

Quiz #1 - ENCE 436

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$$f_c' = 35 \text{ MPa}$$

$$f_y = 420 \text{ MPa}$$

$$B_1 = 0.8$$

$$\gamma_{cc} = 24 \text{ kN/m}^3 \quad (2.4 \text{ t/m}^3)$$

Q.1

Short, circular, spirally column

$$\rho_c = 2\%$$

$$\phi = 0.85$$

$$\text{long. bars } \phi 28 \Rightarrow A_{\text{bar}} = 6.19 \text{ cm}^2$$

Spiral $\phi 10$

$$\textcircled{a} \phi P_n \geq P_u \quad \Rightarrow P_n = \frac{P_u}{\phi} = \frac{640}{0.85} = 764.7 \text{ t}$$

-Preliminary size:

$$A_g = \frac{P_n}{0.85 f_c'} = 764$$

$$\phi P_n = \phi A_g f_c' + \phi A_s (f_y - 0.85 f_c') \quad , \quad A_s = A_g \rho_g$$

$$P_n = \phi A_g [f_c' + \rho_g (f_y - 0.85 f_c')] = 764 \text{ t}$$

$$\Rightarrow A_g = \frac{764}{0.428} = 1785 \text{ cm}^2 \Rightarrow D = 47.7 \text{ cm}$$

$$A_g = 50_{\text{cm}} \times 50_{\text{cm}} \left(\frac{3.14}{4} \right) = 1962.5 \text{ cm}^2$$

$$A_s = 39.25 \text{ cm}^2 \Rightarrow \# \text{ bars long.} = 6.4 \approx 8 \text{ bars}$$

$$D = 50 \text{ cm} \quad , \quad 8 \phi 28$$

$$\textcircled{b} \quad P_u = 650 \text{ t}, \quad M_u = 65 \text{ t.m}$$

$$e = 10 \text{ cm}$$

$$P_n = \frac{650}{0.85} = 764.7 \text{ t}$$

~~Preliminary size~~
Preliminary size

$$A_g = \frac{P_n}{0.85 f_c' (0.85)} = \frac{764.7}{0.85(0.35)(0.85)} = 3024 \text{ cm}^2$$

$$D = 62 \text{ cm}$$

$$D \approx 65 \text{ cm} \rightarrow A_g = 3316 \text{ cm}^2$$

$$\gamma = \frac{65 - 4 - 4 - 2.8}{65} = 0.83$$

$$K_n = P_n / f_c' A_g = 0.66$$

$$P_n = 0.101$$

checked, $\rho \approx 2\%$

~~$A_s = (0.02)(3024) = 60.48 \text{ cm}^2$~~

$$A_s = (0.02)(3316) = 66.32 \text{ cm}^2 \Rightarrow \# \text{ bars} = 10.8$$

lms. $\approx 12 \text{ bar.}$

$$D = 65 \text{ cm}, \quad 12 \phi 28$$

© $P_u = 650 \text{ t} \rightarrow P_n = 764.7 \text{ t}$

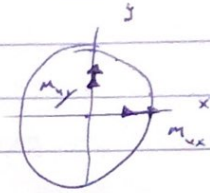
$M_{ux} = 35 \text{ t.m}$

$M_{uy} = 65 \text{ t.m}$

$M_u = \sqrt{35^2 + 65^2}$

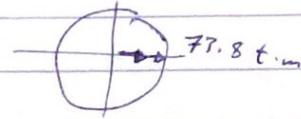
$M_u = 73.8 \text{ t.m}$

$e = \frac{M_u}{P_u} = 11.4 \text{ cm}$



Preliminary size:

$A_g = \frac{P_n}{0.85 f_c' (0.80)} = 3213 \text{ cm}^2$



$\rightarrow D = 64 \text{ cm}$

$\rightarrow D \approx 65 \text{ cm}$

$A_g = 3316 \text{ cm}^2 \Rightarrow A_s = 66.37 \text{ cm}^2$

$K_n = 0.66$

$R_n = 0.105$

$\gamma = 0.83$

from C35-420.8

$\gamma = 0.8$

~~0.02~~ $0.02 = \rho$

from C35-420.9

$\rho = 0.02$

Checked ✓

~~assume D = 70~~ $A_g = 3846.5$

$\rho = 2\%$

~~$K_n = 0.57$ $R_n = 0.093$~~

~~$D = 70$~~

bars = 10.8 bar

≈ 12

$D = 65 \text{ cm}$, 12 ϕ 28.

