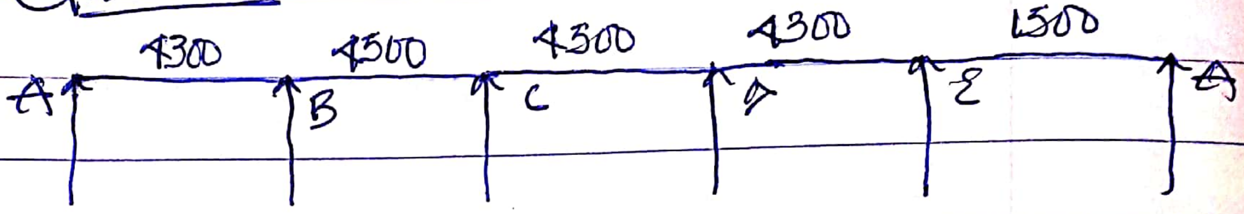
Assignment 2

Question 1



Assuming Thickness ; 150 mm

F_{cu} = 25 N/mm²

F_y = 410 N/mm²

Slab loadings;

Slab weight = 0.15 × 24 = 3.6 KN/m²

Partitions = 1.0 KN/m²

Finishes = 1.2 KN/m²

Total G.K = 5.8 KN/m²

Q.K = 3.0 (Assumed for classroom)

D.L = 1.4(5.8) + 1.6(3.0) = 13 KN/m²

Beam loading;

Self weight of beams = 0.225 × 0.6 × 24 = 5.24 KN/m²

Finishes = 1.2 KN/m²

Wall Load = 3 × 3.47 = KN/m²

Total G.K = 14.85 KN/m²

D.L = 1.4(14.85) = 20.79 KN/m²

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

$K = \frac{l_y}{l_x} = \frac{4300}{4000} = 1.075$

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

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

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

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 = $19.89 + 20.79 = 40.68 \text{ kN/m}^2$

" $= 21.55 + 20.79 = 42.34 \text{ kN/m}^2$

" $= 6.5 + 20.79 = 27.29 \text{ kN/m}^2$

Distribution factor:

$K_{AB} = 1$

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

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

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

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

$K_{AC} = 0.49$

$K_{AE} = 0.51$

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

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

$K_{AE} = 1$

F.E.M :

$$M_{AL} = \frac{wl^2}{12}$$

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

ii) $\frac{42.34 \times 4.5^2}{12} = 71.45$ kN/m

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

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	A		B		C		A		Σ		A	
		AB	BA	BC	CB	CD	AC	AΣ	ΣA	ΣA	AΣ	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		-62.88	-8.77		0		8.77		57.58		-5.1	
BM		62.68	8.77		0		-8.77		-57.38		5.1	
DM	0	62.68	4.47	4.30	0	0	-4.30	-4.47	-14.97	-42.61	-5.1	
TM		2.235	31.34	0	2.15	-2.15	0	-7.49	-2.49	-2.55	-21.31	
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	21.305	0
TM		-7.49	-1.12	0	-7.49	1.64	0	0.63	1.91	10.66	1.77	
OBM		-7.49	-1.12		-3.85		0.63		12.57		1.77	
BM		7.49	1.12		5.85		-0.63		-12.57		-1.77	
DM	0	7.49	0.57	0.55	2.43	2.43	-0.31	-0.32	-3.27	-9.29	-1.77	0
TM		0.24	3.40	1.47	0.28	-0.16	1.47	-1.64	-0.16	-0.87	-4.65	
OBM		0.24	4.57		0.12		-0.17		-1.05		-4.65	
BM		-0.24	-4.57		-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
~~[illegible]~~												
Sum(Σ) =		0	22.88	-82.88	69.05	-69.05	72.06	-72.06	45.46	-45.46	0	

Moments;

$M_A = 0$ KN/m

$M_B = 82.88$ KN/m

$M_C = 69.06$ KN/m

$M_B = 72.06$ KN/m

$M_E = 45.47$ KN/m

$M_A = 0$ KN/m

Free Moment;

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

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

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

iii) $\frac{27.28 \times 1.5^2}{8} = 8.24$ KN/m^2

Span Moment;

