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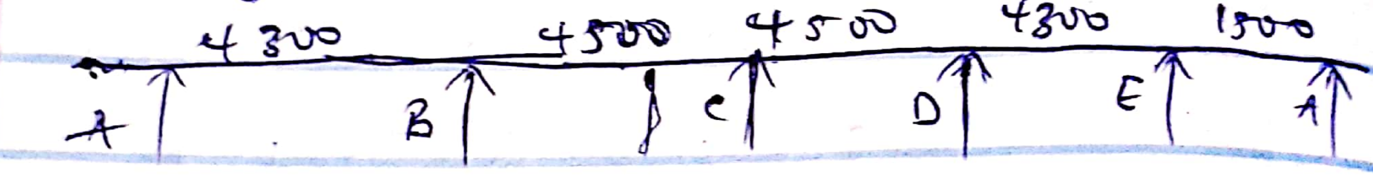
14/sa/4602
Civil Engineering

Assignment 12lo

(1)



Assuming thickness = 150mm

f_{cu} = 25 N/mm²

f_y = 460 N/mm²

Slab loading

Slab weight = 0.15 × 24 = 36 kN/m²

partition = 1.0 kN/m²

finishes = 1.2 kN/m²

Total Gk = 5.8 kN/m²

D.C = 1.4 (5.8) + 16 (3.0) = 13 kN/m²

Beam loading

Self wt of beam = 0.225 × 0.6 × 24 = 3.24 kN/m²

finishes = 1.2 kN/m²

Wall load = 3 × 3.47 = 10.41 kN/m²

Total Gk = 14.85

D.L = 1.4 (14.85) = 20.79 kN/m²

Slab load on beam in longer direction

$= \frac{1}{2} w l x \left(1 - \frac{1}{3k^2}\right)$

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

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

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

$\frac{1}{2} \times 13 \times 4.3 \left(1 - \frac{1}{3 \times (1.075)^2}\right) = 19.89$ kN/m²

$\frac{1}{2} \times 13 \times 4.5 \left(1 - \frac{1}{3 \times (1.125)^2}\right) = 21.55$ kN/m²

Slab load on beam in shorter direction

$= \frac{1}{3} w l x$

$= \frac{1}{3} \times 13 \times 1.5 = 6.5$ 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

$K_{AB} = 1$

$K_{BA} = \frac{1/L_{BA}}{1/L_{BA} + 1/L_{BC}} = \frac{1/4.3}{1/4.2 + 1/4.3} = 0.51$

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

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

$K_{CB} = 1.05 = 0.5$

$K_{BC} = 0.49$

$K_{DE} = 0.51$

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

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

$K_{A'E} = 1$

f.E.M

U.D.L = $\frac{wl^2}{12}$

(1) $\frac{40.68 \times 4.3^2}{12} = 62.68$ kNm

(2) $\frac{42.34 \times 4.5^2}{12} = 71.45$ kNm

(3) $\frac{27.29 \times 1.5^2}{12} = 5.1$ kNm

	A	AB	BD	BC	CB	CD	DC	DF	FD	FA	AF	A
D.F	0	1	0.57	0.44	0.5	0.5	0.41	0.51	0.36	0.24	1	0
f.E.M		62.68	62.68 ~~71.45~~	-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	14.7	-42.61	-5.1	
Tm		2.235	31.34	0	2.13	2.15	0	7.44	2.24	-2.35	-21.80	
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	-18.98	-15.36	0	0	3.67	3.82	1.25	3.54	21.3	0
Tm		-7.94	-1.12	0	-7.68	1.84	0	0.65	1.71	10.66	1.77	

	A		B		C		D		E	
OBM		-7.99		-1.12		-5.85		0.63		12.57
BM		7.99		1.12		5.85		-0.63		-12.57
DM	0	7.99	0.57	0.55	2.43	2.43	-0.31	-0.32	-3.27	-9.14
TM		0.24	3.40	1.42	0.28	-0.16	1.47	1.64	-0.16	-0.84
OBM		0.24		4.87		0.12		-0.17		-1.05
BM		-0.29		-4.87		-0.12		0.07		1.05
DM	0	0.29		-2.39	-0.06	0.06	0.0	0.09	0.27	0.7
Σ	=	0	82.88	-82.88	69.05	-69.05	72.06	-72.06	45.47	-45.46