(d)

$$D = 65 \text{ cm}$$

$$D_{ch} = 57 \text{ cm}$$

14 ϕ 30 bars

$$S_{req.} = \frac{\pi (d_s)^2}{D_{ch} \rho_{sreq}}$$

$$\rho_{sreq} = 0.45 \left(\frac{D^2}{D_{ch}^2} - 1 \right) \frac{f_c'}{f_{yt.}} = 0.0113$$

$$S_{req.} = 4.89 \text{ cm}$$

$$\text{clear } S = 3.89 \text{ cm}$$

$$2.5 \frac{cm}{cm} < 7.5 \frac{cm}{cm}$$

$$S_{req} = 4 \text{ cm}$$

$$\text{clear} = 3 \text{ cm} \checkmark$$

long. bar spacing

$$S = \frac{\pi (D_{ch} - 1 - 1.5) - 14(3)}{13} = 10.76 \text{ cm} > S_{min} \checkmark$$

$$S_{min} = \max \{ 1.5 d_b, 4 \text{ cm} \} = 4.5 \text{ cm.}$$

Q.2

braced building

all Column Square $b = h = 45 \text{ cm}$.

all beams rec. $b = 45 \text{ cm}$, $h = 60 \text{ cm}$

$$I_{g,c} = 341718 \text{ cm}^4$$

$$M_1 = 44.8 \text{ t.m} \quad \left. \begin{array}{l} \\ \\ \end{array} \right\} \text{Single curvature.}$$

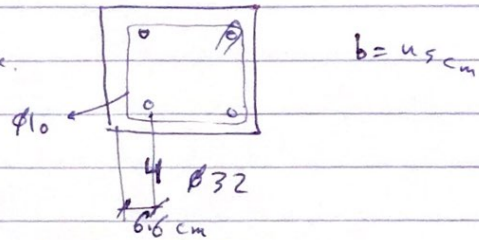
$$M_2 = 44.8 \text{ t.m}$$

$$A_{\text{bar}} = 8.04 \text{ cm}^2$$

$$L_g = 9 \text{ m}$$

$$L_c = 8 \text{ m} \Rightarrow L_u = 8 - 0.6 = 7.4 \text{ m}$$

Column
 $h = 45 \text{ cm}$



$$P_u = 1.2(120) + 1.6(80) = 272 \text{ t}$$

$$\textcircled{a} \quad \psi_A = \psi_B = \frac{\sum [E_c I_c / L_c]}{\sum [E_s I_s / L_s]} = \frac{7 [0.7 I_{c,c} / L_c]}{2 [0.35 I_{s,s} / L_s]} = 0.95$$

$$K = 0.77$$

$$\textcircled{b} \quad \left(\frac{K L_u}{r} \right)_{\text{limit}} = 34 + 12 \left(\frac{M_{\text{max}}}{M_{2\text{ns}}} \right) \quad \text{or} \quad 40 \\ = 34 - 12 = \boxed{22}$$

$$r = 0.3 h_{\text{column}}$$

$$\frac{K L_u}{r} = \frac{(0.77) (7.4)}{(0.3) (0.6)} = 31.655 > \left(\frac{K L_u}{r} \right)_{\text{limit}} = 22$$

\therefore Column is slender.

$$\textcircled{c} \quad M_{\max} = \delta_{ns} M_m, \quad M_{\min} = P_4 (e_{\min})$$

$$= (P_4) \left(\frac{15 + 0.03 h_{\text{mm}}}{1000} \right)$$

$$\delta_{ns} = \frac{C_m}{1 - \alpha}$$

$$M_{\min, \text{min}} = (272) (0.0285)$$

$$C_m = 0.6 - 0.4 \left(\frac{M_{\min}}{M_{\max}} \right) \geq 0.4$$

$$= 7.752 \text{ t.m}$$

not control

$$C_m = 1$$

$$\beta_{\text{dfs}} = \frac{(1.2)(120)}{272} = 0.53$$

$$I_g = \frac{1}{12} BH^3 = \frac{1}{12} (49)^4 \text{ cm}^4$$

$$E_c = \frac{4700 \sqrt{f_c}}{100} = 278 \text{ t/cm}^2, \quad E_s = 2000 \text{ t/cm}^2$$

$$I_{se} = (2)(2)(8.04)(22.5 - 6.6)^2 = 8130 \text{ cm}^4$$

$$EI = \text{large of } \frac{(0.2) E_c I_g + E_s I_{se}}{1 + 0.53} = \frac{23045466}{12007230} \text{ t.cm}^2$$

$$\frac{0.14 E_c I_g}{1 + 0.53} = \frac{24836000}{24836000} \text{ t.cm}^2 \checkmark$$

$$P_{cr} = 754 \text{ t}$$

$$\alpha = \frac{272}{(0.75) 754} = 0.48$$

$$\delta_{ns} = \frac{1}{1 - 0.48} = 1.926 \leq 1.4$$

$$\delta_{ns} = 1.4$$

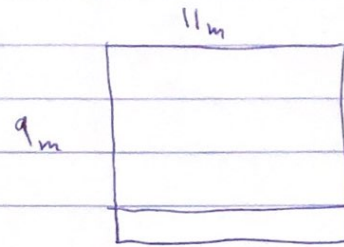
$$M_{\max} = \delta_{ns} M_m = 62.72 \text{ t.m}$$

