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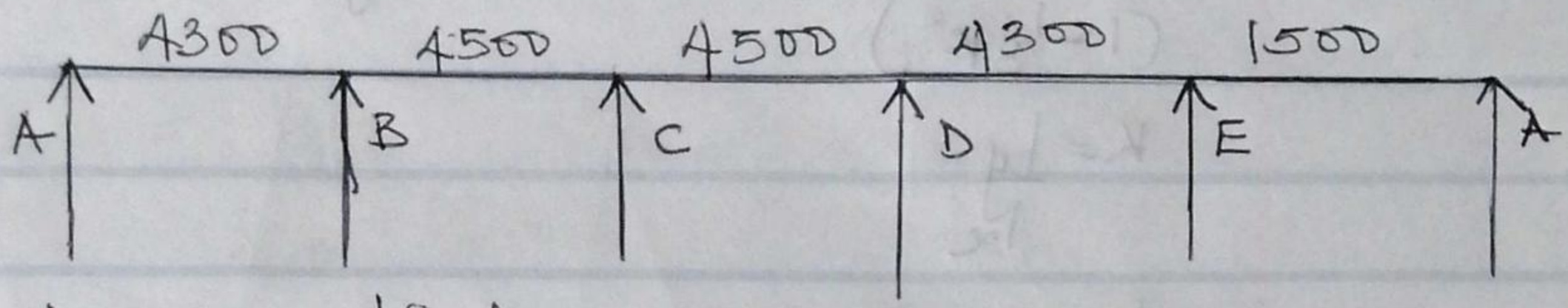
17/ENG03/055
Civil Engineering
Structural Design
Assignment II



Assuming thickness : 150mm

$f_{cu} = 25 N/mm^2$

$f_y = 410 N/mm^2$

Slab loading

Slab weight = $0.15 \times 24 = 3.6 kN/m^2$

Partition = $1.0 kN/m^2$

finishes = $1.2 kN/m^2$

Total G.k = $5.8 kN/m^2$

assuming for classroom

$D.L = 1.4(5.8) + 1.6(3.0) = 13 kN/m^2$

Beam loading

Self wt of beam = $0.225 \times 0.6 \times 24 = 5.24 kN/m^2$

finishes = $1.2 kN/m^2$

Wall load = $3 \times 3.47 = 10.41 \text{ kN/m}^2$

Total G.k = 14.85

D.L = $14 (14.85) = 20.79 \text{ kN/m}^2$

Slab load on beam in longer direction = $\frac{1}{2}$ wlx.

$(1 - \frac{1}{3}k^2)$

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

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

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

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

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

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

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

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

$K_{AB} = 1$

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

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

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

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

$K_{DC} = 0.49$

$K_{DE} = 0.51$

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

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

$K_{AE} = 1$

F.E.M

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

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		B		C		D		E		A	
	AB		BA	BC	CB	CD	DC	DE	ED	EA	AE	A
DIF	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	-4.80	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		-7.44		-4.79		-21.305	
BM	-2.235		-31.34		0		7.44		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	0.68	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	-0.81	-0.37	-3.27	-9.29	-1.77	0
TM		0.29	8.40	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	0.06	0.09	0.27	0.78	4.65	0
Σ	=	0	22.88	-82.88	67.06	-69.05	72.06	-72.06	45.47	-45.46	0	

Moments

M_A - 0 KNm

M_b = 82.88 kNm

M_c = 69.06 kNm

M_2 = 72.06 KNm

M_c = 45.47 KNm

M_a = 0 KNm

free moment

for $\frac{w \cdot D \cdot L}{8} = \frac{wL^2}{8}$

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 $\frac{27.29 \times 1.5^2}{8} = 8.24 KN/m^2$