Moments

Ma = 0 kNm

Mb = 82.88 kNm

Mc = 69.06 kNm

MD = 72.06 kNm

ME = 45.47 kNm

MA = 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

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

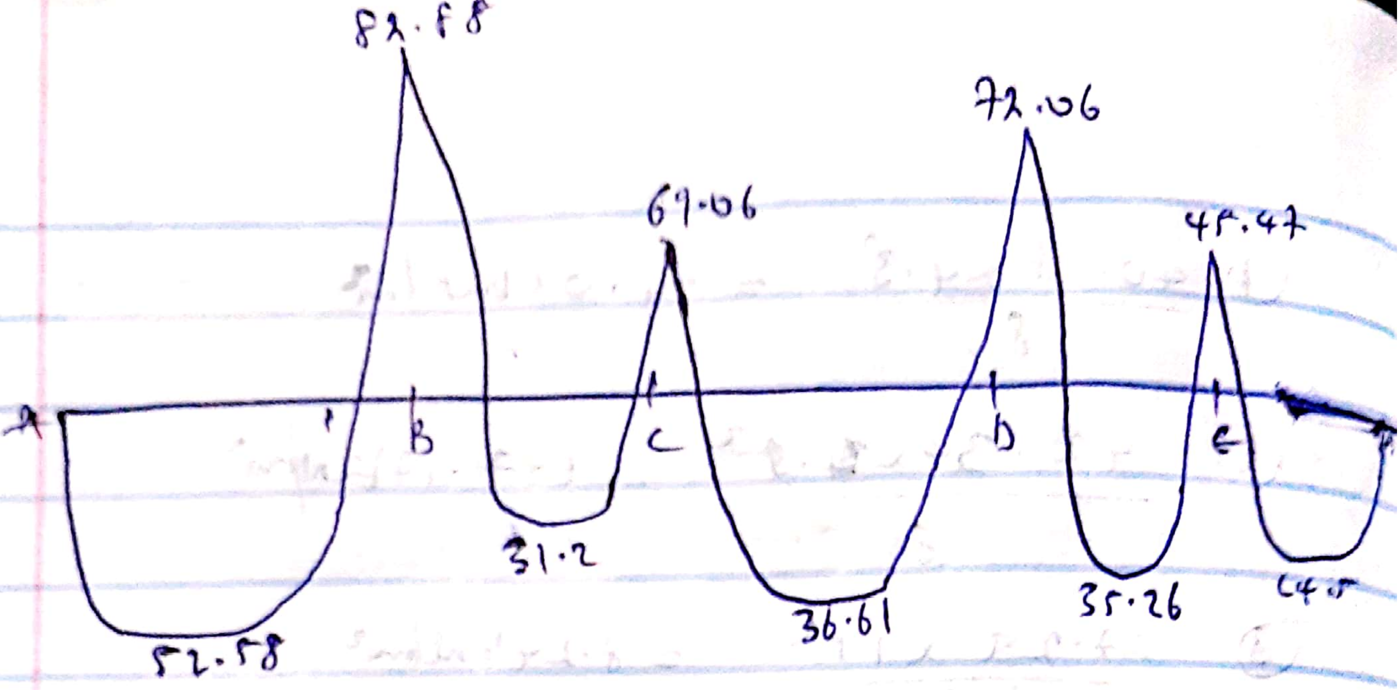
$M_{BC} = M^f - \left(\frac{M_B + M_C}{2}\right) = 107.17 - \left(\frac{82.88 + 69.06}{2}\right) = 1.2 \, kNm$

$M_{CD} = M^f - \left(\frac{M_C + M_D}{2}\right) = 107.17 - \left(\frac{69.04 + 72.06}{2}\right) = 36.6 \, kNm$

$M_{DE} = M^f - \left(\frac{M_D + M_E}{2}\right) = 94.02 - \left(\frac{72.06 + 45.47}{2}\right) = 35.36 \, kNm$

$M_{EA} = M^f \left(\frac{M_B + M_A}{2}\right) = 8.24 - \left(\frac{45.47 + 0}{2}\right) = \left(\frac{45.47 + 0}{2}\right) =$

