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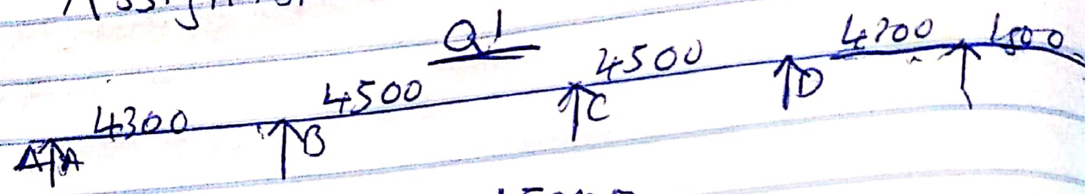
17/ENG03/025
CVE 308 - Structural design
Assignment 2.



Assuming thickness = 150mm
$f_{cu} = 25 N/mm^2$
$f_y = 410 N/mm^2$

Slab Loading
Slab weight = 0.15 × 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
D.L 1.4G_k + 1.6Q_k
D.L = 1.4(5.8) + 1.6(3.0) = 13 KN/m^2

Beam Loading
Self wt. of beam = 0.225 × 0.6 × 24 = 3.24 KN/m^2
finishes = 1.2 KN/m^2
wall Load = 3 × 3.47 = 10.41 KN/m^2
Total G_k = 14.85

D.L = 1.4(14.85) = 20.79 KN/m^2

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

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

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

$\frac{4500}{4000}$ = 1.0125

$\frac{1}{2} \times 13 \times 4.3 \left(1 - \frac{1}{3 \times (0.75)^2}\right) = 19.89 KN/m^2$

$\frac{1}{2} \times 13 \times 4.05 \left(1 - \frac{1}{3 \times (1.23)^2}\right) = 21.55 KN/m^2$

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

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

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

$K_{AB} = 1$

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

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

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

$K_{DC} = 0.49$

$K_{DE} = 0.57$

$K_{ED} = 0.26$

$K_{EA} = 0.79$

$K_{A'E} = 1$

FEM

U.D.L $= wl^2/12$

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

$\frac{42.34 \times 4.5^2}{12} = 71.45 KN/m$

$\frac{27.29 \times 1.5^2}{12} = 5.1 KN/m$

Moments

$M_a = 0 KN/m$

$M_b = 82.88 KNm$

$M_c = 69.06 KNm$

$M_D = 72.66 KNm$

$M_E = 45.47 KNm$

$M_{A'} = 0 KNm$

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.) $\frac{27.29 \times 1.5^2}{8} = 7.68 KN/m^2$

Span moment

$M_{AB} = 94.02 - \left(\frac{0+82.88}{2}\right) = 52.58 KNm$

$M_{BC} = 107.17 - \left(\frac{82.88+69.06}{2}\right) = 31.2 KNm$

$M_{CD} = 107.17 - \left(\frac{69.06+12.06}{2}\right) = 36.61 KNm$

$M_{DE} = 94.02 - \left(\frac{72.66+45.47}{2}\right) = 35.26 KNm$

$M_{EA'} = 7.68 - \left(\frac{45.47+6}{2}\right) = -15.7 KNm$

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

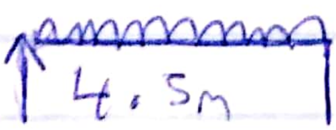
$= \frac{40.68 \times 4.3}{2} = 87.462\,KN$

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

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

$= (40.68 \times 4.3) - 68.19 = 106.73\,KN$

For B



$V_B = \frac{wL}{2} = k$

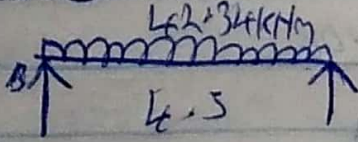
$= \frac{42.34 \times 4.5}{2} = 95.27\,KN$

$V_{BC} = V_B + \left(\frac{M_a + M_c}{L}\right) = 95.27 + \left(\frac{82.58 + 69.06}{4.5}\right)$

$V_{BC} = 129.03\,KN$

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

For C



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

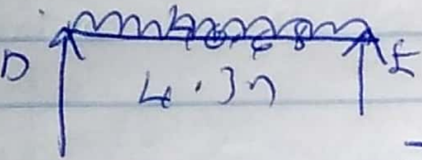
$= \frac{42.34 \times 4.5}{2} = 95.27 KN$

