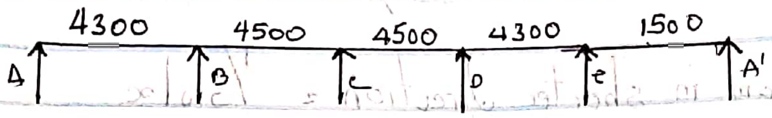
Okiemute Waterway
17/ENG03/056
Civil Engineering
Assignment 2

1)



Assuming thickness = 150mm

f_{cu} = 25 N/mm²

f_y = 410 N/mm²

Slab loading

Slab weight = 0.15 × 24 = 3.6 kN/m²

Partition = 1.0 kN/m²

Finishes = 1.2 kN/m²

Gk = 5.8 kN/m²

D.L = 1.4(5.8) + 1.6(3.0) = 13 kN/m²

Beam loading

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

Finishes = 1.2 kN/m²

Wall load = 3 × 3.47 = 10.41 kN/m²

∴ Gk 14.85

DL = 1.4 (14.85) = 20.79 kN/m²

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

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

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

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

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

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

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

$K_{AB} = 1$

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

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

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

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

$K_{DC} = 0.49$

$K_{DE} = 0.51$

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

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

$K_{A'E} = 1$

FEM

UDL $= \frac{wl^2}{12}$

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

Scanned with CamScanner

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'
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	
OBM	-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	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	-0.32	-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	0.08	0.09	0.27	0.78	4.65	0
Σ		0	22.88	-82.88	69.06	-69.05	~~72.06~~ 72.06	-72.06	[illegible] 45.47	-45.46	0	

Moments

$M_a = 0\,kN/m$

$M_b = 82.88\,kN/m$

$M_c = 69.06\,kN/m$

$M_d = 72.06\,kN/m$

$M_e = 45.47\,kN/m$

$\therefore M_{a'} = 0\,kN/m$

Free moment

For UDL $= \frac{wL^2}{8}$

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

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

3) $\frac{27.29 \times 1.5^2}{8} =$ ~~8.24 kN/m²~~ $7.68 kN/m^2$

Span Moment

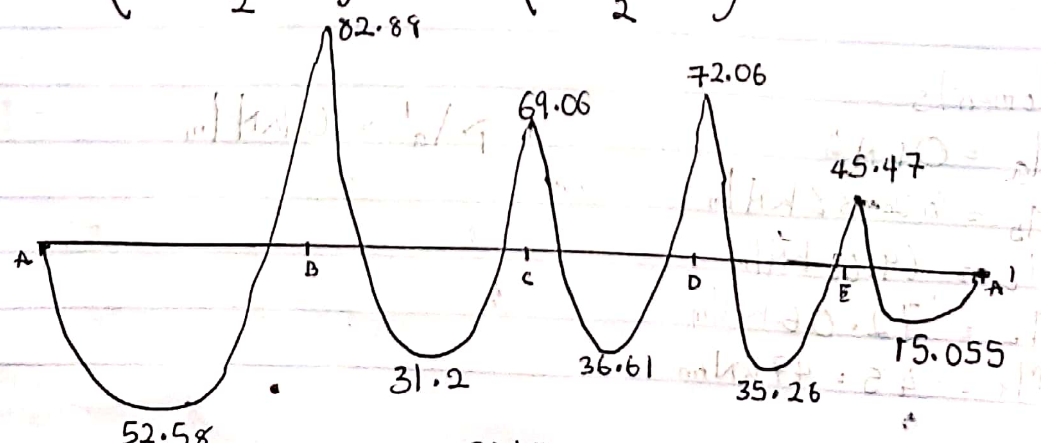
$M_{AB} = M^F - \left(\frac{M_A + M_B}{2}\right) = 94.02 - \left(\frac{0 + 82.88}{2}\right) = 52.58 kNm$

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

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

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

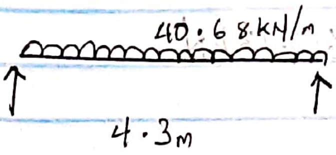
$M_{EA'} = M^F - \left(\frac{M_E + M_{A'}}{2}\right) = 7.68 - \left(\frac{45.47 + 0}{2}\right) = -15.055$



BMD

Shear force

For A



$V_A = wl/2 = V_B$

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

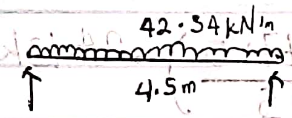
$V_{AB} = V_a + \left(\frac{M_A - M_B}{L}\right) = 87.462 + \left(\frac{0 - 82.88}{4.3}\right)$

