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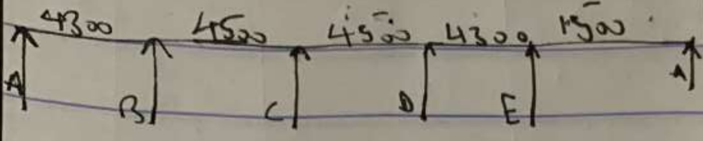
17/ENG03/011
Civil Engineering.

(1)



Assuming thickness = 150mm

$f_{cu} = 25\ N/mm^2$

$f_y = 410\ N/mm^2$.

Slab loading

Slab weight $= 0.15 \times 24 = 3.6\ kN/m^2$

Partitions $1.0\ kN/m^2$

finishes $= 1.2\ kN/m^2$

Total $G_k = 5.8\ kN/m^2$

$D.L = 1.4(5.8) + 1.6(3.0) = 13\ kN/m^2$

Beam loading.

self weight of beam $= 0.225 \times 0.6 \times 24$

$= 3.24\ kN/m^2$

finishes $= 1.2\ kN/m^2$

Wall load $= 3 \times 3.47 = 10.41\ kN/m$

Total $G_k = 14.85$

$D.L = 1.4(14.85) = 20.79\ kN/m$

Slab load on beam in longer direction

$= \frac{1}{2} w l_x \left(1 - \frac{1}{3k^2}\right)$

$k = l_y / l_x$

$4300 / 4000 = 1.075$

$4500 / 4000 = 1.125$

$\frac{1}{2} \times 13 \times 4.3 \left(1 - \frac{1}{3(1.075)^2}\right) = 19.89\ kN/m$

$\frac{1}{2} \times 13 \times 4.5 \left(1 - \frac{1}{3(1.125)^2}\right) = 21.55\ kN/m^2$

Slab load on beam in short direction

$= \frac{1}{3} w l_x$

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

Total load $= 19.89 + 20.79 = 40.68\ kN/m$

$= 21.55 + 20.79 = 42.34\ kN/m$

$= 6.5 + 20.79 = 27.29\ kN/m$

Distribution factor

$K_{AB} = 1$

$K_{BA} = \frac{1/L_{BA}}{1/L_{BA} + 1/L_{BC}} = \frac{1/4.3}{1/4.3 + 1/4.5} = 0.5$

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

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

$K_{CD} = 1 - 0.55 = 0.5$

$K_{CD} = 0.45$

$K_{DC} = 0.81$

$K_{CD} = \frac{1/4.5}{1/4.8 + 1/4.5} = 0.5$

$K_{CD} = 1 - 0.5 = 0.5$

$K_{DC} = 0.45$

$K_{DE} = 0.81$

$K_{CD} = \frac{1/4.3}{1/4.3 + 1/1.5} = 0.26$

$K_{BA} = 1 - 0.26 = 0.74$

$K_{AB} = 1$

F.E.M

$M = wl^2/12$

(1) $\frac{40.68 \times 4.5^2}{12} = 62.68$ kN/m

(2) $\frac{42.34 \times 4.5^2}{12} = 71.45$ kN/m

(3) $\frac{27.29 \times 1.5^2}{12} = 5.1$ kN/m

	A	AB	BA	BC	CB	CD	DC	DE	ED	EA	AE	A
D.F	0	1	0.51	0.49	0.5	0.5	0.49	0.51	0.26	0.74	1	0
FEM		-62.68	62.68	-71.45	71.48	-71.45	71.45	-62.68	62.68	-5.1	5.1	
OBM		62.68	-8.77		0		8.77		57.58		-5.1	
BM	62.18		8.77		0		8.77		-57.58		5.1	
DBM	0	62.68	4.47	4.30	0	0	-4.30	-4.47	-14.97	-42.61	-5.1	0
Im		2.235	31.34	0	2.15	-2.15	0	-7.49	-2.24	-2.55	-21.305	
OBM	2.235		31.34		0		-7.49		-4.79		-21.305	
BM	-2.235		-31.34		0		7.49		4.79		21.305	
DM	0	-2.235	-15.98	-15.36	0	0	3.67	3.82	1.29	3.54	4.31	0
TM		-7.99	-1.12	0	-7.69	1.84	0	0.83	1.91	0.86	1.77	
OBM	-7.99		-1.12		-5.85		0.83		12.57		1.77	
BM	7.99		1.12		5.85		-0.63		-12.57		-1.77	
DM	0	7.99	0.57	0.55	2.93	2.93	-0.31	-0.37	-3.27	-9.29	-1.77	0
TM		0.29	3.40	1.47	0.28	-0.16	1.47	-1.64	-0.16	-0.89	4.65	
OBM	0.29		4.87		0.12		0.17		-1.05		-4.65	
BM	-0.29		-4.87		-0.12		0.17		1.05		4.65	
DM	0	0.29	-2.48	-2.39	-0.06	-0.06	0.06	0.09	0.27	0.78	4.65	0
Total		0	82.88	-82.88	69.6	-69.06	72.06	-72.06	45.47	45.46	0	

