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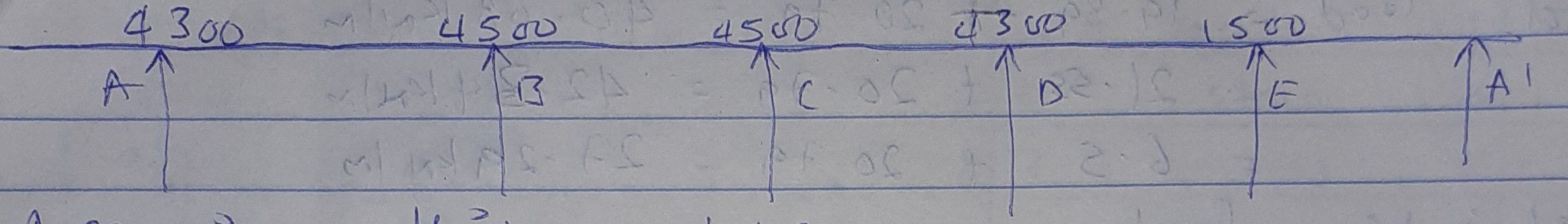
17/ENG03/1061
CIVIL ENGINEERING

Assignment 2

Question 1



Assuming thickness = 150mm

f_{cu} = 25N/mm²

f_y = 410N/mm²

Slab loading

Slab weight = 0.15 × 2.4 = 3.6KN/m²

partition = 1.2 KN/m²

Finishes = 1.2KN/m²

Total G.k = 5.8 KN/m²

D.L = 1.4 (5.8) + 1.6 (3.0) = 13KN/m²

Beam loading

Self wt of beam = 0.225 × 0.6 × 2.4 = 3.24 KN/m

Finishes = 1.2 KN/m²

Wall load = 3 × 3.47 = 10.41 KN/m²

Total G.k = 14.85

D.L = 1.4 (14.85) = 20.79 KN/m²

Slab load on beam in longer direction = 1/2 w/x (1 − 1/3x²)

k = ly/lx

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

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

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

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

Slab load on beam in shorter direction $= 1/3\ w/x$

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

Total load $= 19.89 + 20.79 = 40.68 \text{ kN/m}$

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

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

Distribution factor

$K_{AB} = \underline{1}$

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

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

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

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

$K_{DC} = 0.49$

$K_{DE} = 0.51$

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

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

$K_{A'E} = \underline{1}$

FEM

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

1) $\frac{40.68 \times 4.3^2}{12} = 62.68 \text{ KN/M}$

2) $\frac{42.34 \times 4.5^2}{12} = 71.45 \text{ KN/M}$

3) $\frac{27.29 \times 1.5^2}{12} = 5.1 \text{ KNM}$

	A		B		C		D		E		A
		AB	BA	BC	CB	CD	DC	DE	ED	EA'	A'E	A'
DF	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	-42.81	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	0		5.85		0.63		12.57	1.77	
BM	7.99		1.12	0		-5.85		-0.63		-12.57	-1.77	
DM	0	7.99	0.57	0.55	2.93	2.93	-0.31	-0.37	-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	4.15	0
TM		0	22.88	-82.88	69.06	-69.05	72.06	-72.06	45.46	-45.46	0	
Σ	=											

