ASSIGNMENT TWO

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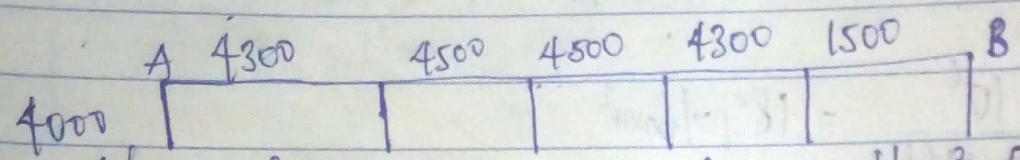
17/SC/14/013
Civil Engineering
CVE 308



Using slab thickness = 150mm, $f_y = 410 N/mm^2$ & $f_{cu} = 25 N/mm^2$.

Slab loading

Wt of slab = $0.15 \times 24 = 3.6 KN/m^2$

Partition = $1 KN/m^2$

finishes = $1.2 KN/m^2$

$5.8 KN/m^2$

Design load = $1.4 g_k + 1.6 q_k = (1.4 \times 5.8) + (1.6 \times 3.0)$

$= 12.92 KN/m^2 \approx$ ~~$13 N/m^2$~~ $13 KN/m^2$

Beam Load

Self wt of beam = $0.225 \times 0.6 \times 24 = 3.24 KN/m^2$

finishes = $1.2 KN/m^2$

wall load = $3 \times 3.$~~47~~ $=10.$~~41~~ KN/m^2

Dead load = ~~$14.7 KN/m^2$~~ $14.85 KN/m^2$

$DL = 14.85 \times 1.4 = 20.79 KN/m^2$

- Slab load on beam = $\frac{1}{3} wlx \left(1 - \frac{1}{3K^2}\right)$ (Longer direction)

$= \frac{1}{3} \times 13 \times 4.3 \left(1 - \frac{1}{5.8^2}\right) = 18.08 KN/m^2$

$= \frac{1}{3} \times 13 \times 4.5 \left(1 - \frac{1}{5.8^2}\right) = 18.92 KN/m^2$

Shorter direction = $\frac{1}{3} wlx$

$= \frac{1}{3} \times 13 \times 1.5 = 6.5 KN/m^2$

Total load on beam $= 20.79 + 18.08 = 38.87 KN/m^2$

$20.79 + 18.92 = 39.71 KN/m^2$

$20.79 + 6.5 = 27.29 KN/m^2$

Using Hardy Cross Method

Distribution factor (Df)

