Assignment 2

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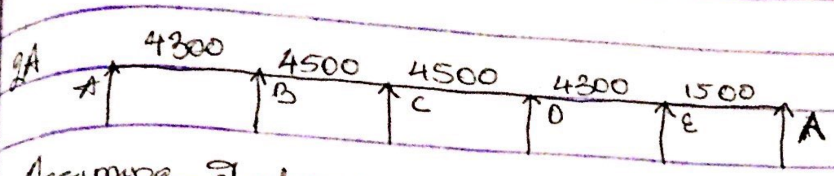
17/ENG03/005
Civil Engineering

2A



Assuming thickness = 150 mm

Fcu = 25N/mm²

fy = 410 N/mm²

Slab loading

Slab weight = 0·15 × 24 = 3·6 kN/m²

Partition = 1·0 kN/m²

Finishes = 1·2 kN/m²

Total 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 × ... = ...41 kN/m²

Total Gk = 14·85

D·L = 1·4(14·85) = 20·79 kN/m²

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

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

$\frac{4300}{4000} = 1·075$

$\frac{4500}{4000} = 1·125$

$1·6 \quad \frac{1}{2} \times 13 \times (1 - \frac{1}{3(1·075)^2}) = 19·89 \text{ kN/m}^2$

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

Slab load on beam in shorter direction = 1/3 wlx

= 1/3 × 13 × 1.5 = 6.5 kN/m²

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

$K_{AB} = 1$

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

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

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

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

$K_{DC} = 0.49$

$K_{DE} = 0.51$

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

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

$K_{AE} = 1$

F.E.M

$UDL = wl^2/12$

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

2) $\frac{42.2 \times 4.5^2}{12} = 71.45$ kN/m

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

D.F

FEM

OBM

BM

DM

TM

OB

B

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	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	21.3	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	4.68	0
Σ =		0	22.88	-82.88	69.06	-69.05	72.06	-72.06	45.47	-45.46	0	

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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

Fixed moment

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

1) $\frac{40.68 \times 4.5^2}{8} = 94.02 kNm^2$

2) $\frac{42.34 \times 4.5^2}{8} = 107.17 kNm^2$

3) $\frac{27.29 \times 1.5^2}{8}$ = ~~8.24 kNm²~~ ~~224.390 kNm²~~ 7.68 kNm²

Span Moment

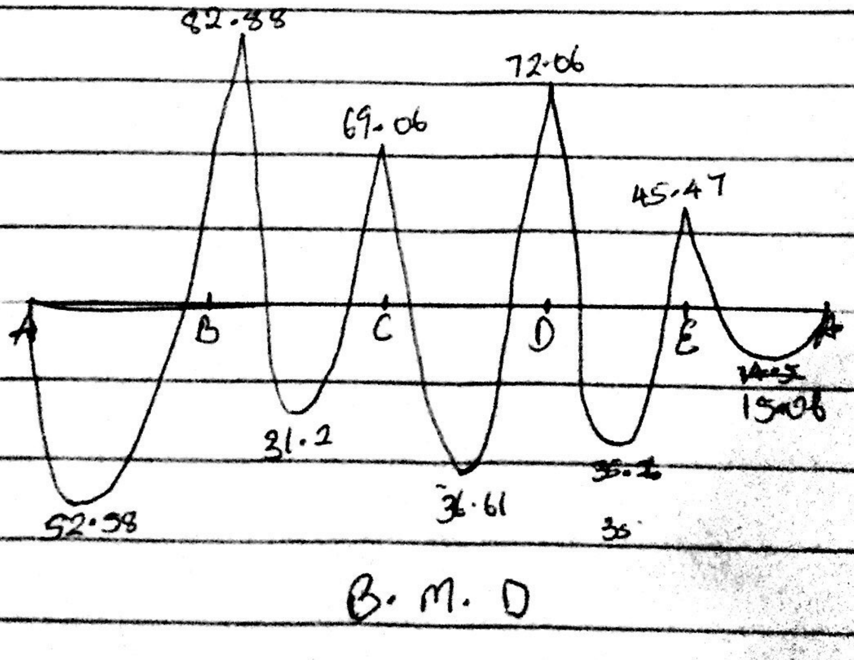
$M_{AB} = M^F - \left(\frac{M_A + M_B}{2}\right) = 94.02 - \left(\frac{0 + 82.88}{2}\right) = 52.58 kNm$

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

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

$M_{DE} = 94.02 - \left(\frac{72.06 + 45.47}{2}\right) = 35.26 kNm$

M_{EA} = ~~224.390~~ ~~8.24~~ 7.68 $- \left(\frac{45.47 + 0}{2}\right)$ = ~~14.5 kNm~~ ~~201.5 kNm~~ 15.055 kNm



B. M. D

Shear

For A

V_{AB}

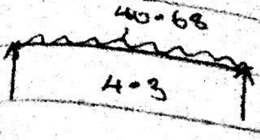
V_{BA}

For B

For

Shear Force

For A



$V_A = wl/2 = V_B$

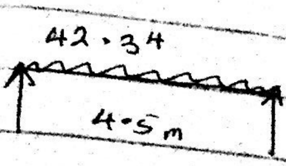
$= \frac{40.68 \times 4.3}{2} = 87.462\,kN$