Moments

$M_a = 0 KNm$

$M_b = 82.88 KNm$

$M_c = 72.06 KNm$

$M_D = 45.47 KNm$

$M_E = 45.47\ kNm$

$M_{A'} = 0 kNm$

Free moment

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

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

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

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

Span moment

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

$= 52.88 kNm$

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

$= 31.2 kN/m$

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

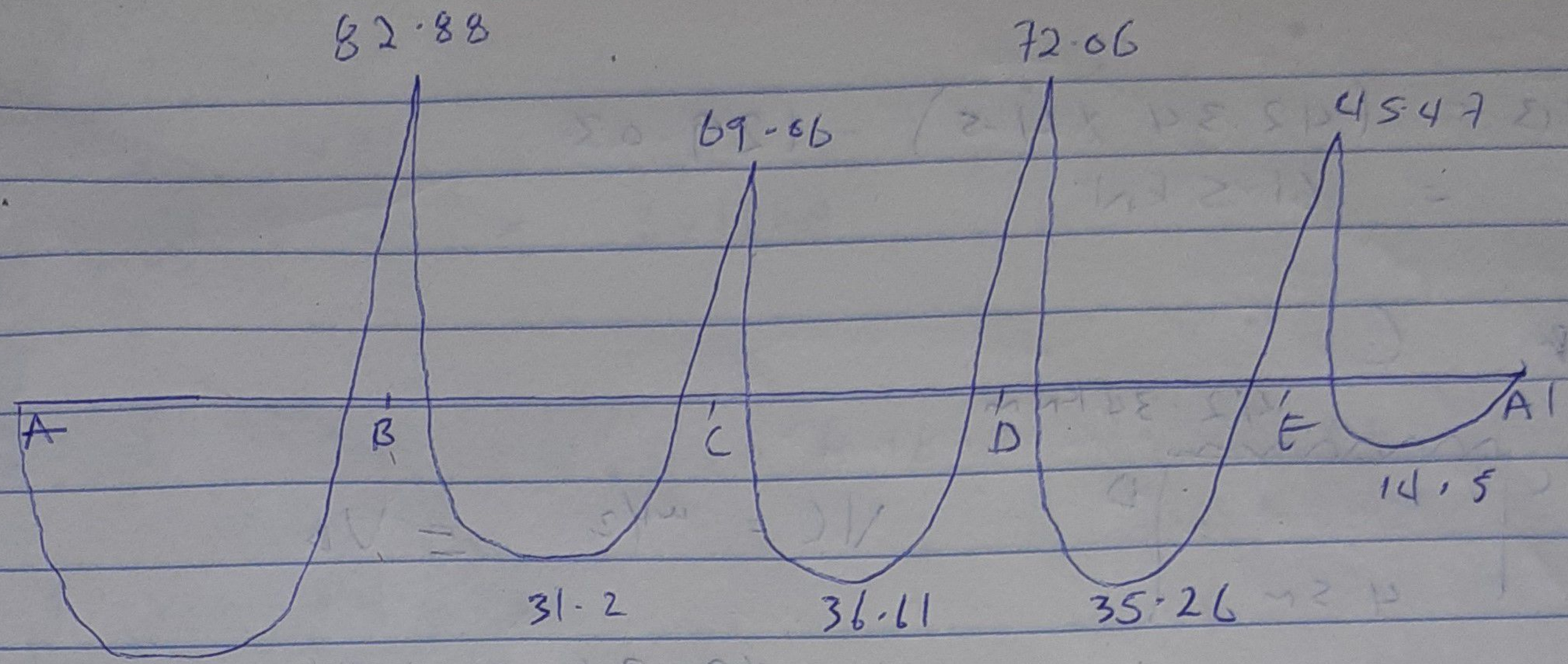
$= 36.6 kNm$

$M_{DE} = M^E = \left(\frac{M_D + M_E}{2}\right) = \frac{94.02}{2} - \left(\frac{72.064\ 45.47}{2}\right)$

