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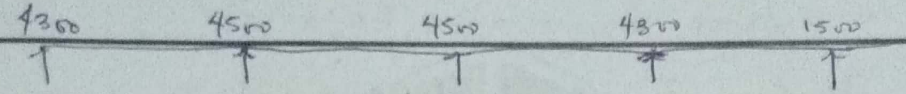
17/ENG031001

Question 1



Assuming thickness to be 150mm

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

$f_y = 460N/mm^2$

Slab loadings

Slab weight = 0.15 × 24 = 3.6 kN/m²

Partition = 1.0 kN/m²

Finishes = 1.2 kN/m²

Total Gk = 5.8

ULS = 1.4(5.8) + 1.6(3.0) = 13 kN

Beam loadings

Self weight of beam = 0.225 × 0.6 × 24 = 5.24 kN/m²

Finishes = 1.2 kN/m²

Wall load = 3 × 3.47 = 10.71 kN/m

Total Gk = 14.85

U.L = 1.4(14.85) = 20.79 kN/m²

Slab load on beam in longer direction

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

$k = \frac{l_y}{l_x}$

$\frac{4300}{4000} = 1.075$

$\frac{4500}{4000} = 1.125$

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

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

Slab load on beam in shorter direction

$= w l_x$

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

Total load $= 19.89 + 20.79 = 40.68 kN/m^2$

$= 21.55 + 20.79 = 42.34 kN/m^2$

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

Distribution factor

$K_{AB} = 1$

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

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

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

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

Scanned by CamScanner

$K_{DC} = 0.49$

$K_{DE} = 0.51$

$K_{ED} = \dfrac{1/4.3}{1/4.3 + 1/1.5} = 0.26$

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

$K_{AE} = 0$

F.E.M

$M_{FE} = \dfrac{wl^2}{12}$

1) $\dfrac{40.68 \times 4.3^2}{12}$ $262.4\ kN/m^2$

$\dfrac{42.34 \times 4.5^2}{12} = 71.45\ kN/m^2$

$\dfrac{29.29 \times 1.5^2}{12} = 5.1\ kN/m^2$

	A		B		C		D		E		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		62.69	62.68		21.x	71.45	71.45	-42.68	62.68	5.1	5.1	
BBM	-62.68		-8.77		0		8.77		53.58		-5.1	
COM	62.68		8.77		0		-8.77		-53.58		5.1	
[illegible]	0	62.68	4.77	4.10	0	0	-4.30	4.47	14.72	-42.61	-5.1	0
Tm		2.245	31.34	0	2.15	21.16	0	2.44	-2.24	-2.55	-21.30	
BBM	-2.235		-1.12		-5.85		-0.685		12.57		1.77	
COM	-2.235		1.12		6.85		-0.7		-12.57		-1.77	
[illegible]	0	2.44	0.57	0.55	2.45	2.48	-0.29	0.28	-3.29	-9.29	-1.77	0
Tm		0.29	3.40	1.42	0.28	-0.18	1.4	-1.44	-0.14	0.19	-4.03	

OBM	0.24		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	-2.41	-2.39	0.06	0.06	0.04	0.09	0.27	0.78	4.65	0
Σ	=	0	22.88	-82.88	69.04	-69.05	72.04	-72.09	49.4	45.44	0	

Moments

$M_A = 0\,kN/m$

$M_B = 82.88\,kN/m^2$

$M_C = 69.04\,kN/m^2$

$M_D = 72.06\,kN/m^2$

$M_E = 45.47\,kN/m$

$M_F = 0\,kN/m^2$

Free moment

For U.D.L $= \frac{wl^2}{8}$

$\frac{40.84 \times 4.3^2}{8} = 94.02\,kN/m^2$

$\frac{42.34 \times 4.5^2}{8} = 107.17\,kN/m^2$

$\frac{27.29 \times 1.5^2}{8} = 8.24\,kN/m^2$

Span Moment

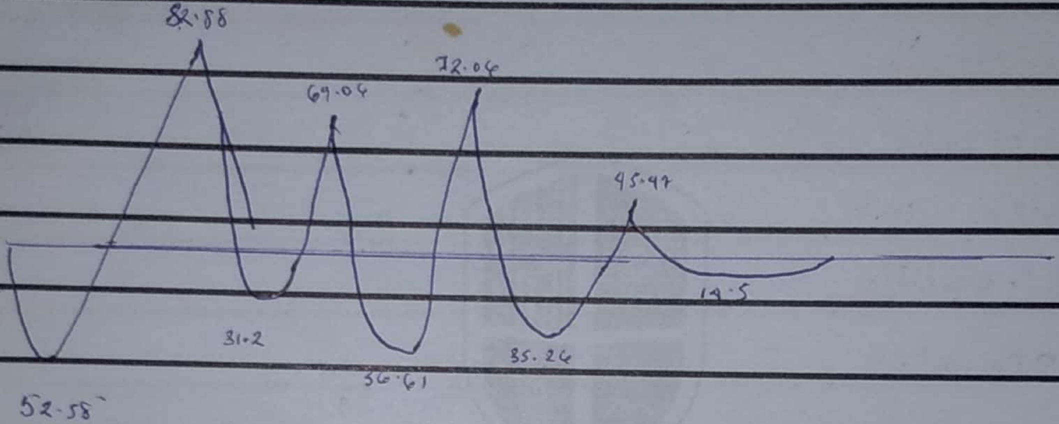
$M_{AB} = M^1 - \left(\frac{M_A + M_B}{2}\right) = 94.02 - \left(\frac{0 + 82.88}{2}\right) = 52.58\,kN/m^2$

