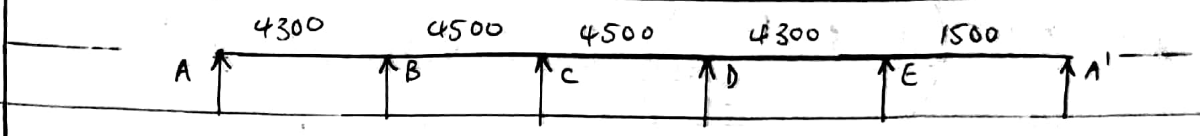
Mkpouto Ubong Obot
Civil Engineering
17/ENG03/015

Q1



Assuming thickness ; 150mm
$f_{cu} = 25 N/mm^2$
$f_y = 410 N/mm^2$

Slab loading
Slab weight = $0.15 \times 24 = 3.6 kN/m^2$
Partition = $10 kN/m^2$
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 wt of beam = $0.225 \times 0.6 \times 245 \cdot 24 kN/m^2$
finishes = $1.2 kN/m^2$
Wall load = $3 \times 3.47 = 10.41 kN/m^2$
Total G.K = 14.85

$D.L = 14(14.85) = 20.79 kN/m^2$
Slab load on beam in longer duration = $\frac{1}{2} u d x (1 - \frac{1}{3}K^2)$
$K = \frac{L_y}{L_x}$
$\frac{4300}{4000} = 1.075$
$\frac{4500}{4000} = 1.125$
$\frac{1}{2} \times 13 \times 4.3 \left(1 - \frac{1}{3} \times (1.075)^2\right) = 19.89 kN/m^2$

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

Slab beam 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 $= 19.89 + 20.79 = 40.68 kN/m$

$= 21.55 + 20.79 = 42.34 kN/m$

$= 6.54 + 20.79 = 27.29 kN/m$

Distribution factor

$K_{AB} = 1$

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

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

$K_{CB} = \frac{\frac{1}{4.5}}{\frac{1}{4.5} + \frac{1}{1.5}} = 0.26$

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

~~KA'C = 1 - 0.26 = 0.79~~

$K_{A'E} = 1$

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

	A	AB	BA	BC	CB	CD	DC	DE	ED	EA	AE	A'
	A		B		C		D		F		A'	
D.F	0	1	0.51	0.44	0.5	0.5	0.49	0.51		0.24	1	0
FEM		-62.68	62.68	11.45	71.45	-71.45	71.45	-62.68		5.1	5.1	
OBM	-62.68		-8.77		0		8.77			5.8	-5.1	
BM	62.68		8.77		0		-8.77			5.8	5.1	
DM	0	62.68	4.47	4.30	0	0	-4.30	-4.47	14.98	-4.61	-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	
DM	-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	21.3	0
TM		-7.99	-1.12	0	-7.69		0	0.625	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		-1.71	
DM	0	7.99	0.57	0.55	2.93	2.94	-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	
BM	0	0.29	-2.48	-2.39	-0.06	0.06	0.0	0.09	0.27	0.78	4.65	0
	=	0	22.88	-82.88	69.06	-69.05	72.06	-72.06	45.46	-45.46	0	

Moments

$M_a = 0KNm$

$M_b = 82.88KNm$

$M_c = 69.06kNm$

$M_D = 72.06kNm$

$M_E = 45.47KNm$

$M_{A'} = 0KNm$

Free moment

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

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

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

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

Span moment

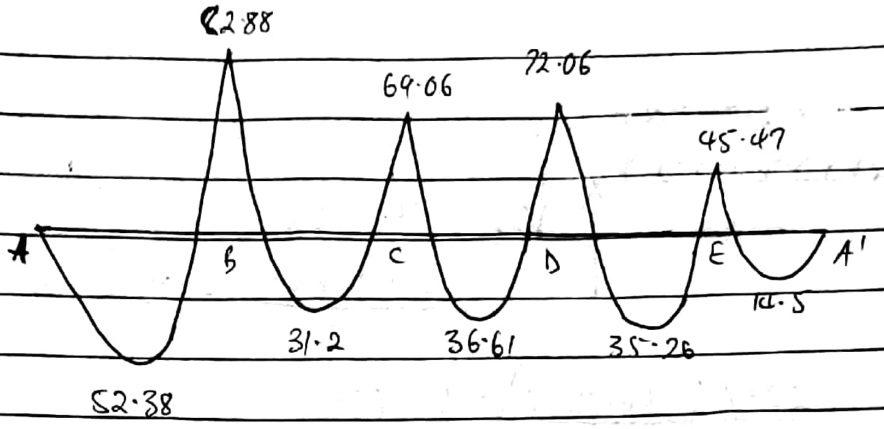
$M_{AB} = M - \left(\frac{M_A + M_B}{2}\right) = 94.02 - \left(\frac{0 + 82.88}{2}\right) = 52.58\,KNm$

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

$M_{CD} = M - \left(\frac{M_C + M_D}{2}\right) = 107.17 - \left(\frac{69.06 + 12.06}{2}\right) = 36.6KNm$

$M_{DE} = M - \left(\frac{M_D + M_E}{2}\right) = 94.02 - \left(\frac{12.06 + 45.47}{2}\right) = 35.26KNm$

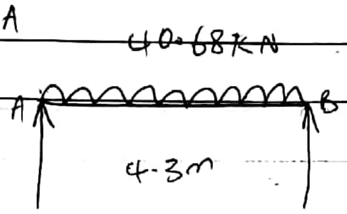
$M_{EA'} = M' - \left(\frac{M_E + M_{A'}}{2}\right) = 8.24 - \left(\frac{45.47 + 0}{2}\right) = -14.5KNm$