Moment

$M_a = 0$ kNm

$M_b = 82.88$ kNm

$M_c = 69.06$ kNm

$M_D = 72.06$ kNm

$M_E = 45.47$ kNm

$A_x = 0$ kNm

Fixed moment (for UDL) $= wL^2/8$

(1) $40.88 \times 4.3^2/8 = 94.02$ kN/m²

(2) $42.34 \times 4.5^2/8 = 107.17$ kN/m²

(3) $27.29 \times 1.5^2/8 = 8.24$ kN/m²

span moment

$M_{AB} = M^f - \left(\frac{M_A + M_B}{2}\right)$

$= 94.02 - \left(\frac{0 + 82.88}{2}\right) = 52.58\,kNm$

$M_{BC} = M^f \left(\frac{M_B + M_C}{2}\right)$

$= 107.17 - \left(\frac{82.88 + 69.06}{2}\right) = 31.2\,kNm$

$M_{CD} = M^f - \left(\frac{M_C + M_D}{2}\right)$

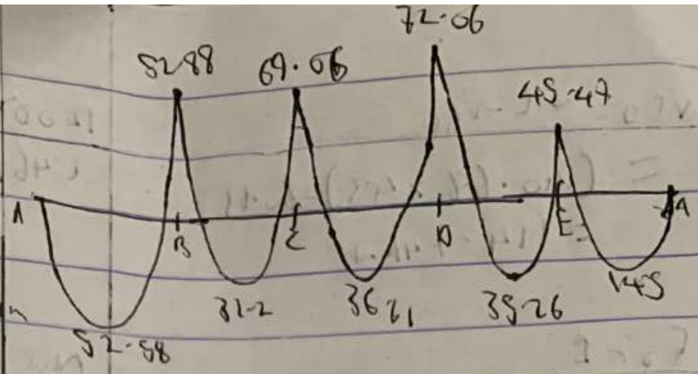
$= 107.17 - \left(\frac{69.06 + 72.06}{2}\right) = 36.61\,kNm$

$M_{DE} = M^f - \left(\frac{M_D + M_E}{2}\right)$

$= 94.02 - \left(\frac{72.06 + 45.47}{2}\right) = 35.26\,kNm$

$M_{EA} = M^f - \left(\frac{M_E + M_A}{2}\right)$

$= 8.24 - \left(\frac{45.47 + 0}{2}\right) = 14.5\,kNm$



B.M.D

Shear force

for A $\quad V_A = \frac{wL}{2} = V_B$

$= \frac{40.68 \times 4.3}{2} = 87.462\,kN$

$V_{AB} = V_A + \left(\frac{M_A - M_B}{L}\right) = 87.462 + \left(\frac{0 - 82.88}{4.3}\right) = 68.19$

$V_{BA} = wL - V_{AB}$

$= (40.68 \times 4.3) - 68.19 = ~~106.7~~$

$= 106.73\,kN$

for B $\quad V_B = wL/2 = V_C$

$= \frac{42.34 \times 4.5}{2} = 95.27\,kN$

$V_{BC} = V_B + \left(\frac{M_B + M_C}{L}\right) = 95.27 + \left(\frac{82.88 + 69.06}{4.5}\right)$

