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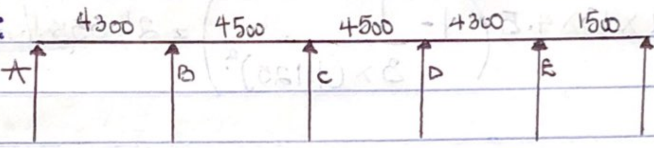
MATRIC NUMBER: 17/ENG03/059

ASSIGNMENT TITLE: ASSIGNMENT 2 BEAM

COURSE TITLE: STRUCTURAL DESIGN 1

COURSE CODE: CVE 308

QUESTION 1:



Assuming thickness: 150mm

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

$F_y = 410N/mm^2$

Slab loading

Slab weight = 0.15×24 = 36KN/m²

Partition = 1.0KN/m²

Finishes = 1.2KN/m²

Total G.K 5.8KN/m²

DL = 1.4(5.8) + 1.6(8.0) = 13KN/m²

Beam loading

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

Finishes = 1.2KN/m²

Wall load = 3×3.47 = 10.41KN/m²

Total G.K = 14.85

D.L = 14(14.85) = 20.79KN/m³

Slab load on beam in longer direction

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

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

$\frac{4300}{4000} = 1.075$, $\frac{1}{2} \times 13 \times 4.3 \left(1 - \frac{1}{3 \times (1.075)^2}\right) = 19.89 KN/m^2$

$\frac{4500}{4000} = 1.125$, $\frac{1}{2} \times 13 \times 4.5 \left(1 - \frac{1}{3 \times (1.125)^2}\right) = 21.55 KN/m^2$

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

$= \frac{1}{3} \times 13 \times 1.5$

$= 6.5 KN/m^2$

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

$K_{AB} = 1$

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

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

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

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

$K_{DC} = 0.49$

$K_{DE} = 0.51$

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

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

$K_{A'E} = 1$

F.E.M

$UDL = \frac{\omega L^2}{12}$

1.) $\frac{40.68 \times 4.3^2}{12} = 62.68$ kN/m

2.) $\frac{42.34 \times 45^2}{12} = 71.45$ 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'	
D.F	0	1	0.51	0.49	0.5	0.5	0.49	0.51	0.26	0.79	1	0
FEM		-62.68	62.68	-71.45	71.45	-71.45	71.45	-62.68	62.68	5.1	5.1	
OBM	-62.68		-8.77		0	0	8.77		57.58		-5.1	
DM	-62.68		8.77		0		8.77		-57.58		5.1	
TM	0	62.68	4.97	4.30	0	0	-4.30	-4.41	-14.98	-42.61	-51	0
		2.235	31.34	0	2.15	-2.15	0	-2.49	-2.24	-2.55	-21.30	
OBM	2.235		81.34		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	1.25	8.54	21.31	0
TM		-7.99	-1.12	0	-7.69	1.84	0	0.69	1.41	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	0.32	-3.27	-9.29	-1.77	0
TM		0.29	3.40	1.42	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	-248	-2.39	-0.06	-0.06	0.09	-0.09	0.27	0.78	4.66	0
Σ		0	22.88	-82.88	69.05	-69.05	72.66	-72.06	4546	-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 UDL $= \frac{WL^2}{8}$

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

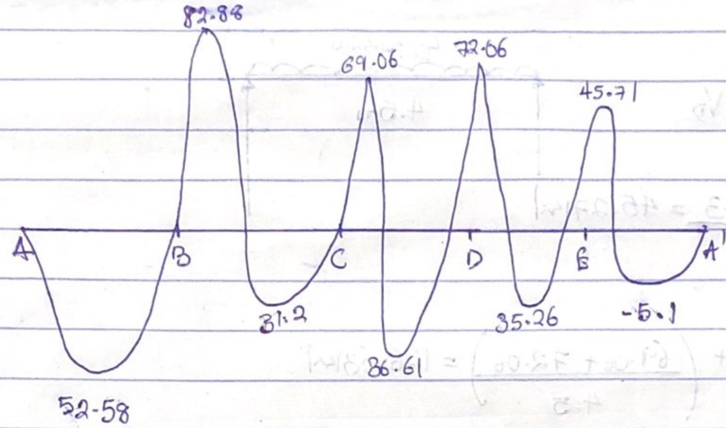
$M_{AB} = M^F - \left(\frac{M_A + M_B}{2}\right) = 94.02 - \left(\frac{0 + 82.88}{2}\right) = 52.58 KN/m$

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

$M_{CD} = M^F - \left(\frac{M_C + M_D}{2}\right) = 107.17 - \left(\frac{69.06 + 12.06}{2}\right) = 36.61 KN/m$