8 par moment

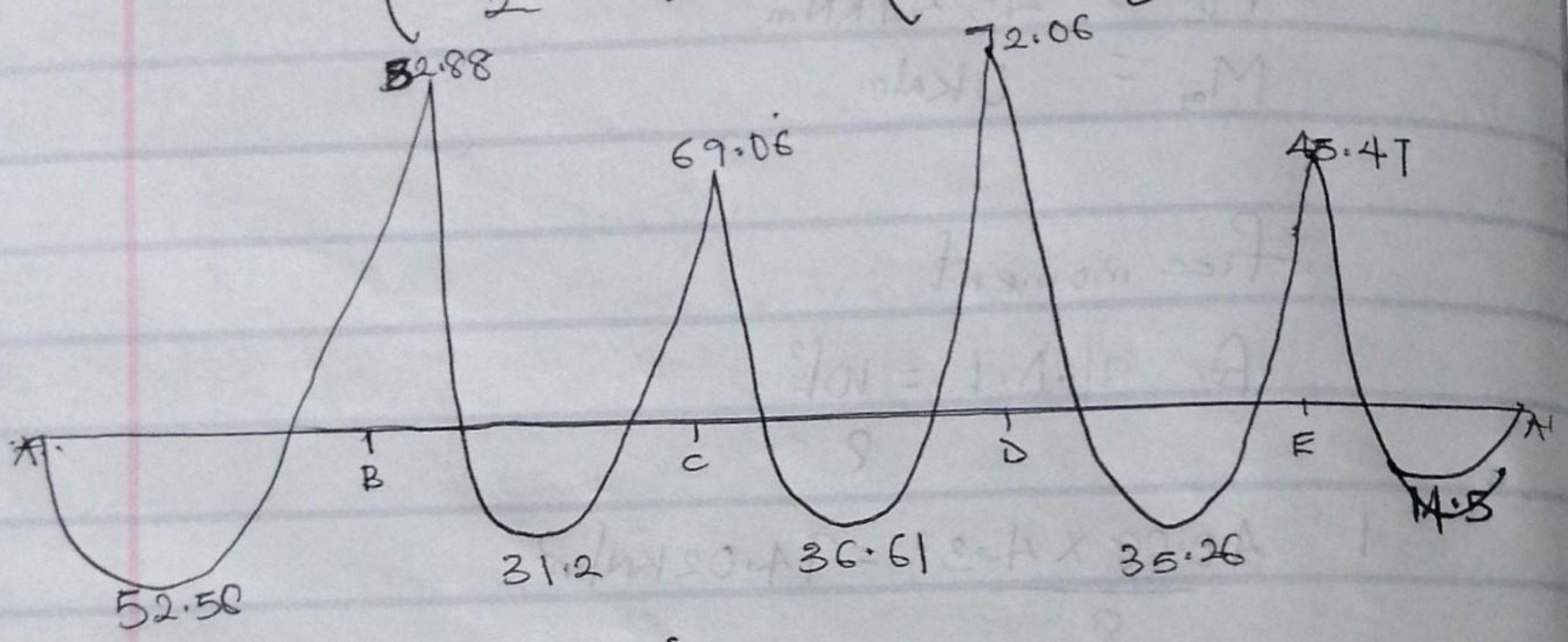
$M_{AB} = M^f - \left(\frac{M_A + M_B}{2}\right) = 94.02 - \left(\frac{0+82.88}{2}\right) = 57.58 KNm$

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

$$M_{CD} = M^F - \left(\frac{M_C + M_D}{2}\right) = 107.17 - \left(\frac{69.06 + 12.06}{2}\right) = 36.6\ kNm$$

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

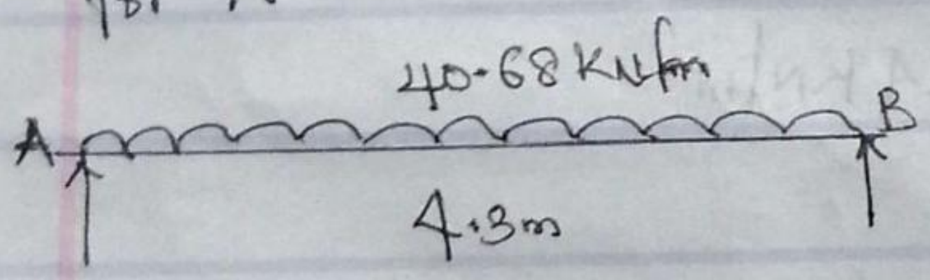
$$M_{EA'} = M^F - \left(\frac{M_E + M_{A'}}{2}\right) = 8.24 - \left(\frac{45.47 + 0}{2}\right) = -14.5\ kNm$$



B.M.D

Shear force

for A



$$V_A = wL/2 = V_B$$

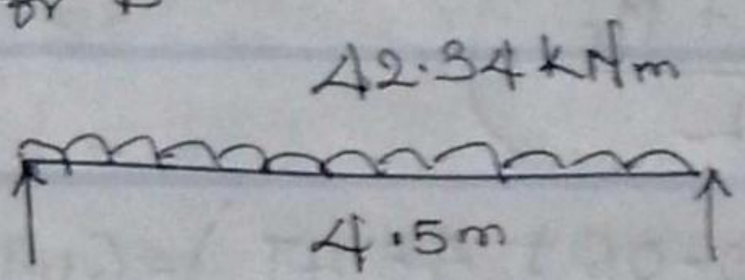
$$= \frac{40.68 \times 4.3}{2} = 87.462\ kN$$