$= 129.03\,kN$

$V_{CB} = (42.34 \times 4.5) - 129.03 = 61.5\,kN$

for C $\quad V_C = wL/2 = V_D$

$= 42.34 \times 4.5 / 2 = 95.27\,kN$

$V_{CD} = 95.27 + (69.06 + 72.06 / 4.5) = 126.63\,kN$

$V_D = (42.34 \times 4.5) - 126.63 = 63.19\,kN$

for D $\quad V_D = wL/2 = V_E$

$= 40.68 \times 4.3 / 2 = 87.46\,kN$

$V_{DE} = 87.46 - \left(\frac{72.06 + 45.47}{4.3}\right)$

$= 60.13\,kN$

$V_{ED} = wL - V_{DE}$

$= (40.68 \times 4.3) - 60.13$

$= 114.74\,kN$

For E

$V_E = wL/2 = V_A = \frac{8.24 \times 1.5}{2}$

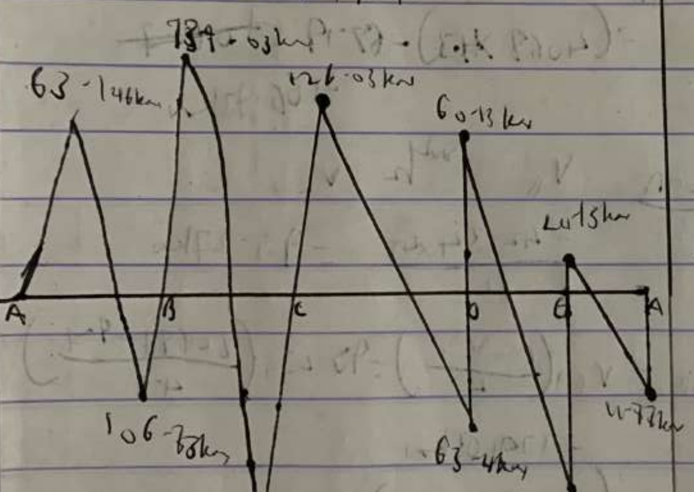
$= 6.18\,kN$

$V_{BA} = V_A - \left(\frac{M_B - M_A}{L}\right)$

$= 6.18 - \left(\frac{45.47 - 40}{1.5}\right) = 24.43\,kN$

$V_{AE} = (8.24 \times 1.5) - 24.13$

$= 11.77\,kN$



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Base design

$N = 1200\,kN$ $\gamma = 1.46$

Strength: 25-410 N/mm²

$f_b = 150\,kN/m^2$

Area of base $= \frac{N \times 1.1}{\gamma \times f_b}$

= [illegible]

$\frac{1200 \times 1.1}{1.46 \times 150} = 6.027\,m^2$

$\sqrt{6.027} = 2.45\,m \approx 2.5$

Net pressure $= f_{net} = \frac{N \times 1.1}{B}$

$\frac{1200 \times 1.1}{2.5}$ [illegible] $- 24 \times 0.660 \times 1.4$

$= 505.824\,kN/m$

Moment, $m = \frac{f_{net} l^2}{2}$

$L = \frac{1}{2}(B - h)$

Length A base = 660

$L = \frac{1}{2}(2.5 - 0.225) = 1.138 \approx 1.14\,m$

$M = \frac{505.824 \times 1.14^2}{2} = 328.68\,kNm$

$d = h - cover - \frac{1}{2}\phi$

$= 660 - 50 - 10 = 600\,mm$

$K = \frac{M}{bd^2 f_{cu}} = \frac{328.68 \times 10^6}{1000 \times 600^2 \times 25} = 0.037$

$z_a = 0.87 \sqrt{0.25 \times 0.037/0.9} = 0.96$

> 0.95

$z = z_a d = 0.95 \times 600 = 570\,mm$

$A_s = \frac{M}{0.95 f_y z} = \frac{328.68 \times 10^6}{0.95 \times 410 \times 570} = 1480.44\,mm^2$

provide Y_{25} @ 300 c/c (1640) size of column

Punching shear

column size = 225 X 480 mm

f_{ck}/f_y = 25 - 410 mm

Area footing: 6.027 m²

size of footing = 2500 x 2500

q, net pressure = 505.824 kN

depth = 600

Continual section $d/2$ = 300

300 + 300 + 225 = 825 mm

300 + 300 + 480 = 1080 mm

Area force $V_A = q \times$ [Area of footing $- (0.342)^2$]

$= 505.824 [2.5 \times 2.5 - (0.3 + 0.6)^2]$

~~$V_A = 2781.684$~~

$V_A = 2751.68$

Normal shear stress $\tau_v = V/bd$

b = perimeter of critical section.

d = effective span depth

$$\tau_v = \frac{2751.68 \times 10^3}{((2 \times (825) + 2(1080)) \times 600)}$$

$\therefore \tau_v = 1.223 N/mm^2$

permissible shear stress

$\tau_c = k_s \times \tau_c$

$k_s = (0.5 + \beta_c)$ but not > 1

β_c = Ratio of shorter to longer side of column

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

$k_s = 1$

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

$\tau_v = 1.223 N/mm^2$

$\tau_v \leq \tau_c$

Hence depth assumed is okay.

checking for f_v with actual size of footing

unit weight of concrete = 24 kN/m²

" " " soil = 1.091×10^{-6} kN/m²

Actual pressure footing below =

$q = (1200 \times 2.5 \times 2.5) + (24 \times 0.66) +$

$(1.091 \times 10^{-6} \times 0.66$

$q = 214.94 kN/m^2$