$K_{BA} = \frac{1/4.3}{1/4.3 + 1/4.5} = 0.51$

$K_{BC} = 1 - K_{BA} = 1 - 0.51 = 0.49$

$K_{CB} = \frac{1/4.5}{1/4.5 + 1/4.5} = 0.5 = K_{CD} = 0.5$

$K_{DC} = \frac{1/4.3}{1/4.3 + 1/4.3} = 0.49$

$K_{DE} = 1 - K_{DC} = 1 - 0.49 = 0.51$

$K_{EB} = \frac{1/4.3}{1/4.3 + 1/4.5} = 0.26 \qquad K_{EF} = 1 - 0.26 = 0.74$

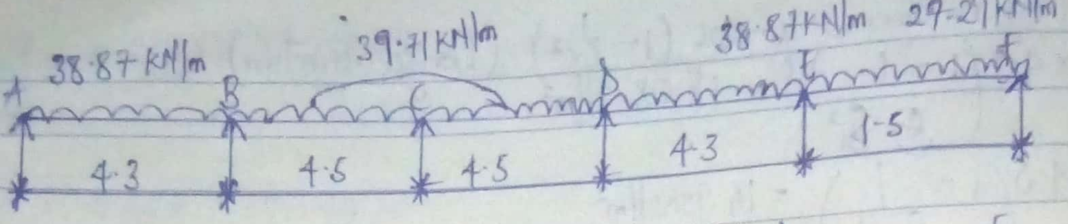
FEM => Fixed End Moment

for UDL $= \pm \frac{wl^2}{12}$

$\frac{38.87 \times 4.3^2}{12} = 59.89 KN/m$

$\frac{39.71 \times 4.5^2}{12} = 67.01 KN/m$

$\frac{27.29 \times 1.5^2}{12} = 5.1 KN/m$



	A		B		C		D		E		F	
	A	AB	BC	BD	CB	CD	DC	DE	ED	EF	FE	F
DF	0	1	0.51	0.49	0.5	0.5	0.49	0.51	0.26	0.74	1	0
FEM		-59.89	59.89	-67.01	67.01	-67.01	67.01	-59.89	59.89	-6.1	6.1	
OBM	-57.89		-7.12		0		7.12		54.79		5.1	
BM	57.89		7.12		0		-7.12		-54.79		-5.1	
DM	0	57.89	3.63	3.49	0	0	-3.49	-8.63	-14.25	-40.54	-5.1	0
TM		1.82	29.95	0	1.75	-1.75	0	-7.13	-1.82	-2.55	-20.27	0
OBM	~~-7.63~~ 1.82		29.95		0		-7.13		-4.37		-20.27	
BM	-1.82		-29.95		0		7.13		4.37		20.27	
DM	0	-1.82	-15.27	-14.68	0	0	3.49	3.64	1.14	3.23	20.27	0
TM		-7.64	-0.91	0	-7.34	1.75	0	0.57	1.82	10.14	1.62	0
OBM	-7.64		-0.91		-5.59		0.57		11.96		1.62	
BM	7.64		0.91		5.59		-0.57		-11.96		-1.62	
DM	0	7.64	0.46	0.45	2.8	2.8	-0.28	-0.29	-3.1	8.9	-1.62	0
TM		0.23	3.82	1.4	0.23	-0.14	1.4	1.6	-0.15	-0.81	-4.5	0
OBM	0.23		5.22		0.09		-0.2		-0.96		-4.5	
BM	-0.23		-5.22		-0.09		0.2		0.96		4.5	
DM	0	-0.23	-2.66	-2.56	-0.05	-0.05	0.1	0.1	0.25	0.71	4.5	0
~~TM~~												
Total		0	79.42	-78.42	64.9	68.9	68.72	-67.72	44.04	-43.08	0	

$M_A = 0$, $M_B = 79.42$ kN/m, $M_C = 64.9$ kN/m $M_D = 68.72$ kN/m $M_E = 44.04$ kN/m $M_F = 0$

Free moment $= \frac{wl^2}{8}$

$= \frac{38.87 \times 4.3^2}{8} = 89.84$ kN/m^2

$= \frac{39.71 \times 4.5^2}{8} = 100.52$ kN/m^2

$= \frac{27.29 \times 1.5^2}{8} = 7.68$ kN/m^2

Span Moment

$M_{ab} = M_f - \left(\frac{M_a + M_b}{2}\right) = 89.84 - \left(\frac{0 + 79.42}{2}\right)$

$= 50.13$ kN/m

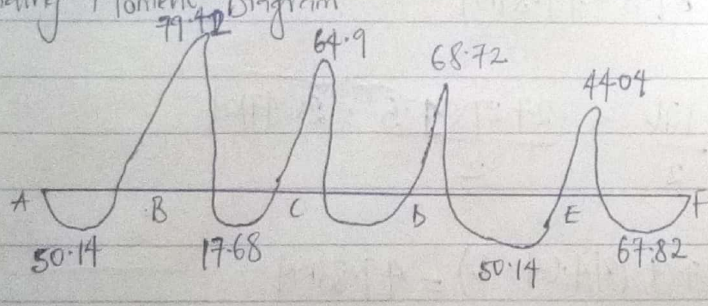
$M_{ab} = M_{dc} = 50.13$ kN/m

$M_{BC} = 89.84 - \left(\frac{79.42 + 64.9}{2}\right) = 17.68$ kN/m

$M_{BC} = M_{CD} = 17.69$ kN/m

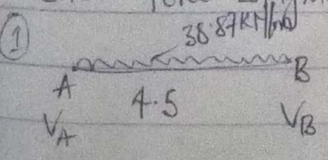
$M_{ef} = 89.84 - \left(\frac{44.04 + 0}{2}\right) = 67.82$ kN/m