$M_{BC} = M^2 - \left(\frac{M_B + M_C}{2}\right) = 107.17 - \left(\frac{82.88 + 69.04}{2}\right) = 31.2\,kN/m^2$

$M_{CD} = M^F - \left(\frac{M_C + M_B}{2}\right) = 109.17 - \left(\frac{67.04 + 72.06}{2}\right) = 36.61\,kNm$

$M_{DE} = M^F - \left(\frac{M_B + M_E}{2}\right) = 94.02 - \left(\frac{72.06 + 45.47}{2}\right) = 35.26\,kNm$

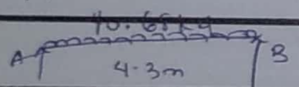
$M_{EA} = M^F - \left(\frac{M_E + M_A}{2}\right) = 8.24 - \left(\frac{45.47 + 0}{2}\right) = -14.5\,kNm$



BMD.

Shear force.

For A



$V_A = \frac{wl}{2} = V_B$

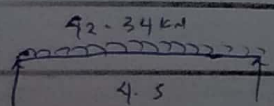
$= \frac{40.68 \times 4.3}{2} = 87.462\,kN$

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

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

$= (40.68 \times 4.3) - 68.19 = 106.73\,kN$

For B



$V_B = \frac{wl}{2} = V_C$

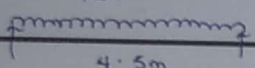
$= \frac{42.34 \times 4.5}{2} = 95.27kN$

$V_{BC} = V_B + \left(\frac{M_B + M_C}{l}\right) = 95.27 + \left(\frac{82.68 + 69.09}{4.5}\right) = 129.03kN$

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

$= 61.5kN$

For C



$V_C = \frac{wl}{2} = V_D$

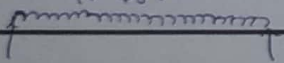
$= \frac{42.34 \times 4.5}{2} = 95.27kN$

$V_{CD} = 95.27 + \left(\frac{69.66 + 72.06}{4.5}\right) = 126.63kN$

$V_{DC} = (42.34 \times 4.5) - 126.63$

$= 63.17kN$

For D



$V_D = wl/2 = V_E$

$= \frac{40.68 \times 4.3}{2} = 87.46kN$

$V_{DE} = V_D - \left(\frac{M_D + M_E}{l}\right)$

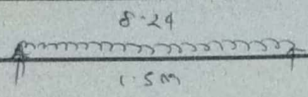
$= 87.46 - \left(\frac{72.06 + 45.47}{4.3}\right) = 60.13kN$

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

$= (40.68 \times 4.3) - 60.13$

$= 114.74kN$

For E



$V_E' = \frac{wl}{2} = V_B$

$= \frac{8.24 \times 1.5}{2} = 6.18$ kN

$V_{EA} = V_E - \left(\frac{M_E + M_A'}{L}\right) = 6.18 - \left(\frac{45.47 + 0}{1.5}\right) = 24.13$ kN

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

$= 11.72$ kN

Question 2

Base design

$N = 1200$ kN

Strength = 25 – 460 N/mm²

$f_b = 150$ kN/m²

Area of base plate $= \frac{N \times 1.1}{\lambda \times f_b}$, $\lambda = 1.46$

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

$\sqrt{6.027} = 2.45 m \simeq 2.5$

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

$\frac{1200 \times 1.1}{2.5} = 24 \times 0.660 \times 1.4$

$= 505.824$ kNm

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

where $l = \frac{1}{2}(B - b)$

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

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

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

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

$K = \frac{m}{bd^2 f_{cu}} = \frac{328.68 \times 10^6}{1000 \times 600^2 \times 25} = 0.032$

$l_a = 0.5 + \sqrt{0.25 - \frac{0.032}{0.9}} = 0.96 > 0.95$

$Z = l_a d = 0.95 \times 600 = 570\,mm$

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

Punch shear.

Column size = 225 x 450 mm

$f_{cu} - f_y = 25 - 410\,mm$

Area footing = 6.024 mm²

Size of footing = 2500 x 2500

q = net pressure = 505.824 kN/m

depth = 600

Critical section = $d/2$ = 300

~~300~~

300 + 300 + 225 = 825 mm

300 + 300 + 450 = 1050 mm

Shear force = $q_u \times$ [Area of footing − (0.3 + d)]

= 505.824 [2.5 x 2.5 − (0.3 + 0.4)]

V_u = 2791.45

Nominal shear stress $\tau_v = V_u / bd$

b = Parameter of critical section

d = effective depth

$\tau_v = \dfrac{2751.68 \times 10^3}{[(2 \times (825) + 2(1050)] \times 600]}$

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

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 larger side of columns

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

$k_s = 1$

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

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

$\tau_v \leq \tau_v'$

Hence depth assumed is ok

checking for Fb with actual size of footing

Unit weight of concrete = $24\ kN/m^2$

weight of soil = 1.091×10^{-6} kN/m

Actual pressure footing below

$\tau = (1200 \times 2.5 \times 2.5) + (24 \times 0.660) + (1.091 \times 10^{-6} \times 0.00)$

$\tau = 214.94\ kN/m^2$