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

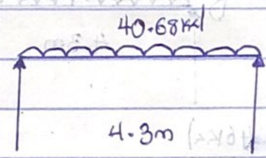
$M_{EA'} = M^F - \left(\frac{M_B + M_{A'}}{2}\right) = 8.68 - \left(\frac{45.47 + 0}{2}\right) = -15.1 KN$



B.M.D

Shear Force

For A



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

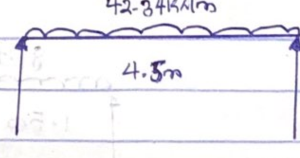
$= \frac{40.68 \times 4.2}{2} = 87.462kN$

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

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

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

For B



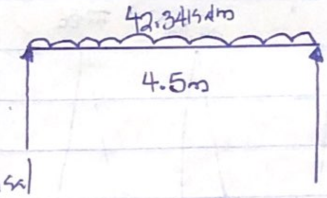
$V_B' = \frac{wL}{2} = V_C$

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

$V_{BC} = V_B + \left(\frac{M_B + M_C}{L}\right) = 95.27 + \left(\frac{82.68 + 69.06}{4.5}\right)$

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

For C

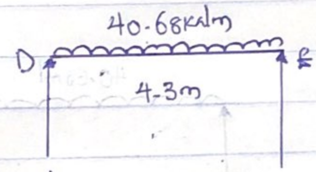


$V_C' = \frac{wL}{2} = V_D$

$= \frac{42.34 \times 4.3}{2} = 45.27kN$

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

For D



$V_D' = \frac{wL}{2} = V_E$

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

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

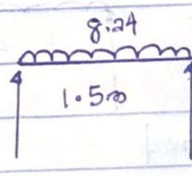
$= 87.46 - \left(\frac{72.06 + 45.47}{4.3}\right) = 60.18kN$

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

$= (40.68 \times 4.3) - 60.13$

$= 114.79kN$

For E

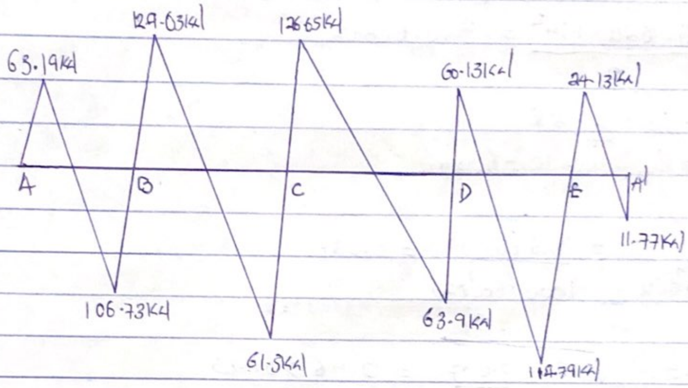


$V_E' = \frac{wL}{2} = V_E'$

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

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

$V_{A'E} = (8.24 \times 1.5) - 24.13$
$= 11.77\,kN$



Question2

Base design
M = 1200kN
Strength = 25-41kN/mm²
F_b = 150kN/m²

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

$\frac{1200 \times 1.1}{1.46 \times 180} = 6.027m^2$

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

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

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

$= 505.804kN/m$

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

where $L = \frac{1}{2}(B-h)$ and = depth of base = 660

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

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

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

$= 660 - 50 - 10 = 600mm$

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

$R_a = 0.5 + \sqrt{0.25 + \frac{0.037}{0.9}} = 0.96 > 0.95$

$Z = I_a d = 0.95 \times 600 = 570mm$

$A_s = \frac{M}{0.95 f_y z} = \frac{328.68 \times 10^6}{0.95 \times 410 \times 510} = 1480.44mm^2$

Provide Y25 @ 300c/c (1640)

Punching shear

column size = 225 x 450mm

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

Area footing = $6.027m^2$

Size of footing = 2500 x 2500

q^2, Net pressure = 505.824 kN/m

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

300 + 300 + 225 = 825mm

300 + 300 + 450 = 1050mm

Shear force $V_a = q_u \times$ (Area of loading $- (0.3+d)$]
$= 505.824\,[2.5\times2.5 - (0.3+0.6)^2$
$V_a = 2751.6844$

Normal shear stress $\tau_v = \frac{V_a}{bd}$

b = Parameter of critical section, d = effective pan or depth

$\tau_v = \frac{2751.68\times10^3}{[(2\times(825)+2(1050))\times600]}$

$\tau_v = 1.223N/mm^2$

Permisible sheer 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 larger side of columns

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

$K_s = 1$

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

$\tau_v = 1.223N/mm^2$

$\tau_v \leq \tau_v'$

∴ Hence depth assumed is ok

checking for fb with actual size of loading

unit weight of concrete = $24kN/mm^2$

unit weight of soil = $1.091\times10^{-6}kN/mm$

Actual pressure loading below;

$q = (1200\times2.5\times2.5) + (24\times0.660)$

$q = 214.94kN/m^3$