Bending Moment Diagram



Shear Force Diagram

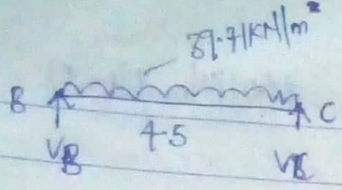
(1)



$V_A = V_B = \frac{wl}{2} = \frac{38.87 \times 4.3}{2} = 83.57$ kN

$V_{AB} = V_A + \frac{(M_A + M_B)}{L} = 83.57 + \frac{(0 + 79.42)}{4.3} = 102.04$ kN

$V_{BC} = wl - V_{ab} = (38.87 \times 4.3) - 102.04 = 65.101$ kN

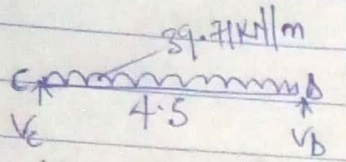
(ii)


$V_B = V_B = \frac{wl}{2} = \frac{39.71 \times 4.5}{2} = 89.35KN$

$V_{BC} = V_B + \frac{(M_B - M_C)}{L} = 89.35 + \frac{(79.42 - 64.9)}{4.5}$

$= 92.58KN$

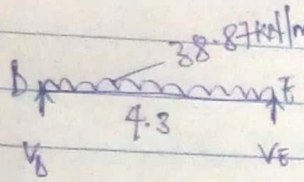
$V_{CB} = Wl - V_{BC} = 39.71 \times 4.5 - 92.58 = 86.12KN$

(iii)


$V_C = V_D = \frac{wl}{2} = \frac{39.71 \times 4.5}{2} = 89.35KN$

$V_{CD} = V_C + \frac{(M_C - M_D)}{L} = 89.35 + \frac{(64.9 - 68.72)}{4.5} = 88.5KN$

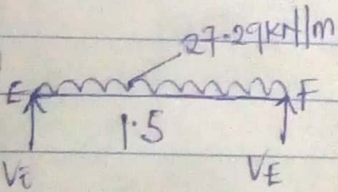
$V_{DC} = Wl - V_{CD} = (39.71 \times 4.5) - 88.5 = 90.2KN$

(iv)


$V_D = V_E = \frac{wl}{2} = \frac{38.87 \times 4.3}{2} = 83.57KN$

$V_{DE} = V_D + \frac{(M_D - M_E)}{L} = 83.57 + \frac{(68.72 - 44.04)}{4.3} = 89.3KN$

$V_{ED} = Wl - V_{DE} = (38.87 \times 4.3) - 89.3 = 77.84KN$

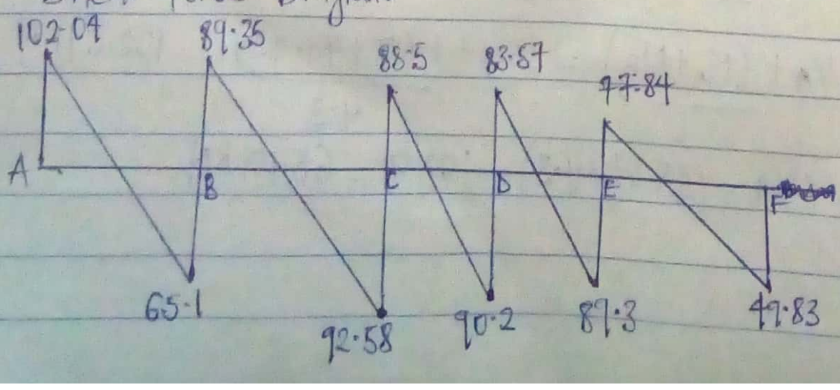
(v)


