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1181401 Final Exam.

$f_c' = 28$ MPa , $f_y = 420$ MPa , $\gamma_{conc} = 24$ kN/m³

2.4 t/m³

Q.1 all beams in all lines column

$t = 30$ cm

$d = 26$ cm

long beam : $b = 60$ cm , $h = 90$ cm , $d = 81$ cm

Short " : $b = 50$ cm , $h = 70$ cm , $d = 61$ cm

Column : 50 x 50 cm²

DL = 1 t/m²

LL = 0.5 t/m²

$W_u = 2$ t/m²

direct design method.

α_f for all Panels > 4

(a) for frame A:

$L_2 = 9$ m

$$M_o = \frac{w_u L_2 (L_n)^2}{8}$$

$L_n = 12 - 0.5 = 11.5$ m (colum face to face)

$$M_o = \frac{(2)(9)(11.5)^2}{8} = 297.6 \text{ t.m}$$ for all Spans in frame A.

by using figure (m.d):

exterior Span: $0.16 M_o = 47.6$ t.m

$0.57 M_o = 169.6$ t.m

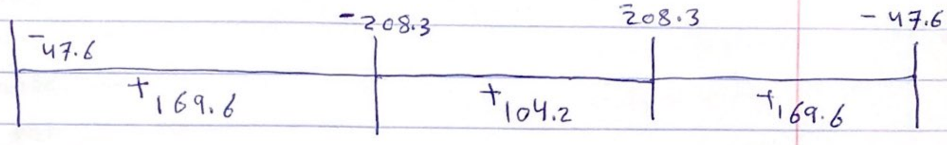
$0.7 M_o = 208.3$ t.m

Int. Span : $0.35 M_o = 104.2$ t.m

$0.65 M_o = 193.4$ t.m

long. dist. moment in (t.m):

frame A



(b) long. m = 100 t.m

location 1

negative moment at ext. support

$\frac{L_2}{L_1} = \frac{9}{12} = 0.75$

$\alpha_1 = \frac{E_{cb} I_b}{E_{cs} I_s}$

(long direction).

$\Rightarrow \alpha_1 = 2.9$

$\frac{\alpha_1 L_2}{L_1} = 2.2$

$\beta_t = \frac{E_{cb} C}{2 E_{cs} I_s}$

$\Rightarrow C = ?$

$I_b = K \frac{b_w h^3}{12}$

$b_E/b_w = 3$

$t/h = 0.33$

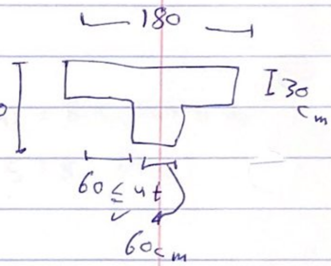
$\Rightarrow K = 1.61$

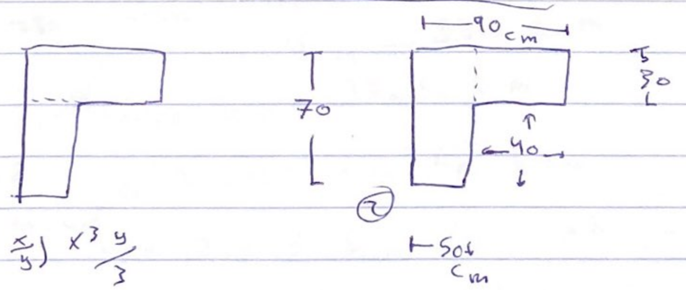
$\Rightarrow I_b = (1.61) \frac{(60)(90)^3}{12}$

$I_b = 5\ 868\ 450 \text{ cm}^4$

$\Rightarrow I_s = \frac{1}{12} (900)(30)^3$

$= 2\ 025\ 000 \text{ cm}^4$





← Short beam.

① $C = \sum (1 - 0.63 \frac{x}{y}) \frac{x^3 y}{3}$

$= (1 - 0.63 \frac{3}{9}) (\frac{30^3 * 90}{3}) + (1 - 0.63 \frac{4}{5}) (\frac{40^3 * 50}{3})$

$= 639\ 900 + 529\ 067$

$= 1.17 * 10^6 \text{ cm}^4$

②

$C = (1 - 0.63 \frac{3}{4}) \frac{(30)^3 (40)}{3} + (1 - 0.63 \frac{5}{7}) \frac{(50)^3 (70)}{3}$

$= 189\ 900 + 1\ 604\ 167$

$= 1.79 * 10^6 \text{ cm}^4$

controls.