$= 35.26 kN$

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

$= -14.5 kNm$

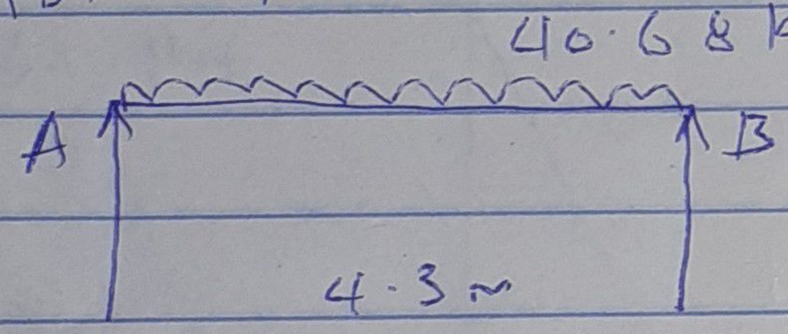


52·58

B·M·D

Shear force

for A



$$V_A = wL/2 = V_B$$

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

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

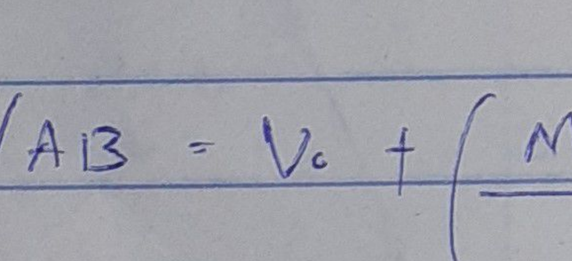
$$= 68.19$$

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

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

for B

42·34 kN/m



$$V_B = wL/2 = V_C$$

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

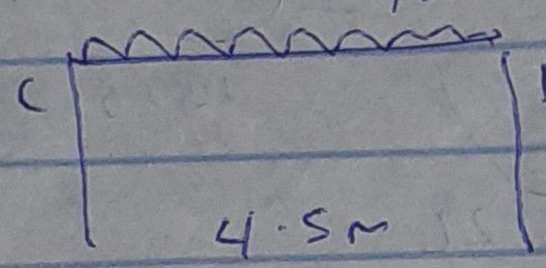
$$V_{BC} = V_B + \left(\frac{M_B + M_C}{1}\right) = 95.27 + \left(\frac{82.68 + 69.06}{4.5}\right)$$

$$= 129.03 kN$$

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

$= 61.5\ kN$

For C



$V_C = wl/2 = V_D$

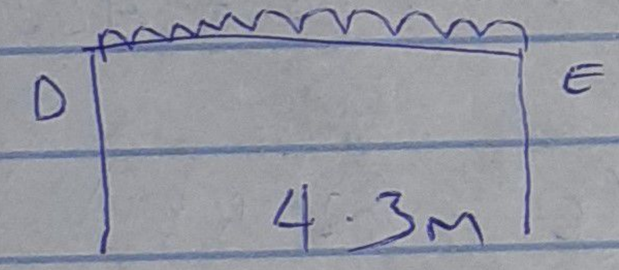
$= \frac{42.34 \times 4.5}{2} = 95.27\ kN$

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

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

$= 63.91\ kN = 63.9\ kN$

For D



$V_D = wl/2 = V_E$

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

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

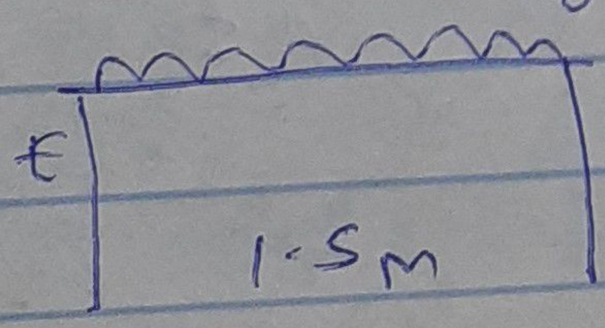
$= 87.46 - \left(\frac{72.06 + 45.47}{4.3}\right) = 60.13\ kN$