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

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

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

for B



$V_{BC}\ \frac{WL}{2} = V_C$

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

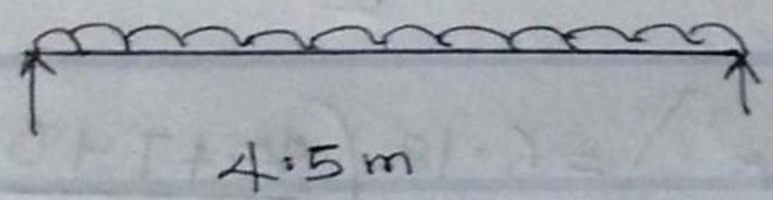
$V_{BC} = V_B + \left(\frac{M_B + M_C}{L}\right) = 95.27 + \left(\frac{82.68 + 69.06}{4.5}\right)$

$= 129.08kN$

$V_{CB} = (42.34 * 4.5) = 129.08$

$= 61.5kN$

for C



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

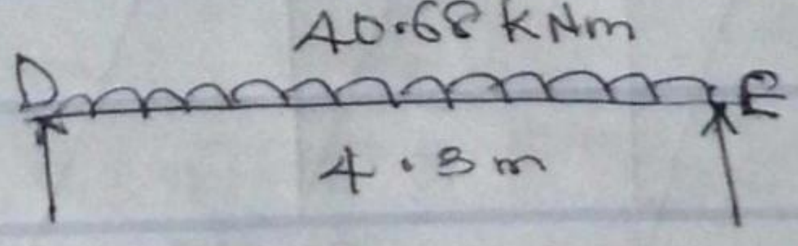
$= \frac{42.34 \times 4.5}{2} = 95.27KN$

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

$V_{DC} = (40.34 \times 4.5) - 126.63$

$= 63.99\ kN$

for D



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

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

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

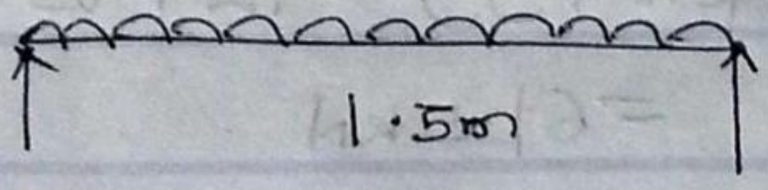
$$= 87.46 - \left(\frac{72.06 + 45.47}{4.3}\right) = 60.13\,kN$$