$V_{CD} = 95.27 + \left(\frac{64.06 + 72.06}{4.5}\right) = 126.63 KN$

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

$= 63.19 KN$

for D



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

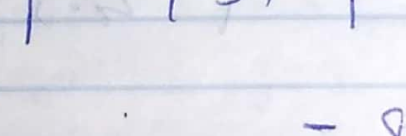
$= 87.46 KN$

$V_{DE} = 87.46 - \left(\frac{12.06 + 45.47}{4.3}\right) = 60.13 KN$

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

$= 114.79 KN$

For E =



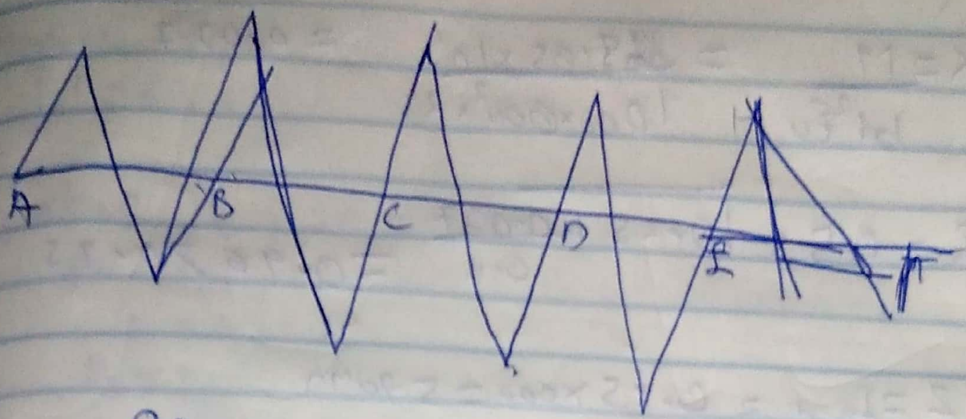
$V_E' = \frac{wL}{2} = V_E'$

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

$V_{EA} = 24.13 KN$

$V_{AE} = (8.24 \times 1.3) - 24.13$

$= 11.77 KN$



Q2

N = 1200KN

strength = 25 - 410 KN/m²

f_b = 150KN/m²

Area of base req $= \frac{N \times 1.1}{a \times f_b}$

a = 1.46

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

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

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

$= \frac{1200 \times 1.1}{2.5} = 24 \times 0.66 \times 1.4$

$= 503.824 KNm$

Moment, $m = \frac{f_{net} L^2}{2}$ where $L = 1/2 (B - h)$ &

depth of base = 660

$L = 1/2 (2.5 - 0.225) = 1.138 \approx 1.14m$

~~M = 505.5 5.05~~

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

$= 328.681 KNm.$

d = h - cover - 1/2 Q

d = 660 - 50 - 10 = 600mm

$K = \frac{M}{bd^2 f_{cu}} = \frac{328.68 \times 10^6}{1000 \times 600^2 \times 23} = 0.037$

$l_a = 0.5 + \sqrt{0.25 + \frac{0.037}{0.9}} = 0.967 \; 0.95$

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

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

Provide Y25 @ 300c/c (1640)

Punching shear
Column size = 225 × 450mm
Cover = 25-410mm
Area footing = $6.027m^2$
Size of footing = 2500 × 2500
Net pressure = 505.824kN/m
depth = 600
Critical section, d/2 = 300
300 + 300 + 225 = 825mm
300 + 300 + 450 = 1050mm

Shear force $V_n = q_n \times \{\text{Area of footing} - (0.3+d)^2\}$
$= 505.824[2.5 \times 2.5 - (0.3+0.6)^2]$
$V_n = 2751.68kN$

Normal shear stress, $\tau_u = V_n/bd$

~~b =~~

τ_u = ~~2751~~ $\frac{2751.68 \times 10^3}{(2 \times 825) + 2(1050) \times 600}$
$\tau_u = 1.223 N/mm^2$

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Permissible Shear stress

$\tau_c' = K_s + \tau_c$

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

β_c = Ratio of Short to Large side of Column

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

$K_s = 1$

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

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

$\tau_v \leq \tau_v'$

thkee depth assumed is OK

Checking for f_b with actual size of footing

Unit weight of concrete = $24 KN/m^2$

Unit weight of soil = $1.041 \times 10^{-6} KN/m^2$

Actual Pressure footing becom

$q = (1200 \times 2.5 \times 2.5) + (24 \times 0.600) + (1.041 \times 10^{-6} \times 100)$

$q = 214.96 KN/m^2$

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