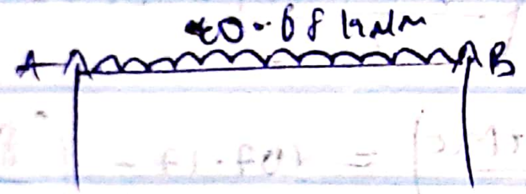
$= 14.5 \, kNm$



B·M·D

Shear force

for A



$V_A = wl/2 = V_B$

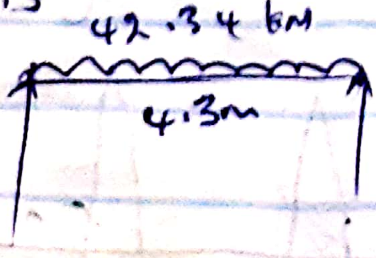
$= \frac{40.68 \times 4.3}{2} = 87.4$ kN

$V_{A \cdot B} = V_A + \left(\frac{M_A - M_B}{L}\right) = 87.462 + \left(\frac{0 - 82.88}{4.3}\right) = 68.$

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

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

for B



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

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

$V_{BA} = V_B + \left(\frac{M_a + M_c}{L}\right) = 95.27 + \left(\frac{82.68 + 69.06}{4.5}\right)$

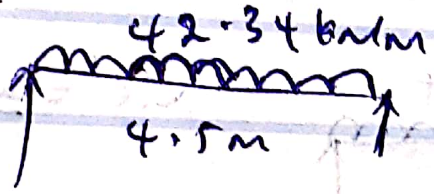
$= 129.03\ kN$

~~$V_{BC} = V_B + \left(\frac{M_a + M_c}{L}\right) = 95.244$~~

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

$= 61.5\ kN$

for C



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

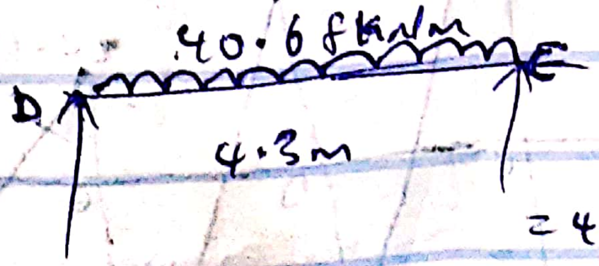
$= \frac{42.34 \times 4.5}{2} = 95.27\ kN$

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

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

$= 63.19\ kN$

for D



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

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

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

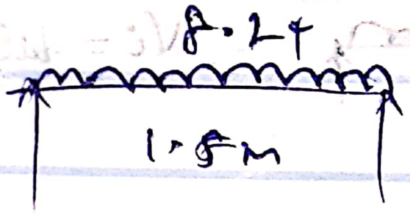
$= 87.46 - \left(\frac{72.06 + 45.47}{4.3}\right) = 60.13\,kN$