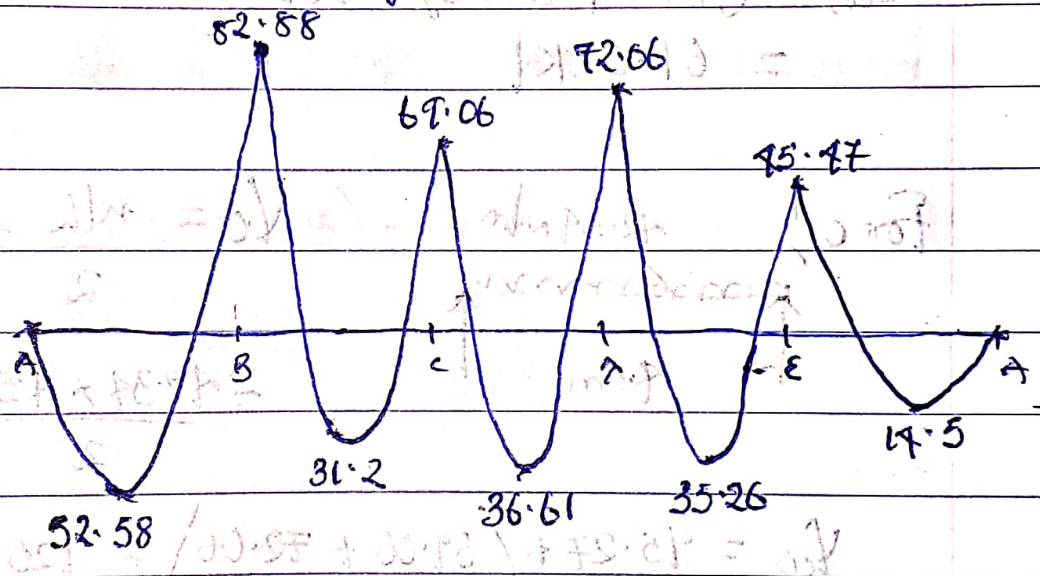
$M_{AB} = M^F - \left(\frac{M_A + M_B}{2}\right) = 94.02 - \left(\frac{0 + 82.88}{2}\right) = 52.58$ KN/m

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

$$M_{CD} = M^F - \left(\frac{M_C + M_D}{2}\right) = 107.17 - \left(\frac{69.09 + 72.06}{2}\right) = 36.61 \text{ kNm}$$

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

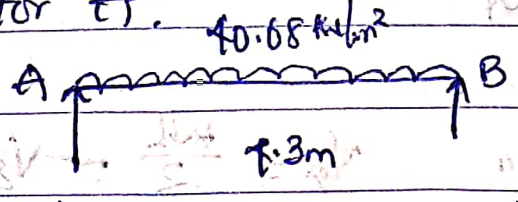
$$M_{EA} = M^F - \left(\frac{M_E + M_A}{2}\right) = 8.24 - \left(\frac{45.47 + 0}{2}\right) = -14.5 \text{ kNm}$$



BMD

Shear Force;

For A:

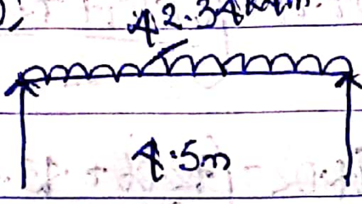


$$V_A = \frac{wL}{2} = V_B = \frac{40.68 \times 4.3}{2} = 87.462 \text{ kN}$$

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

$$V_{BA} = wL - V_{AB}$$
$$= (40.68 \times 4.3) - 68.19 = 106.73 \text{ kN}$$

For B:



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

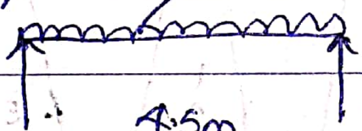
$= \frac{42.34 \times 4.5}{2} = 95.27\ kN$

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

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

$= 61.5\ kN$

For C:



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

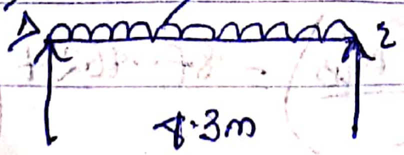
$= \frac{42.34 \times 4.5}{2} = 95.27\ kN$

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

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

$= 63.19\ kN$

For D:



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

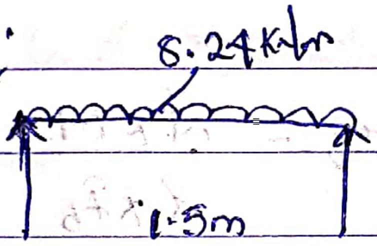
$= \frac{40.68 \times 4.3}{2} = 87.46\ kN$

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

$V_{ED} = (40.68 \times 4.3) - 60.13$

$= 114.79\ kN$

For E;