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

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

$$= 114.79\,kN$$

For E

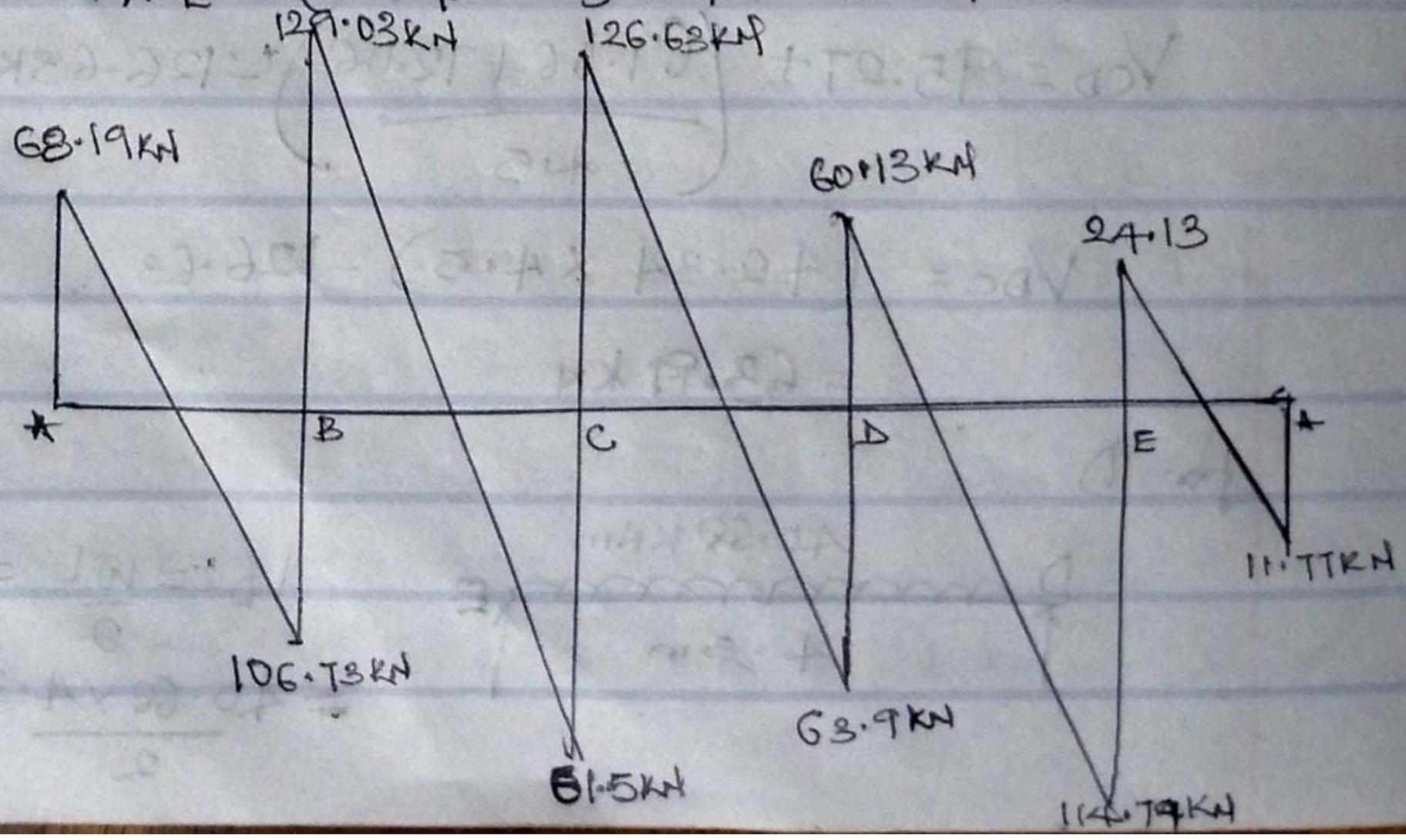


$$V_E' \frac{-wL}{2} = V_D'$$

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

$$V_{EX}' = V_E \left(\frac{M_E + M_A'}{L}\right) = 6.18 - \left(\frac{45.47 + 0}{15}\right) = 24.13\,kN$$

$$V_{A'E} = (8.24 \times 1.5) - 24.13 = 11.77\,kN$$



Qno. 2.

Base design

- N = 1200 kN

Strength = 25 - 410 Nmm²

fb = 150 kN/m²

Area of base req = $\frac{N \times 1.1}{l \times fb}$ $l = 1.46$

$\frac{1200 \times 1.1}{1.46 \times 150}$ = 6.027 m²

$\sqrt{6.027}$ = 2.45 m ≈ 2.5

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

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

= 505.824 kN/m

moment ; M = $\frac{f net \, l^2}{2}$

where l = ½ (B - h) ϕ

= depth of base = 660

L = ½ (2.5 − 0.225) = 1.1375 ≈ 1.14 m

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

d = h − Cover − ½ϕ

$= 660 - 50 - 10 = 600mm$

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

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

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

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

Provide Y25 @ 300 c/c (1640)

Punching shear

Column size = 225 × 450mm

for fy = 25-410mm

Area Footing = $6.027m^2$

Size of footing = 2500 × 2500

q^3, Net pressure = 508.824 KN/m

depth = 600

Critical section $d/2 = 300$

300 + 300 + 225 = 825mm

300 + 300 + 450 = 1050mm

Shear force V_n = q_n × [Area of footing − $(0.3+d)^2$]

= 505824 [2.5×2.5 − $(0.3+0.6)^2$]

V_n = 2751.68

Normal Shear stress $\tau_v = \frac{V_n}{bd}$

b = parameter of critical section

d = effective span/depth

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

τ_v = 1.223 N/mm²

Permissible Shear Stress

$\tau_c' = K_s \times \tau_c$

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

B_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/mm²

$\tau_v = 1.223$ N/mm²

$\tau_v \leq \tau_c$

Hence depth assumed is ok ✓

Checking for fb 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

$q = (1200 \times 2.5 \times 2.5) + (24 \times 0.660) + (1.091 \times 10^{-6} \times 0.66)$

$q = 7515.84$ KN/m²