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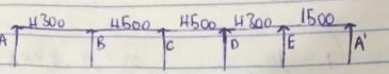
Assignment 2. Q.4.1



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 = 1.2KN/m²
Total G.K = 5.8KN/m²

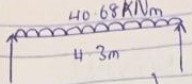
D.L = 1.4(5.8) + 1.6(3.0) = 13KN/m²

Beam loading
Self wt of beam = 0.225 × 0.6 × 24 = 5.24 KN/m²
finishes = 1.2KN/m²
wall load = 3 × 3.47 = 10.41KN/m²
Total G.K = 14.85

D.L = 1.4(14.85) = 20.79 KN/m²

Shear Force

For A



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

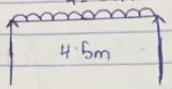
$= \frac{40.68 \times 4.3}{2} = 87.462\,KN$

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

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

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

For B



$V_{BC} = \frac{wL}{2} = V_C$

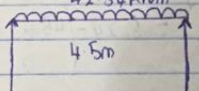
$= \frac{42.34 \times 4.5}{2} = 95.27\,KN$

$V_{BC} = V_B + \left(\frac{M_B + M_C}{L}\right) = 95.27 + \left(\frac{82.68 + 69.06}{4.5}\right) = 129.03\,KN$

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

$= 61.5\,KN$

For C



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

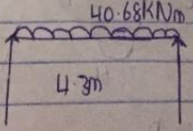
$= \frac{42.34 \times 4.5}{2} = 95.27\,KN$

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

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

$= 63.19\,KN$

For D



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

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

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

$K_{DC} = 0.49$

$K_{DE} = 0.51$

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

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

$K_{A'E} = 1$

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

Fixed Moments

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) $\frac{27.29 \times 1.5^2}{8} = 8.24\ KN/m^2$

Span moment

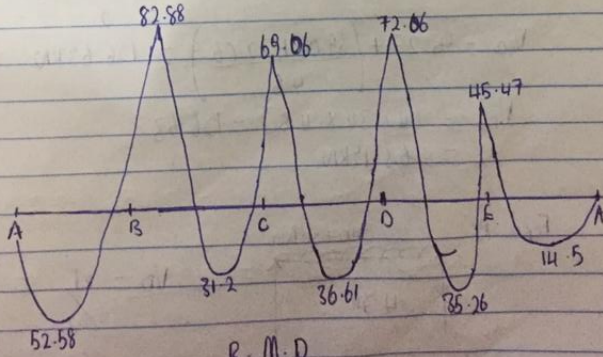
$M_{AB} = M^F - \left(\frac{M_A + M_B}{2}\right) = 94.02 - \left(\frac{0 + 82.88}{2}\right) = 52.58\ KNm$

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

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

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

$M_{EA'} = M^F - \left(\frac{M_E + M_{A'}}{2}\right) = 8.24 - \left(\frac{45.47 + 0}{2}\right) = -14.5\ KNm$



B.M.D

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

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

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

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

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

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

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

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

Total load $= 19.89 + 20.79 = 40.68 KN/m$

$= 21.55 + 20.79 = 42.34 KN/m$

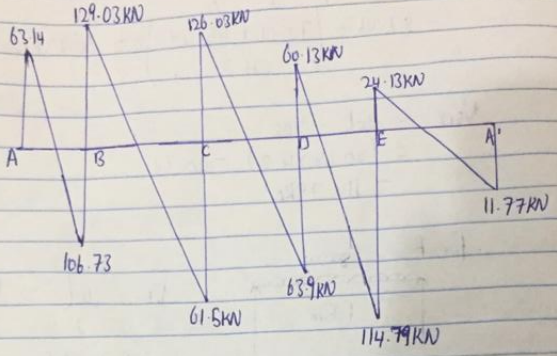
$= 6.5 + 20.79 = 27.29 KN/m$

Distribution factor

$K_{BS} = 1$

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

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



No 2

Raft design

$N = 1200\,KN$

Strength $= 25 - 41\,N/mm^2$

$F_b = 150\,KN/m^2$

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

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

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

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

$K_s = (0.5 + \beta_c)$ but not greater than 1
β_c = Ratio of shorter to larger side of column
$T_c = 0.25\sqrt{f_{cu}}$
$K_s = 1$

$T_c = 0.25\sqrt{25} = 1.25\ N/mm^2$
$T_v = 1.223\ N/mm^2$
$T_v \leq T_v$

Hence depth assumed is OK ✓

Checking for R_b with actual size of footing
Unit weight of concrete = $24\ KN/mm^2$
Unit of of soil = $1.091 \times 10^{-6}\ KN/mm^2$

Actual pressure footing below

$q = (1200 \times 2.5 \times 2.5) + (24 \times 0.660) + (1.091 \times 10^{-6} \times 0.66)$

$q = 214.94\ KN/m^2$

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

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

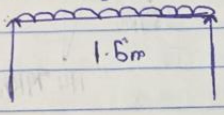
$= 87.46 - \left(\frac{72.06 + 45.47}{4.3}\right) = 60.13\,KN$

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

$= (40.68 \times 4.3) - 60.13$

$= 114.79\,KN$

for E



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

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

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

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

$= 11.77\,KN$

Punching shear

Column Size = 225 x 450mm

Beauty = 25-410mm

Area Footing = 6.027m²

Size of footing = 2500 x 2500

q^3, Net pressure = 505.824 KN/m

depth = 600

critical section, $d/2$ = 300

300 + 300 + 225 = 825mm

300 + 300 + 450 = 1050mm

Shear force $V_n = q_n \times [\text{Area of footing} - (0.3+d)(0.3+0.6)]$

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

$V_n = 2751.68N$

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

b = perimeter of critical section

d = effective depth

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

$\tau_v = 1.223 N/mm^2$

Permissible Shear Stress

$\tau c' = Ks \times \tau c$

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

$= 505.824 kNm$

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

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

$ = depth of base = 660

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

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

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

$= 660 - 50 - 10 = 600mm$

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

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

$z = R = 0.95 \times 600 = 570mm$

$A_s = \frac{m}{0.956yz} = \frac{328.68 \times 10^6}{0.95 \times 410 \times 570} = 1480.44mm^2$

Readable Y25 @ 300 c/c (1640)

	A	AB	BA	B	BC	CB	C	CD	DC	D	DE	ED	E	EA'	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	71.45		-71.45	71.45		-62.68	62.68		5.1	5.1	
DBM		-62.68	-8.77			0			8.77		57.58			-5.1		
BM		62.68	8.77			0			-8.77		-57.58			5.1		
DM	0	62.68	4.47	4.30		0	0		-4.30	-4.47	-14.97	-42.61	-5.1		0	
TM		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	1.25	3.54	21.31				
TM		-7.99	-1.12	0		-7.68	1.84	0	0.63	1.91	10.65	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	0.56		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				
Σ	=	0	22.88	-82.88		69.06	-69.06	72.06	-72.06	45.47	-45.46	0				

Moments

$M_A = 0 KNm$

$M_B = 82.88 KNm$

$M_C = 69.06 KNm$

$M_D = 72.06 KNm$

$M_E = 45.47 KNm$

$M_{A'} = 0 KNm$