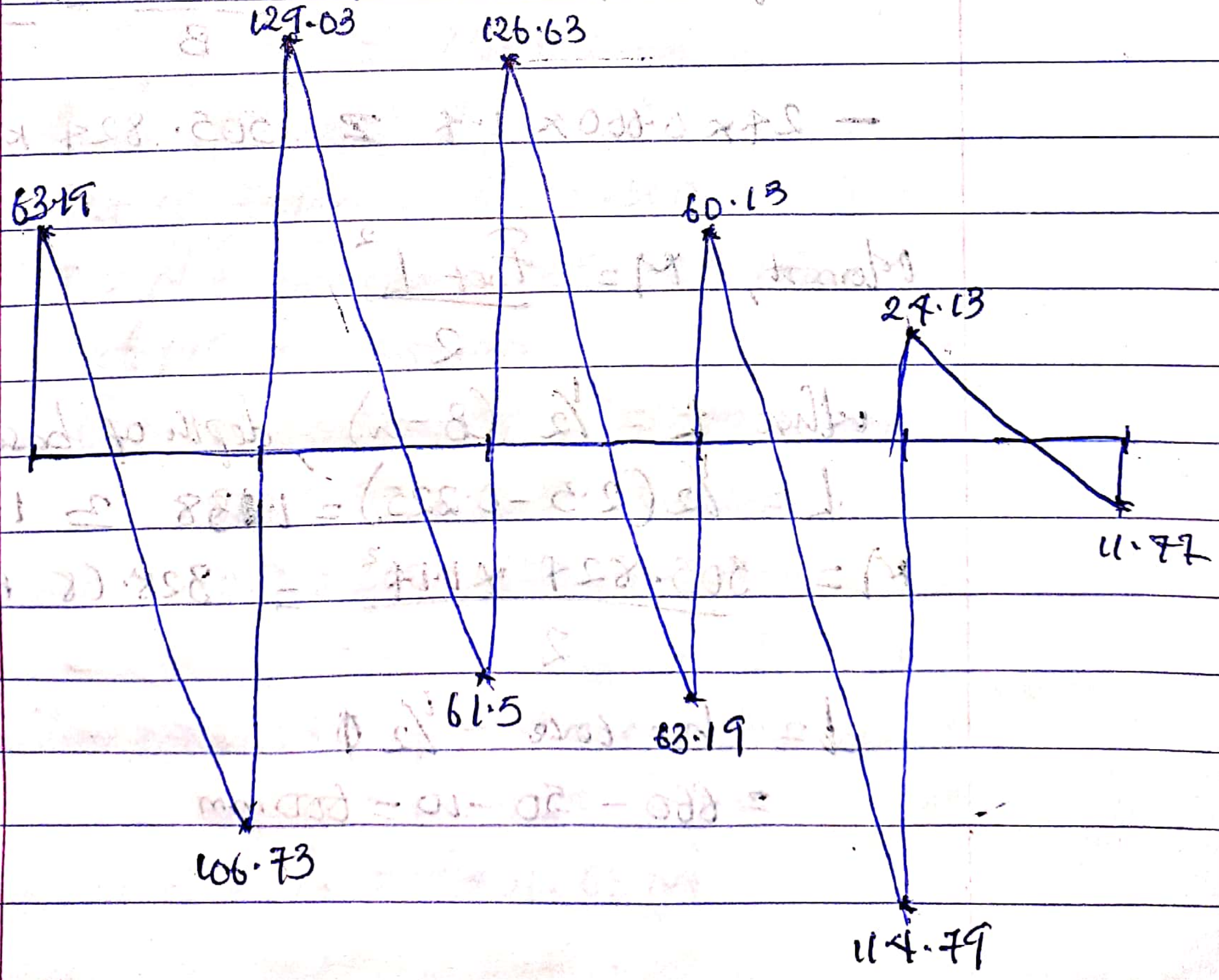
$V_E = \frac{wL}{2} = V_A$

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

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

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

$= 11.77\ kN$



Question 2

Base design:

N = 1200 KN

Strength = 25 - 410 N/mm²

F_b = 150 KN/m²

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

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

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

Net Pressure, $F_{net} = \frac{N \times 1.1}{B} = \frac{1200 \times 1.1}{2.5}$

$- 24 \times 0.660 \times 1.4 = 505.824$ KN/m

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

where $L = \frac{1}{2}(B - h)$, depth of base = 660

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

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

d = h - cover - ½ φ

= 660 - 50 - 10 = 600 mm

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$K = \frac{M}{bd^2 f_{cu}} = \frac{328.68 \times 10^6}{1000 \times 600^2 \times 25} = 0.037$

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

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

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

Provide Y25 @ 300 c/c (1640)

Punching Shear:

Column Size = 225 x 450mm

f_{cu}, f_y = 25 - 410 mm

Area footing = $6.027 m^2$

Size of footing = 2500 x 2500

q = Net Pressure = 505.824 kN/m

depth = 600 mm

Critical Section, $\frac{d}{2}$ = 300mm

300 + 300 + 225 = 825 mm

300 + 300 + 450 = 1050 mm

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

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

V_n = 2751.68 kN

Normal Shear Stress $\tau_v = V_u / bd$

b = perimeter of critical section

d = effective span / 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;

$\tau_c' = K_s \times \tau_c$

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

β_c = Ratio of shorter to larger side of column

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

$K_s = 1$

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

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

Hence depth assumed is OK

Checking for f_b with actual size of footing;

Unit weight of concrete = 24 KN/m²

Unit weight of soil = 1.091×10^{-6} KN/m²

Actual pressure footing;

$q = (1200 \times 2.5 \times 2.5) + (24 \times 0.660) + (1.091 \times 10^{-6} \times 0.0\ldots)$

$q = 214.94$ KN/m²

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