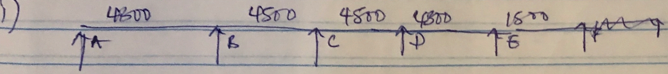
SIMON BOLMEH DION
17/ENG03/051
CIVIL ENGINEERING
STRUCTURAL DESIGN 1
CVE 308

10 MAY, 2020

ASSIGNMENT TWO - BEAM

1)



Assuming thickness = 150mm

F_{cu} = 25N/mm²

F_y = 410N/mm²

Slab Loading

Slab weight = 0.15 × 24 = 3.6kN/m²

partition = 1.0kN/m²

finishes = 1.2kN/m²

Gk = 5.8 kN/m²

DL = 1.4 (5.8) + 1.6(3.0) = 13 kN/m²
(assuming 3.0 for classroom)

Beam Loading

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

Finishes = 1.2kN/m²

wall load = 3 × 3.47 = 10.41 kN/m²

Total G.K = 14.85

D.L = 1.4 (14.85) = 20.79kN/m²

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

$k = l_y / l_x$

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

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

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

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

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

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

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

$f_{AB} = 1$

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

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

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

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

$f_{DC} = 0.49$

$f_{DE} = 0.51$

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

$r_{EA} = 1 - 0.26 = 0.74$
$r_{AE} = 1$

F.E.M

UDL $= wl^2/12$

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

2) $\frac{42.34 \times 4.5^2}{12} = 71.45$ 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	
			0.51	0.475	0.5	0.5	0.47	0.51	0.26	0.74	1	0
D.F	0	1										
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		57.38		-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	-14.4	-14.61	-5.1	0
TM		2.235	31.34	0	21.5	-2.15	0	2.49	-2.21	-2.35	-21	
OBM	22.235		31.34		0		-7.49		-4.79		-21.3	
BM	-2.235		-31.34		0		7.49		4.79		21.3	
DM	0	-2.235	-15.98	-15.86	0	0	3.67	3.82	1.25	3.54	21.3	0
TM		-7.99	-1.12	0	7.49	1.54	0	0.63	1.91	10.86	1.77	
OBM	-7.99		-1.12		-5.58		0.63		12.57		1.77	
BM	7.59		1.12		5.55		-0.63		-12.57		-1.7	
DM	0	7.99	0.57	0.55	2.73	2.75	-0.31	-0.32	-3.27	-9.29	-1.7	0
TM		0.29	3.40	1.44	0.48	-0.16	1.47	-1.64	-0.16	0.57	-4.65	

		0.29									
			4.57								
		-0.29			0.12		-	0.17	7.05	-4.65	
			-4.57		-0.12		0.17		1.05	4.65	
	0	-0.27	-2.48	-2.39	0.02	-0.06	0.036	0.09	0.27	0.28	4.65
		0	27.58	-82.58	69.06	-69.5	72.06	-72.06	45.47	4.46	0

Moments

$M_A = 0\,kN/m$

$M_B = 82.58\,kN/m$

$M_C = 69.06\,kN/m$

$M_D = 72.06\,kN/m$

$M_E = 45.47\,kN/m$

$M_A = 0\,kN/m$

Free moment
for U.D.L $= wl^2/8$

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

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

$$\frac{27.29 \times 1.5^2}{8} = 7.67\,kN/m^2$$

Span moment

$$M_{AB} = M_f - \left(\frac{M_A + A_B}{2}\right) = 94.02 - \left(\frac{0 + 82.58}{2}\right) = 52.58\,k$$

$$M_{BC} = M_f - \left(\frac{M_B + M_C}{2}\right) = 107.17 - \left(\frac{82.58 + 67.06}{2}\right) =$$

$31.2\,kN/m.$

$M_{CD} = M_f - \left(\frac{M_C + M_D}{2}\right) = 107.17 - \left(\frac{69.06 + 72.05}{2}\right)$

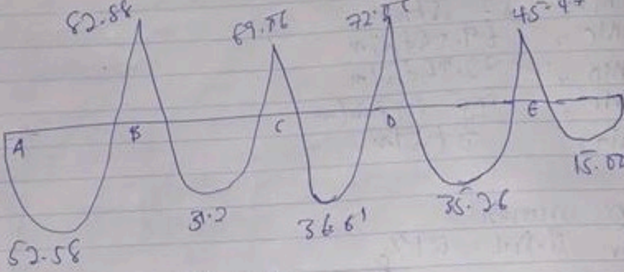
$= 36.61$ kN/m

$M_{DE} = M_f - \left(\frac{M_D + M_E}{2}\right) = 74.02 - \left(\frac{72.56 + 45.47}{2}\right)$

$= 35.26$ kN/m

$M_{EA} = M_f - \left(\frac{M_E + M_F}{2}\right) = 7.67 - \left(\frac{45.47 + 0}{2}\right)$