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

$= (40.68 \times 4.3) - 60.13$

$= 114.79\,kN$

for E

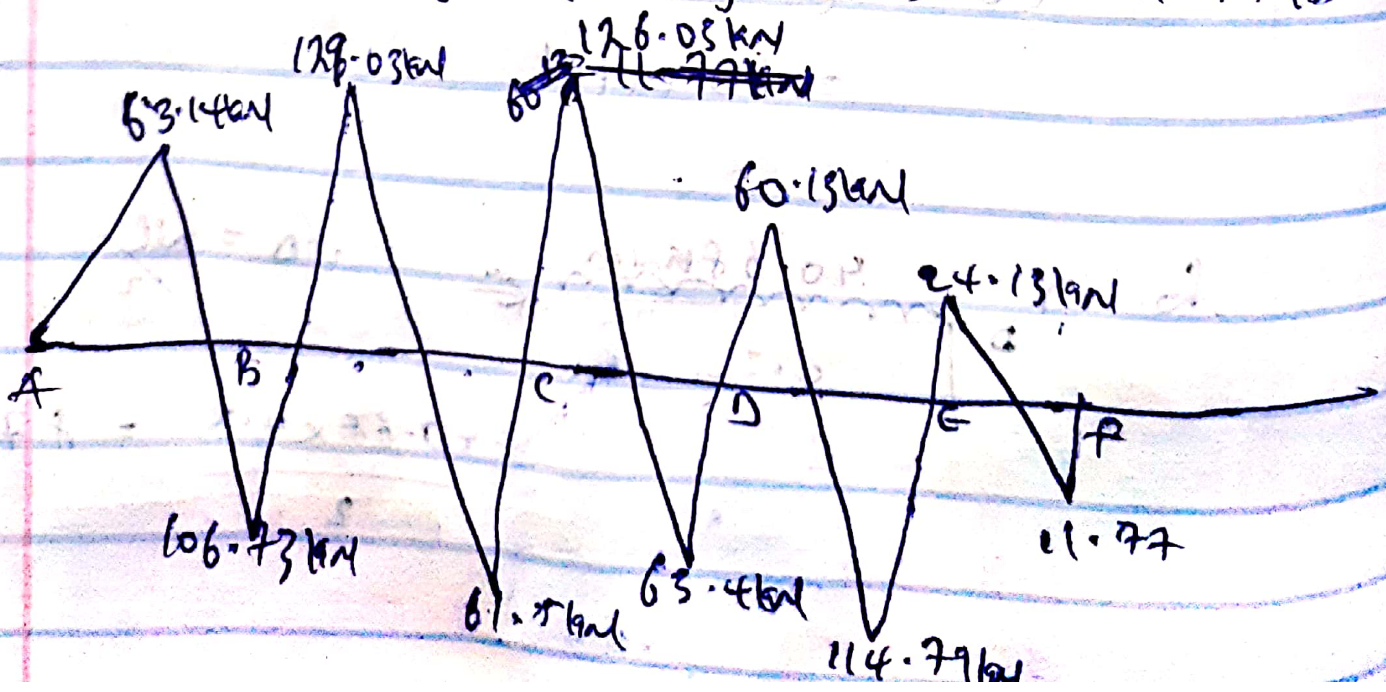


$V_{E'} = \frac{wl}{2} = V_{D'}$

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

$V_{EA} = V_A - \left(\frac{M_E + M_A}{L}\right) = 6.18 - \left(\frac{45.47}{1.5}\right) = 24.13\,kN$

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



② Beam design

$N = 1200$ kN

Strength $= 25 - 460$ N/mm²

$f_B = 150$ kN/mm²

Area of base $= \frac{N \times 1.1}{\lambda \times f_b}$ $\lambda = 1.46$

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

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

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

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

$= 505.824$ kN/m.

moment, $m = \frac{f_{net} \, l^2}{2}$

where $l = \frac{1}{2}(B - h)$ f =

depth of base $= 660$

$l = \frac{1}{2}(2.5 - 0.225) = 1.638 \simeq 1.74 m$

$$M = \frac{505.824}{2} \times 1.14^2 = 328.88\,kNm$$

$$d = h - cover - \tfrac{1}{2}\phi$$
$$= 660 - 50 - 10 = 600\,mm$$

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

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

$$z = k_a d = 0.95 \times 600 = 570\,mm$$

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

provide 7 Y20 @ 300 c/c (B6 ed)

Punchions Shear

Column Size = 225 x 450 mm
fcu fy = 25 - 460 mm
Area footing = 6.027 m²
Size of footing = 2800 x 2800

q_s, Net pressure = 808.824 kN/m
depth = 600
critical section, $d/2 = 300$

$300 + 300 + 225 = 825$ mm
$300 + 300 + 450 = 1050$ mm

Shear force $V_a = q_u \times$ [Area of footing $- (0.3 + d)^2$]
$= 808.824\,[2.5 \times 2.5 - (0.3 + 0.6)^2]$
$V_A = 2781.68$ kN

Normal shear stress $\tau_v = V_a / b d$
b = peremeter of critical section
d = effective span depth

$\tau_v = \dfrac{2781.68 \times 10^3}{(2 \times (825) + 2(1050)) \times 600)}$

$\tau_v = 1.223$ N/mm²

Permissible shear stress
$\tau_c = k_s \times \tau_c$

$k_s = (0.5 + \beta c)$

βc = Ratio of shorter to larger side of columns

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

$k_s = 1$

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

$\tau_u \leq \tau_u'$

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/mm²

Actual pressure footing below

~~q = (1200 × 2.5 × 2.5) +~~

$q = (1200 \times 2.5 \times 2.5) + (24 \times 0.660) + (1.091 \times 10^{-6} \times 0.4)$

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