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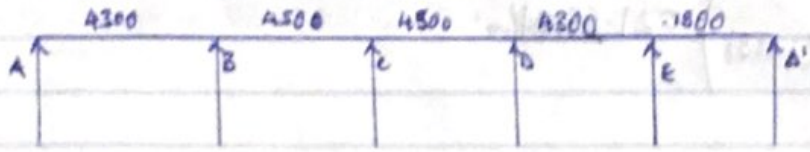
17/ENG03/033
Civil Engineering
Structural Design.

Assigment II

①



Assuming Thickness = 150mm

f_{cu} = 25N/mm²

f_y = 410N/mm²

Slab loading

Slab weight = 0.15×24 = 3.6 KN/m²

Partition = 1.0KN/m²

Finishes = 1.2 KN/m²

Total G.K. = 5.8KN/m²

D.L = 1.4 (5.8)+1.6 (3.0) = 13KN/m²

Beam loading.

Self wt of beam = 0.225×0.6×24 = 5.24 KN/m²

Finishes = 1.2KN/m²

Wall load = 3×3.47 = 6.41KN/m²

Total Gk = 14.85

D.L = 1.4 (14.85) = 20.79KN/m²

Slab load on beam in longer direction = $\frac{1}{2}wl_x(1-\frac{1}{3k^2})$

$K = \frac{L_y}{L_x}$

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

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

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

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

Slab load on beam in shorter direction $= \frac{1}{3} w l x$

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

Total load $= 19.89 + 20.79 = 40.68 \text{ KN/m}$

$= 21.55 + 20.79 = 42.34 \text{ KN/m}$

$= 6.5 + 20.79 = 27.29 \text{ KN/m}$

Distribution Factor.

$K_{AB} = 1$

$K_{BA} = \frac{1/_{AB}}{1/_{AB} + 1/_{BC}} - \frac{1/_{4.3}}{1/_{4.2} + 1/_{4.5}} = 0.51$

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

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

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

$K_{BC} = 0.49$

$K_{CB} = 0.51$

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

$K_{EA'} = 1 - 0.26 = 0.79$

$K_{AE} = 1$

F.E.M

$U.D.L = \frac{wl^2}{12}$

① $\frac{40.68 \times 4.3^2}{12} = 62.68$ 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'	A'E	A'
	A		B		C		D		E		A'	
	0	1	0.61	0.49	0.5	0.5	0.49	0.51	0.26	0.74	1	0
		-62.68	62.68	-71.45	71.45	-71.45	71.45	-62.68	62.68	-5.1	5.1	
D.F	-62.	68	-8.	77	φ		8	77	57	5.8	-5	.1
FEM	62.	88	8.	77		0	-8	77	-57	-58.61	5.	1
OBM	0	6268	4.47	4.30	0	0	-4.30	-4.47	-14.97	42.61	-5.1	
BM		2.235	31.84	0	2.15	-2.15	0	-7.49	-2.24	-2.55	-21.34	
DM												
TM												
OBM	2.	235	31.	34	φ		-7.	49	-4.	79	-21	.305
BM	-2.	235	-31.	34	φ		7.	49	4.	79	21	.305
DM	0	-2.235	-15.98	-16.36	0	0	3.67	3.82	1.25	3.54	21.31	0
TM		-7.99	-1.12	0	-7.69	1.84	0	0.63	1.91	10.66	1.77	
OBM	-7.	99	-1.	12	-5.	85	0	.63	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	9.9	-1.77	0
TM		0.29	3.40	1.47	0.28	-0.16	1.47	-1.64	0.16	-0.19	-4.65	
OBM	0	.29	4.	87	0	.12	-0.	17	-1.	05	-4	.65
BM	-0	.29	-4	4.87	-0	.12	0.	17	1.	05	4	.65
DM	0	-0.29	-2.48	-2.39	-0.06	-0.06	0.08	0.09	0.27	0.78	4.65	0
Σ		0	22.88	-82.88	69.06	69.05	72.06	-72.06	45.46	-45.46	0	

Moments

$M_A = 0\,KN/m$

$M_B = 82.88\,KN/m$

$M_C = 69.06\,KN/m$

$M_D = 72.06\,KN/m$

$M_E = 45.47\,KN/m$

$M_{A'} = 0\,KN/m$

Free Moment.

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

① $\frac{40.68 \times 4.3^2}{8} = 94.02\,KN/m^2$

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

③ $\frac{27.29 \times 1.5^2}{8} = 7.68\,KN/m^2$

Span moment.

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

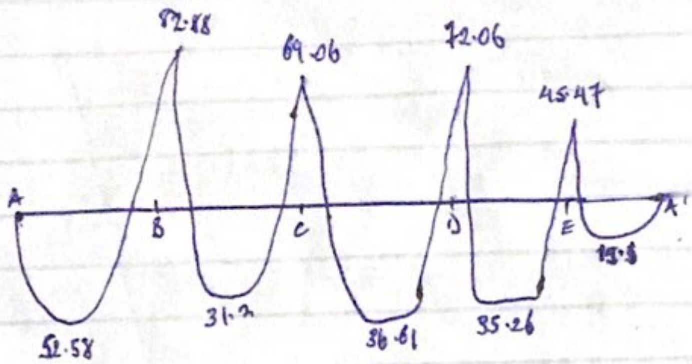
$M_{BC} = M^F - \left(\frac{M_B + M_C}{2}\right) = 107.17 - \left(\frac{82.88 + 69.06}{2}\right) = 31.2\,KN/m$

$M_{CD} = M^F - \left(\frac{M_C + M_D}{2}\right) = 107.17 - \left(\frac{69.06 + 72.06}{2}\right) = 36.61\,KN/m$

~~$M_{DE} = M^F - \left(\frac{\quad + M_E}{2}\right) = 8.24 - \left(\frac{45.47 + 0}{2}\right) = -14.5\,KN$~~

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

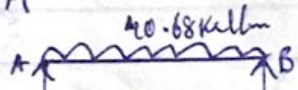
$M_{EA'} = M^F - \left(\frac{M_E + M_{A'}}{2}\right) = 8.24 - \left(\frac{45.47 + 0}{2}\right) =$ [illegible] 15 KN/m



B.M.D.