$V_E = V_F = \frac{wl}{2} = \frac{27.29 \times 1.5}{2} = 20.47KN$

$V_{EF} = V_E + \frac{(M_E - M_F)}{L} = 20.47 + \frac{(44.04 - 0)}{1.5} = 49.83KN$

$V_{FE} = Wl - V_{EF} = (27.29 \times 1.5) - 49.83 = -8.895KN$

Shear Force Diagram



Scanned by CamScanner

6. Base Design

$N = 1200KN$, $f_b = 150$, $h = 660mm$

Area required $= \frac{N \times 1.1}{\alpha f_b}$ where $\alpha = 1.46$

$= \frac{1200 \times 1.1}{1.46 \times 150} = 6.03m^2$

For square base, Length of side $= \sqrt{6.03} = 2.46m$

Net Pressure (f_{nd}) $= \frac{N \times 1.1}{B} - 1.4 \times h \times 24$

$= \frac{1200 \times 1.1}{2.46} - 1.4 \times 0.66 \times 24$

$= 514.41 KN/m$

Moment $= \frac{f_{nd} l^2}{2}$

$l = 1/2 (B - h)$

$l = 1/2 (2.46 - 0.66) = 0.9m$

$M = \frac{514.41 \times 0.9^2}{2} = 208.34 KNm$

$d = h - cover - 1/2 \phi$

$= 660 - 50 - 1/2 (25) = 597.5mm$

$K = \frac{M}{bd^2 f_{cu}} = \frac{208.34 \times 10^6}{1000 \times 597.5^2 \times 25} = 0.023$

$I_a = 0.5 + \sqrt{0.25 - \frac{K}{0.9}} = 0.5 + \sqrt{0.25 - \frac{0.023}{0.9}} = 0.95 > 0.95$

$= 0.95$

(Z)
$I_a d = 0.95 \times 597.5 = 567.6mm$

$A_s = \frac{M}{0.95 f_y Z} = \frac{208.34 \times 10^6}{0.95 \times 410 \times 567.6} = 942.37mm^2$

∴ Provide Y25 @ 300 c/c ($A_s = 1640mm^2$)

For Punching Shear

Column dimension = 225 × 450

Area of footing = $6.8m^2$ Footing size = 2500 × 2.25

Net Pressure = 514.41 KN/m

(ii) Depth = 597.5mm

Critical Section = $d/2$ = 298.75mm

298.75 + 298.75 + 225 ≃ 823mm

298.75 + 298.75 + 450 ≃ 1048mm

Shear Force = V_u = v_u x [area of footing − $(0.3+d)^2$]

$= 514.41 [2.5 \times 2.5 - (0.3 + 0.5975)^2]$

$= 514.41 [6.25 - 0.8055]$

= 2800.7KN

Nominal Shear Stress = $\frac{V_u}{bd}$

b = perimeter of critical section

d = effective depth

$= \frac{2800.7 \times 10^3}{[(2 \times 823) + (2 \times 1048) \times 597.5]}$

$= 2.23 N/mm^2$

Permissible Shear Stress = $k_s \times \tau_c$

$k_s = (0.5 + \beta_c)$, must be < 1

β_c = Ratio of shorter side to longer side of the column

$\tau_c = 0.25\sqrt{f_{cu}}$

$k_s = 0.5 + 2 = 2.5 > 1$

= 1

$\tau_c = 0.25\sqrt{25} = 1.25 N/mm^2$

$\tau_v = 2.23 N/mm^2$

$\tau_v > \tau_c$

Therefore, the depth needs to be increased.