bd} = \frac{100 \times 1884.95}{300 \times 500} = \underline{\underline{1.25}}$

By Interpolation



$\tau_c = 0.67$

$\therefore \tau_c < \tau_v$ ~~Design~~ Minimum shear reinforcement is required.

Step ⑧ :-

4 legged vertical Stirrups @ 8 ϕ.

$A_{sv} = 4 \times \frac{\pi}{4} \times 8^2 = \underline{201.06 \text{ mm}^2}$

Vertical Stirrups → Pg No. (73)

i) $V_{us} = V_u - b d \tau_c$

$= 158.44 \times 10^3 - 300 \times 450 \times 0.67$

$V_{us} = \underline{67990 \text{ mm}}$

$V_{u} = \frac{0.87 f_y A_{sv} d}{S_v} \Rightarrow 67990 = \frac{0.87 \times 415 \times 201.06 \times 450}{S_v}$

$\therefore S_v = \underline{480.46 \text{ mm}}$

2) Spacing = 300 mm.

3) $0.75 \times d = 0.75 \times 450 = \underline{337.5 \text{ mm}}$

$\therefore$ Provide 4 LVS = 8 ϕ @ 300 mm c/c

Step ⑨ :- Check for Deflection :-

$\frac{L}{d}_{(actual)} = \frac{7000}{450} = \underline{15.56}$

Pg No. (38)

$f_s = 0.58 f_y \left(\frac{A_{st} \text{ req}}{A_{st} \text{ prov}} \right) = 0.58 \times 415 \left(\frac{1850.33}{1884.95} \right) = \underline{236.27 \text{ N/mm}^2}$

From Pg. No. (38).

$\therefore K_t = 1.1, \quad K_f = 0.8, \quad K_c = 1$

$\frac{l}{d}_{(allowable)} = \frac{7000}{20} \times 1.1 \times 0.8 \times 1 = \underline{17.6}$

$\therefore \frac{L}{d}_{(act)} < \frac{l}{d}_{(allowable)}$

$\therefore$ Hence it is Safe.

USN

(52)

CMRIT

Internal Assessment Test II – Oct. 2018

Sub:	DESIGN OF RC STRUCTURAL ELEMENTS			Sub code:	15CV51	Branch:	CIVIL
Date:	16/10/2018	Duration:	90 min's	Max marks: 50	Sem / sec:	5^{TH} SEM /A & B	OBE
Note	**Use of is 456:2000 is permitted** **Assume any missing data suitably**						

	Answer all the three full questions	MARKS	CO	RBT
1 (a)	Design the longitudinal reinforcement for the beam of clear span 6m to support a design working live load of 12kN/m. Adopt M25 grade concrete and Fe 415 HYSD bars. Also Show the detailing of reinforcements.	[15]	CO 4	L3
2 (a)	Design a RC slab simply supported of 6m X 3m. Live load acting is $2kN/m^2$ and the floor finish is $0.6\ kN/m^2$. Use M20 grade concrete and Fe 415 grade steel.	[15]	CO 4	L3
3 (a)	A T beam slab consists of beams spaced at 3.2m center to center. Thickness of slab is 120mm. live load on slab is $4.6\ kN/m^2$. The beam has a clear span of 7m wall support is of thickness 300mm. design an intermediate beam for flexure and shear. Sketch the reinforcement details.	[20]	CO 4	L3

Selected

11/10/18

Paper 1