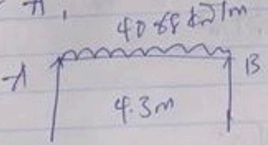
$= -15.05$ kN/m



B.M.D

Shear force

for A,

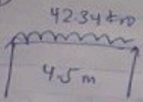


$V_A = \frac{wl}{2} = \frac{40.68 \times 4.3}{2}$

$V_{AB} = V_A + \left(\frac{M_A - M_B}{L}\right) = 87.462 + \left(\frac{0 - 82.58}{4.3}\right) = 68.17$

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

$= (40.68 \times 4.3) - 68.17 = 106.73$ kN for B

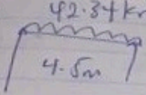


$V_B = \frac{wl}{2} = \frac{42.34 \times 4.5}{2} = 95.27kN$

$V_B = V_B + \left(\frac{M_A + M_B}{L}\right) = 95.27 + \left(\frac{82.88 + 69.06}{4.5}\right) = 129.03kN$

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

for C,

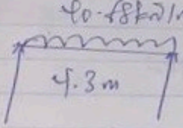


$V_C = \frac{wl}{2} = \frac{42.34 \times 4.5}{2} = 95.27kN$

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

$V_{DC} = (42.34 \times 4.5) - 126.63$
$= 63.19kN$

for D,



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

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

$V_{ED} = wl - V_{DE}$
$= (40.68 \times 4.3) - 60.13$
$= 114.79kN$

30.313

7.67

for E, ~~6.84~~

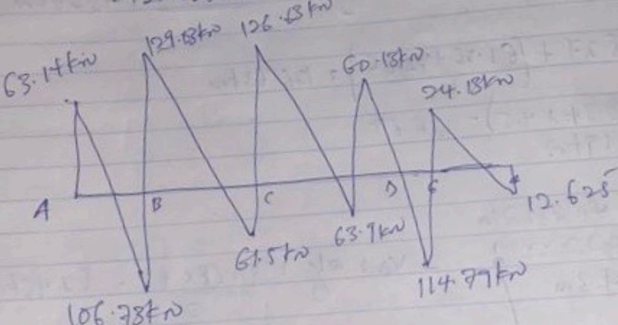
1.5m

$V_E = \frac{wl}{2}$ 7.67

$= \frac{6.84 \times 1.5}{2}$ = ~~6.13kN~~ 5.7525

$V_{EA} = V_E - 6.108 - \left(\frac{45.47 + 0}{1.5}\right)$ = ~~24.13kN~~ 24.56kN
5.7525

$V_{AE} = (7.67 \times 1.5) - 24.13$
11.505 − 24.13
= 12.625kN



Question 2

Base design
N = 1200 kN
Strength = 25 - 460 N/mm^2
fb = 150 kN/m^2

Area of base say = $\frac{N \times 1.1}{\gamma \times f_b}$ γ = 1.46

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

$\sqrt{6.027}$ = 2.45 m ≃ 2.5 m

Net pressure, Fnet = $\frac{N \times 1.4}{B}$

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

= 585.824 kN m

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

Where l = ½ (B - h) $ depth of base = 66

L = ½ (2.5 - 0.225) = 1.678 ≃ 1.7 m

m = $\frac{585.824 \times 1.14^2}{2}$ = 328.68 kN m

d = h - cover - ½ φ

= 660 - 50 - 10 = 600 mm

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

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

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

$A_s = \frac{M}{0.95 f_y z} = \frac{328.68 \times 10^6}{0.95 \times 400 \times 570} = 1482.44mm^2$

Provide Y25 @ 300 c/c (1640)

Punching Shear

Column size = 225 × 450mm

fcu - fy = 25 - 410mm

Area footing = 6.027m²

Size of footing = 2500 × 2500

q³, net pressure = 505.824 kN

depth = 600

Critical section, $d/2 = 300$

300 + 300 + 225 = 825mm

300 + 300 + 450 = 1050mm

$V_u = q_u \times$ [Area of footing} $-$ (0.3 + d)]

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

$V_u = 2751.68$

$\tau_v = V_u / b_o d$

b_o = parameter of critical section
d = effective span depth

$$\tau_v = \frac{2751.68 \times 10^3}{(2 \times (525) + 2(1050)) \times 600)}$$

$\tau_v = 1.223$ N/mm²

permissible shear stress

$\tau_c = k_s \times \tau_c$

$k_s = (0.5 + \beta_c) \leq 1 < 1$

β_c = ratio of shorter to longer side of column

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

$k_s = 1$

$\tau_c' = 0.25\sqrt{25} = 1.25$ N/mm²

$\tau_v = 1.223$ N/mm²

$\tau_v \leq \tau_v'$

Here depth assumed is ok

Checking for f_b with actual size of footing

Unit weight of concrete = 24 kN/mm³
Unit weight of soil = 1.091×10^6 kN/mm³

Actual pressure footing below

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

$q = 214.94$ kN/m²