$\Rightarrow \beta_t = \dfrac{1.79 * 10^6}{(2)\ (2\ 025\ 000)} = 0.44$

$\Rightarrow$ from table of L. dist. moment

	0.5	0.75	1
$\beta_t = 0$	100	100	100
0.44		96.92	
2.5	90	82.5	75

Column strip take $= \dfrac{96.92}{100} * 100$ t.m

M (C.S) = 96.92 t.m → beam (0.85) 96.92 = 82.382 t.m ; slab = 14.538 t.m

M (middle strip = 3.08 t.m

$\alpha \dfrac{L_2}{L_1} \geq 1$

(c) Location 2

long. M = 100 t.m

Positive moment : $\dfrac{L_2}{L_1} = 0.75$, $\alpha_1 \dfrac{L_2}{L_1} = 2.2$

0.5	0.75	1
90	82.5	75

$\Rightarrow$ Column strip take 82.5 %

$M_{c.s} = 82.5$ t.m

$M_{\text{midlle strip}} = 17.5$ t.m

Column Strip
82.5 t.m → 70.125 t.m for beam ; → 12.375 t.m for slab.

(d) $\phi V_c = 0.75 (0.17) \sqrt{f_c'}\ (\lambda)\ (L_2)\ (d)$
28 , 1 , 900, 26

= 157.87 KN

$V_u = W_u \left(\frac{1.15}{2}\right) \left[(9)(12 - 0.5 - 2(0.26))\right] = 113.6$ KN $< \phi V_c$

the Slab adequance for Shear.

Q.2 no ~~beams~~ beams

$t = 35$ cm

Column 80×80 cm^2

$DL = 1$ t/m²
$LL = 0.5$ "
} $w_u = 2$ t/m²

$d_{slab} = 31$ cm

(a)

$DF_{AB} = 1 = Df_{DC}$

$K_{AB} = K_{CD} = \frac{3EI}{L}$

$K_{BC} = \frac{4EI}{L}$

$DF_{BA} = \frac{3}{7}$

$DF_{BC} = \frac{4}{7}$

$FEM_{BA} = FEM_{CD} = \frac{w_u L_2 L_1^2}{8} = 324$ t.m

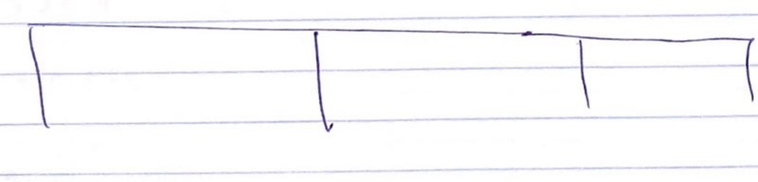
(without -ve)

$Df_{CB} = 4/7$

$D_{CD} = 3/7$

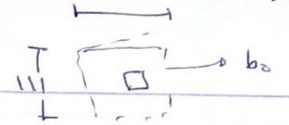
$FEM_{BC} = FEM_{CB} = 216$ t.m

	A	B		C		D
	AB	BA	BC	CB	CD	DC
DF	1	3/7	4/7	4/7	3/7	1
FEM		−324	216	−216	324 →	
Dist.						
CO						



$c_1 + d = 80 + 31 = 111 cm$

$b_o = 444 cm$



<u>Q.2</u>

(b) Punching Shear for interior Column.

$V_u = W_u \left[L_1 L_2 - \text{area within } b_o \right]$

$= (2) \left[(9)(12) - (1.11)^2 \right] = 213.54 \ t$

ϕV_c : Smallest of :

$(0.17)\left(1 + \frac{2}{\beta_c}\right) = (0.17)\left(1 + \frac{2}{1}\right) = 0.51$

40 — $(0.083)\left(\frac{\alpha_s d}{b_o} + 2\right) = 0.3978$

0.33 → Control.

$\therefore \ \phi V_c = (0.75)(0.33)\lambda\sqrt{f_c'} \ b_o d$

$= 180 \ t < V_u = 213.54 \ t$

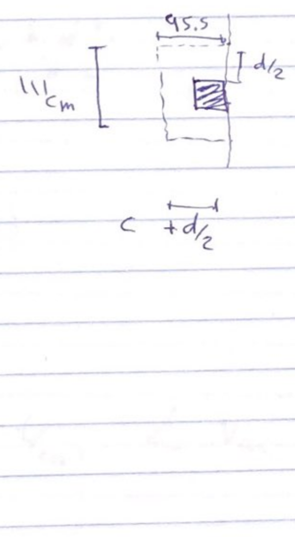
∴ not adequate
shear reinforcement req.

(c) exterior Column.

Consider transfer shear of b.m.