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

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

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

For B



$V_{BC} = wl/2 = V_C$

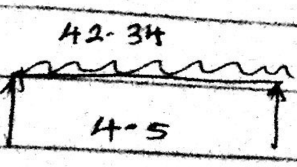
$\frac{42.34 \times 4.5}{2} = 95.27\,kN$

$V_{BC} = V_B + \left(\frac{M_b - M_c}{L}\right) = 95.27 + \left(\frac{82.68 + 69.06}{4.5}\right) = 129.03\,kN$

$V_{CB} = wl - V_{BC}$

$= (42.34 \times 4.5) - 129.03 = 61.5\,kN$

For C



$V_c = wl/2 = V_d$

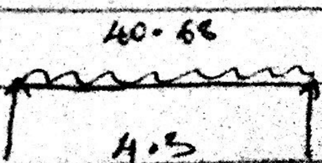
$= \frac{42.34 \times 4.5}{2} = 95.27$

$V_{CD} = V_c + \left(\frac{M_c - M_D}{2}\right) = 95.27 + \left(\frac{69.06 + 72.06}{4.5}\right) = 126.63\,kN$

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

$= 63.90\,kN$

For D



$V_D = wl/2 = V_E$

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

$V_{DE} = V_D - \left(\frac{M_D - M_E}{L}\right) = 87.46 - \left(\frac{72.06 + 45.47}{4.3}\right) = 60.13\,kN$

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

$= (40.68 \times 4.3) - 60.13$

$= 114.79kN$

for E — 8.24 — 1.5

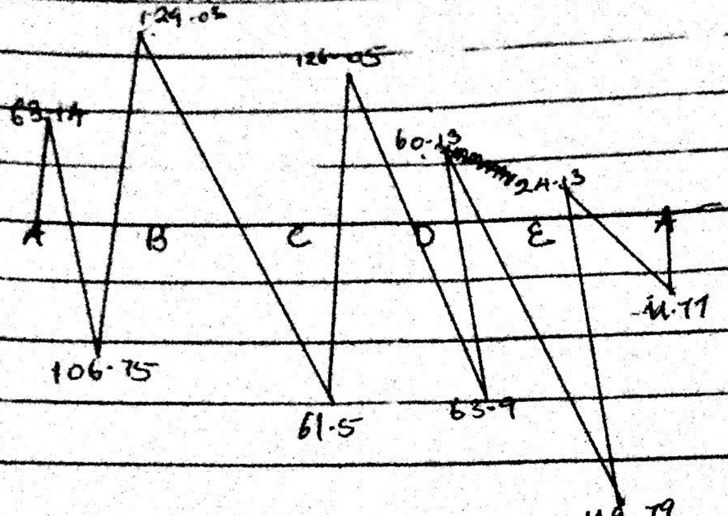
$V_E = \frac{wL}{2}$ V_A

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

$V_{EA} = 6.18 - \left(\frac{45.47+0}{1.5}\right) = 24.13kN$

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

$= 11.77kN$



No 2B)

Base design

N = 1200 kN

Strength = 25 - 410 N/mm^2

Fb = 150 kN/m^2

Area of base = $\frac{N \times 1.1}{\alpha \times Fb}$ $\alpha = 1.46$

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

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

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

$\frac{1200 \times 1.1}{2.5} + [24 \times 0.660 \times 1.4]$

$= 505.824$

Moment, $M = \frac{f_{net} l^2}{2}$ where $l = \frac{1}{2}(B - h)$

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

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

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

$= 660 - 50 - 10 = 600m$

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

$l_a = 0.5 + \sqrt{0.25 - \frac{k}{0.95}} = 0.5 + \sqrt{0.25 - \frac{0.032}{0.95}} = 0.96 > 0.95$

$z = l_a d = 0.95 \times 600 = 570mm$

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

Provide Y25 @ 300 c/c (1640)

Punching Shear

Column Size = 225 × 450mm

$f_{cu} f_y$ = 25 - 400mm

Area footing = 6.027 m^2

Size of footing = 2500 × 2500

q^s, Net pressure = 508.824 kNm

depth = 600

Critical Section, $d/2$ = 300

300 + 300 + 225 = 825 mm

300 + 300 + 450 = 1050mm

Shear Force $V_t = q_n \times$ [Area of footing - $(0.3 \times d)$]

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

$V_a = 2751.684$

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

b = perimeter of critical section

d = effective span depth

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

$\tau_v = 1.223 \, N/mm^2$

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 large side of columns

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

$k_s = 1$

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

$\tau_v = 1.223 \, N/mm^2$

$\tau_v < \tau_c$

Hence depth assumed is Ok

Checking for f_b with actual size of footing

unit weight of concrete = 24 kN/mm²

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

Actual pressure footing below

$q_f = (1200 \times 2.5 \times 2.5) + (24 \times 0.660) + (1.091 \times 10^{6} \times 0.64)$

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

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