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

$= (40.68 * 4.3) - 60.13$

$= 114.79\ kN$

For E



$$VE = w l/2 = VA'$$

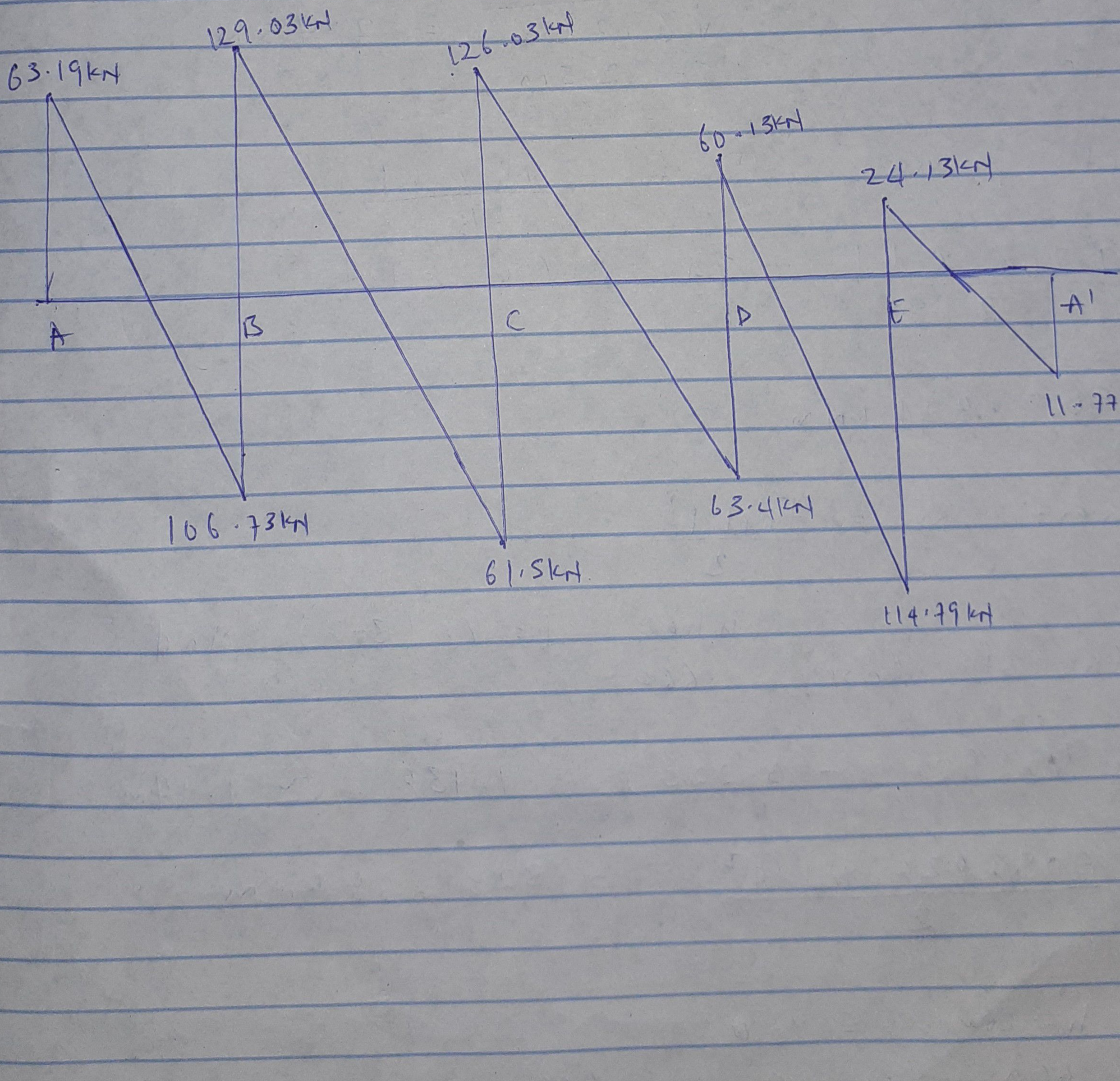
$$= \frac{8.24 \times 1.5}{2} = 6.18 kN$$

$$VEA' = VE - \left(\frac{ME + MA'}{L}\right) = 6.18 - \left(\frac{45.47 + 0}{1.5}\right)$$

$$= 24.13 kN$$

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

$$= 11.77 kN$$



Assignment 2

Question 2

Base design

N = 1200 kN

Strength = 25 - 410 N/mm²

Fb = 150 kN/m²

Area of base req = $\frac{N \times 1.1}{1 + Fb}$ $\quad 1 = 1.46$

$\frac{1200 \times 1.1}{1.46 \times 100}$ = 6.027 m²

$\sqrt{6.027}$ = 2.45 m

≃ 2.5 m

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

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

= 505.824 kN/m

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

where l = ½ (B - h) and

depth of base = 660

l = ½ (2.5 - 0.225) = 1.138 ≃ 1.14m

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

d = h - cover = ½ ø

= 660 - 50 - 10 = 600 mm

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

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

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

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

provide 4 25 @ 300 c/c (1640)

Punching shear

Column Size = 225 x 450mm

Fcu fy = 25 - 410 mm

Area Footing = 6.027 m^2

Size of Footing = 2500 x 2500

q^3, net pressure = 508.824 kN/m

depth = 600

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

300 + 300 + 225 = 825 mm

300 + 300 + 450 = 1050 mm

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

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

$V_n = 2751.68$

Normal shear stress $J_v = \frac{V_n}{bd}$

b = perimeter of Critical section
d = effective Span / depth

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

$$J_v = 1.223 \text{ N/mm}^2$$

Permissible shear stress

$J_v' = k_s \times J_c$

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

β_c = Ratio of shorter to large side of Columns

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

$k_s = 1$

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

$J_v = 1.223 \text{ N/mm}^2$

$J_v \leq J_v'$

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 = $1.091 \times 10^{-6} \text{ KN/mm}^2$

Actual pressure fouting below

$q = (1200 \times 2.5 \times 2.5) + (24 \times 0.660) + (16^{-1} \times 0.66)$

$q = 214.94 \text{ KN/m}^2$