Q.3



beam

$$b = 50 \text{ cm}$$



$$\text{thickness} = 27 \text{ cm}, d = 23 \text{ cm} = 0.23 \text{ m}$$

$$DL = 1.3 \text{ t/m}^2, LL = 0.6 \text{ t/m}^2$$

$$W_u = 2.52 \text{ t/m}^2$$

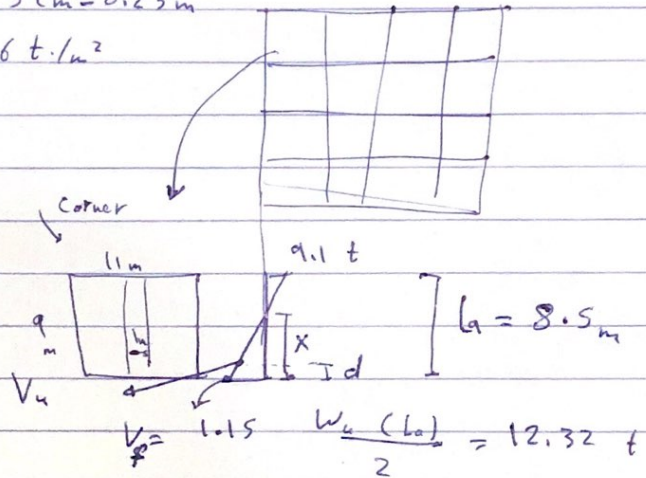
$$X_{F_m} > 2$$

(a)

$$\frac{9.1}{8.5 - X} = \frac{12.32}{X}$$

$$9.1 X = 104.72 - 12.32 X$$

$$X = 4.9 \text{ m}$$



$$\begin{aligned} \phi V_c &= \phi 0.8 \sqrt{F_c'} b d \\ &= (0.75)(0.17) \frac{\sqrt{35}}{100} (100)(23) \\ \phi V_c &= 17.35 \text{ t} \end{aligned}$$

$$\frac{V_u (\text{critical section})}{X - d} = \frac{V_u}{X}$$

$$\Rightarrow V_u = 11.74 \text{ t}$$

$\phi V_c > V_u$ \Rightarrow slab is adequate for shear.

$$L_b = 10.5 \text{ m}$$

(b)

$$m = 0.8$$

(⊗) ↗

for negative moment

$$l_a = 8.5 \text{ m}$$

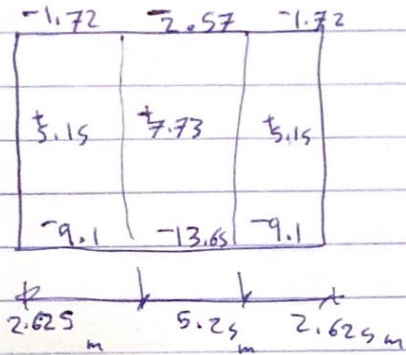
- long dir: $b(C.4, C.8)$

$$C_b = (0.029, 0.041) = 0.041$$

$$C_a = (0.071, 0.075) = 0.075$$

$$M_b = C_b \cdot w \cdot l_b^2 = 11.4 \text{ t.m}$$

$$M_a = 13.65 \text{ t.m}$$



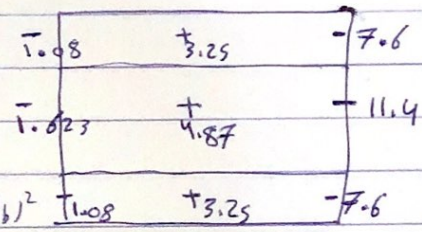
for Positive moment Case 4

- long.

$$C_{b,dl} = 0.016 \rightarrow M_{b,dl} = C_{b,dl} \cdot w \cdot (l_b)^2 = 2.75$$

$$C_{b,ll} = 0.020 \rightarrow M_{b,ll} = 2.11$$

$$M_{b,+} = 4.87 \text{ t.m}$$



- short dir:

$$C_{a,dl} = 0.039 \rightarrow M_{a,dl} = 4.4 \text{ t.m}$$

$$C_{a,ll} = 0.048 \rightarrow M_{a,ll} = 3.37 \text{ t.m}$$

$$M_{a,+} = 7.73 \text{ t.m}$$