$b_o = (95.5)(2) + 111$

$b_o = 302 \ cm.$



$M_u = 0.3 M_o = (0.3)(297.6)$

$= 89.3 \ t.m$

$M_{uv} = (1 - \gamma_f) M_u = 34.12 \ t.m$

$\gamma_f = \frac{1}{1 + \frac{2}{3}\sqrt{\frac{b_1}{b_2}}} = 0.618$

$b_1 = C_1 + d/2 = 95.5 \ cm$

$b_2 = C_2 + d = 111 \ cm$

ϕV_c : $0.083\left(\frac{30(31)}{302} + 2\right) = 0.42$ not control.

$\alpha_s = 30$ > 0.33

$\therefore \phi V_c = (0.75)(0.33)\lambda\sqrt{f_c'}\, b_o\,(31)$

(b_o → 302, (31) → d)

$\phi V_c = 122.6$ t

$V_u = 213.88$ t $> 0.75\,\phi V_c = 91.95$

So → we need to calculate.

$V_u = w_u\,[(9)(12) - (1.11)(0.955)] = 213.88$ t

$$V_{u2} = \frac{V_u}{A_c} + \frac{M_{uv}\,X_2}{J_c}$$

$A_c = b_o\,(t) = (302)(31) = 9362$ cm²

$X_2 = \frac{b_1^2\, d}{A_c} = 30.2$ cm

$J_c = (31)\left[\frac{a_1(95.5)^3}{3} - (2b_1 + b_2)X_2^2\right] + \frac{b_1 d^3}{6}$

$J = 9.936 \times 10^6$ cm⁴

$$V_{u2} = \frac{213.88}{9362} + \frac{(34.12)(100)(30.2)}{(9.936)10^6}$$

$V_{u2} = 0.0332$ t/cm²

$$\phi V_n = \frac{\phi V_c}{b_o d} = \frac{122.6}{(302)(31)} = 0.0131 \text{ t/cm}^2 < V_{u2}$$

$V_{u2} = 0.0332 \frac{t}{cm^2} > \phi V_n = 0.0131 \frac{t}{cm^2}$

not adequate.

Q.3

Short, rectangular Column, $f_c' = 28$ MPa

$F_y = 420$ MPa.

$P_u = 700$ t

$e = 40$ cm.

Reinforcement along all faces. $\rho_g \approx 2\%$

$b = 70$ cm.

$\phi 28$, $\phi 10$ ties.

$h = ?$

$$P_n = \frac{P_u}{0.65} = 1077 \text{ t}$$

$d' = 4 + 1 + 1.4$
$= 6.4$ cm

Premiellary size: $A_g = \frac{P_n}{0.85 f_c' (0.5)} = 9050 \rightarrow h \approx 130$

try $130_{cm} \times 70_{cm}$

$$\gamma = \frac{130 - (2)(6.4)}{130} = 0.9$$

from figure Columns 3.2.4
R 28-420.9
Page 78

$K_n = \frac{P_n}{f_c' A_g} = 0.42$, $R_n = 0.13$ } $\rightarrow \rho = < 0.01$

Try $70_{cm} \times 70_{cm} \rightarrow \gamma = \frac{70 - 2(6.4)}{70} = 0.81 \approx 0.8$

Chart C.3.2.3, R 28-420.8, Page 77

$K_n = 0.78$, $R_n = 0.448$

$\rho >> 2\%$

Try $100 \times 70 \rightarrow \gamma = 0.872$

$K_n = 0.55$

$R_n = 0.22$

Try 110 cm x 70 cm

$\gamma = \frac{110 - (2)6.4}{110} = 0.88$

$K_n = 0.5$, $R_n = 0.182$

From Page 77	From P. 78
R 28-420.8	R 28-420.9
$\rho = 0.024$	$\rho = 0.02$

at $\gamma = 0.88$

$\Rightarrow \rho = 0.0208$

$A_{bar} = 6.1544\ cm^2$

$A_{s\,req.} = \rho\,(A) = 160.16\ cm^2$

$\Rightarrow$ # bars = 26.02 bar. $\Rightarrow$ 28 bar Ø28

Check Spacing

$\Rightarrow S_{min} = \max\{1.5(2.8), 4\} = 4.2\ cm$

maximum 8 bars in same line (Put it in long dir.

$\rightarrow S = \frac{110 - 2(4+1) - 8(2.8)}{7}$

$S = 11.086 > S_{min} = 4.2\ cm$ ✓

Spacing of ties:

$S \le 16\,d_b = 44.8\ cm$

$\le 48\,d_t = 48$

$\le$ least dim. $= 70$

all spacing between long. bars < 15cm.