$= 68.19$

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

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

For B



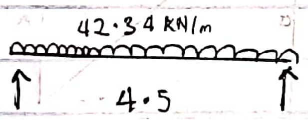
$V_B' = wl/2 = V_c = \frac{42.34 \times 4.5}{2} = 95.271\ kN$

$V_{BC} = V_B \pm \left(\frac{M_a + M_c}{L}\right) = 95.27 + \left(\frac{82.68 + 69.06}{4.5}\right) = 129.03$

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

$= 61.5\ kN$

For C



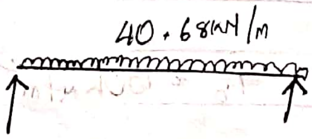
$V_c' = wl/2 = V_D \quad \frac{42.34 \times 4.5}{2} = 95.27$

$V_{CD} = 95.27 + \left(\frac{69.06 + 72.06}{4.5}\right) = ~~129.0~~\ 126.63\ kN$

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

$= 63.9\ kN$

For D



$V_D' = wl/2 = V_E$

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

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

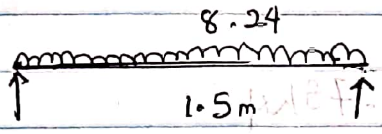
$$= 87.46 - \left(\frac{72.06 + 45.47}{4.3}\right) = 60.13\,kN$$

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

$$= (40.68 \times 4.3) - 60.13$$

$$= 114.794\,kN$$

For F



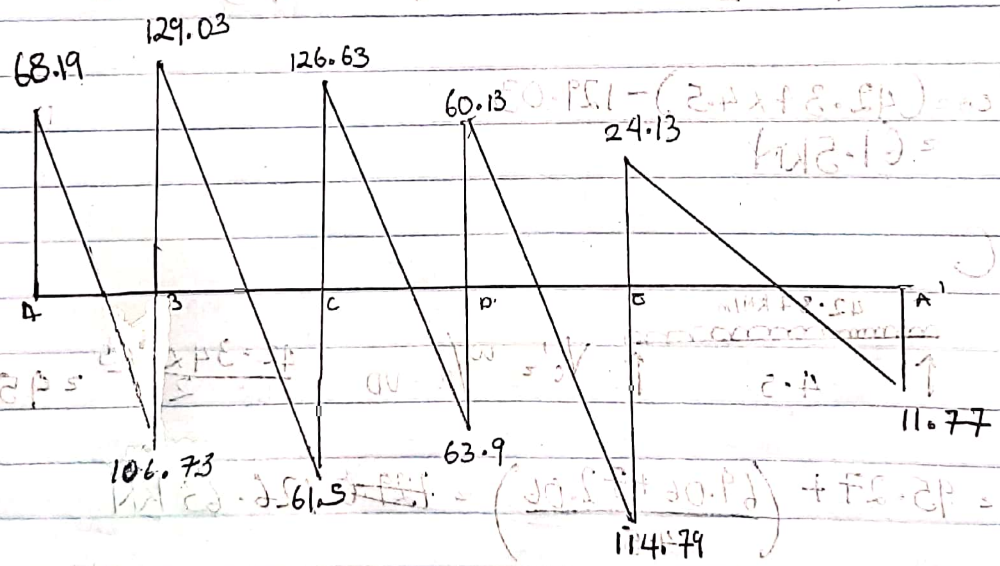
$$V_{E'} = \frac{wl}{2} = V_{A'}$$

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

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

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

$$= 11.77\,kN$$



No 2

Base Design

$N = 1200\,kN$

$f_b = 150\,kN/m^2$

strength = 25 - 410 N/mm^2

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

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

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

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

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

$= 505.824 kNm$

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

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

$L = \frac{1}{2}(2.5 - 0.225) = 1.1375 \approx 1.14 m$

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

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

$= 660 - 50 - 10 = 600mm$

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

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

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

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

Provide Y25 @ 300 c/c (1640)

Punching shear

Column size = 225 x 450 mm

f_{cu} f_y = 25 - 410 mm

Area footing = $6.027 m^2$

Size of footing = 2500 x 2000

q_s = Net pressure = 508.824 kN/m

Depth = 600

Critical section, $d/2 = 300$

$300 + 300 + 225 = 825 mm$

$300 + 300 + 450 = 1050 mm$

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

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

V_A = ~~3160.59~~ ~~2751.68~~ 2751.68

Normal shear stress $\tau_v = V_n / bd$

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

$\tau_v = 1.223 N/mm^2$

$\tau_c' = k_s \times \tau_c$

$k_s = (0.5 + \beta_c)$ 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 f_b with actual size of footing

Unit weight of concrete = 24 kN/mm^2

Unit weight of soil = 1.091×10^{-6} kN/mm^2

Actual pressure footing below

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

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