B.M.D

Shear force

for A



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

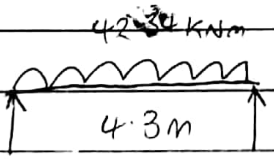
$= \frac{40.68 \times 4.3}{2} = 87.462KN$

$V_{AB} = V_a + \left(\frac{M_A - M_B}{L}\right) = 87.462 + \left(\frac{0.8288}{4.3}\right) = 68.19$

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

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

for B



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

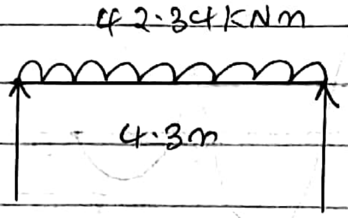
$= \frac{42.34 \times 4.5}{2} = 95.27KN$

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

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

$= 61.5KN$

for C



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

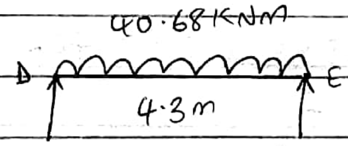
$= \frac{42.34 \times 4.5}{2} = 95.27KN$

$V_{CD} = 95.27 + \left(\frac{69.06 + 72.6}{4.5}\right) = 126.63KN$

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

$= 63.19KN$

for D



$V_{8'} = \frac{wl}{2} = V_E$

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

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

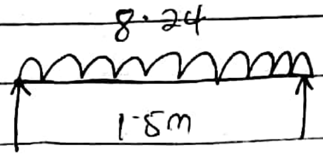
$= 87.46 - \left(\frac{72.06 + 45.47}{4.3}\right) = 60.13KN$

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

$= (40.68 \times 4.3) - 60.13$

$= 114.79 KN$

for E



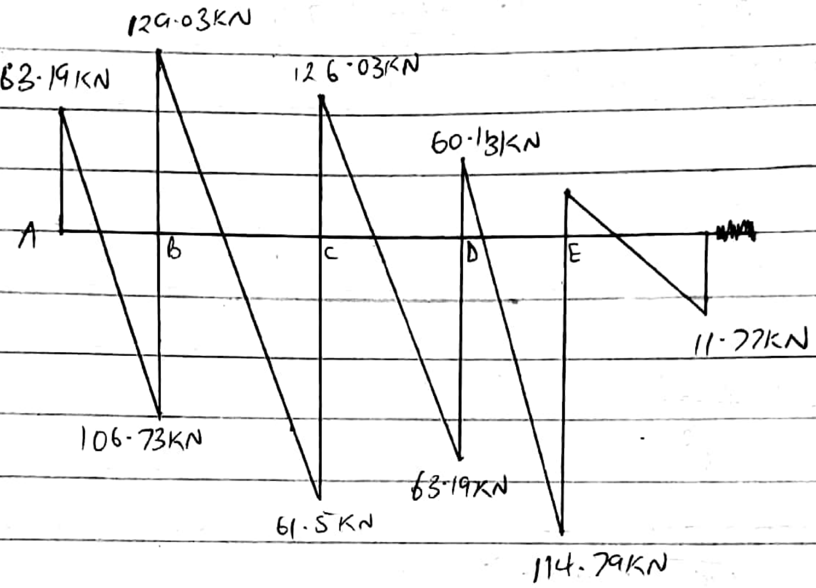
$V_E = \frac{wl}{2} = V_{A'}$

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

$V_{EA'} = V_A - \left(\frac{M_E + M_{A'}}{L}\right) = 6.18 - \left(\frac{45.42 + 0}{1.5}\right) = 24.13KN$

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

$= 11.77KN$



Q2 Base design

N = 1200KN

~~Strength~~ = 25 - 410 N/m²

f_b = 150KN/m²

Area of base req = $\frac{N \times 1.1}{\lambda \times f_2}$ $\lambda = 1.46$

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

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

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

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

= 505.84KNM

moment, $M = \frac{F_{net} l^2}{2}$

where $l = \frac{1}{2}(6 - h)$ $ = depth of base = 660

$L = \frac{1}{2}(2.5 - 0.225) = 1.638 \simeq 1.74m$

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

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

$= 660 - 50 - 10 = 600mm$

$K = \frac{M}{bd^2 k_u} = \frac{328.68 \times 10^6}{1000 \times 600^2 \times 25} = 0.032$

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

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

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

Provide Y25 @ 300 c/c (1640)

Punching Shear

Column size = 225 x 450mm

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

Area footing = $6.027m^2$

size of footing = 2800 x 2500

q^2, Net Pressure = 505.824KNM

depth = 600

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

300 + 300 + 225 = 825m
300 + 300 + 450 = 1050mm

Shear force $V_B = q_n \times [\text{Area of footing} - (0.3 + d)^2]$

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

$V_n = 2751.68$

Normal Shear Stress $T_v = \frac{V_n}{bd}$

b = Peremeter of Critical section
d = effective Span depth

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

$T_v = 1.223 N/mm^2$

Permissible Shear Stress

$T_c' = K_s \times T_c$

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

β_c = Ratio or ~~Sm~~ Shorter to larger side of colums

$T.C = 0.25 \sqrt{f_{ak}}$

K = 1

$T_c' = 0.25 \sqrt{25} = 1.25 N/m^2$

$T_v = 1.223 N/mm^2$

$T_v \leq T_v$

Hence depth assumed is OK ✓

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

- Actual pressure footing below

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

$q_r = 214.94 \, kN/m^2$