Shear force

for A



$V_A = wl/2 = V_B$

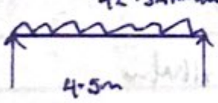
$= \frac{40.68 \times 4.3}{2} = 87.462\,KN$

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

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

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

For B



$V_B' = wl/2 = V_C$

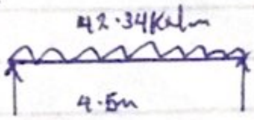
$= \frac{42.34 \times 4.5}{2} = 95.27\,KN.$

$V_{BC} = V_B + \left(\frac{M_B + M_C}{L}\right) = 95.27 + \left(\frac{82.68 + 96.06}{4.5}\right) = 129.03\,KN$

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

$= 61.5\,KN.$

For C



$V_c = w l/2 = V_D$

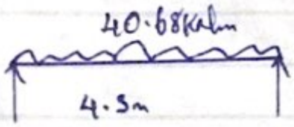
$= \frac{42.34 \times 4.5}{2} = 95.27KN.$

$V_{CD} = 95.27 + \left(\frac{69.06 + 72.06}{4.5}\right) = 126.63KN.$

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

$= 63.9KN.$

For D



$V_D' = wl/2 = V_E$

$= \frac{40.68 \times 4.3}{2} = 87.46KN.$

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

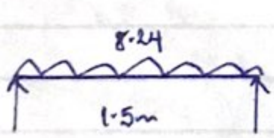
$= 87.46 - \left(\frac{72.06 + 45.47}{4.3}\right) = 60.13KN$

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

$= (40.68 \times 4.3) - 60.13$

$= 114.74KN.$

For E



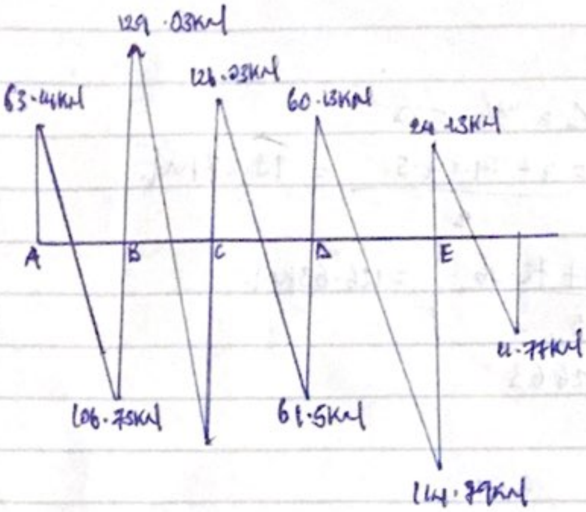
$V_E' = \frac{wl}{2} = V_B'$

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

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

$V_{A'E} = (8.24 \times 1.5) - 24.13$

$= 11.77KN.$



Question 2

Base design

$M = 1200KN$

Strength = 25 - 410N/mm²

$F_b = 105$ KN/m²

Area of base = $\frac{M \times 1.1}{\lambda \times F_b}$ $\lambda = 1.46$

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

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

Net pressure, $F_{net} = \frac{M \times 1.1}{\beta} = \frac{1200 \times 1.1}{2.5}$

$= 24 \times 0.660 \times 1.4$

$= 505.824 KN/m$

Moment, $M = \frac{F_{net} C}{2}$ where $C = \frac{1}{2}(B - h)\beta$ depth of base = 660

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

$m = \frac{505.824 \times 1.14^2}{2} = 328.68 KN/m$

$d = h - cover - \frac{1}{2}\phi = 660 - 50 - 10 = 600mm.$

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

$Z_{cu} = 0.5 + \sqrt{0.25 + \frac{0.037}{0.9}} - 0.96 \geq 0.95$

$= 0.95 \times 600 = 570mm$

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

Provide Y25 @ 300 c/c (1640)

Colum size = 225 x 450mm

Ren fy = 25 - 410 mm

Area Footing = $6.027m^2$

Size of loading = 2500x2500

q = Net pressure = 505.824 KN/m

depth = 600

critical section, $\frac{d}{2} = 300$

300 + 300 + 225 = 825mm

300 + 300 + 450 = 1050mm

Shear force $V_n = q_n \times$ [Area of footing - (0.3 + d)]

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

$V_n = 2751.68$

Normal shear stress $I_v = V_n / bd$

b = Parameter of critical section

d = affective span / depth

$I_v = \frac{2751.68 \times 10^3}{(2 \times (825) + 2(1050) \times 600)}$

$I_v = 1.223 N/mm^2$

Permissible shear stress

$\tau_c' = K_s \times \tau_c$

$K_s = (0.5 + \beta_c)$ but not greater than 1

β_c = Ratio of shorter to longer 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 F_o with actual size of footing.

Unit weight of Concrete = 24 KN/mm²

Unit weight of soil = 1.091×10^{-6} KN/mm²

Actual Pressure footing below

$q = (1200 \times 2.5 \times 2.5) + (24 \times 0.660) + (1.09 \times 10^{6} \times 0.66)$

$q = 214.94 KN/m^2$