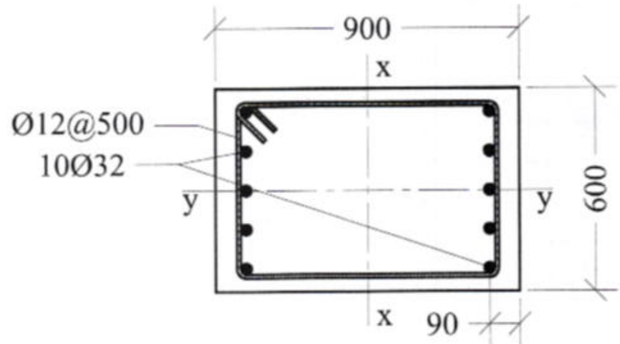
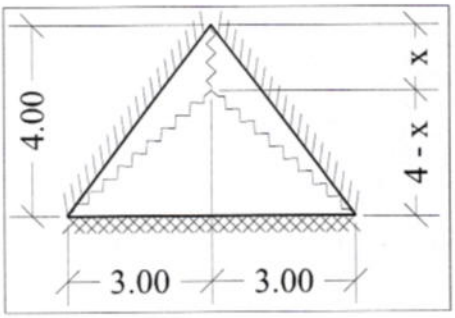
Reinforced Concrete Structures (II)	May. 31, 2014	Time: Three Hours
Fourth Year	Final Exam - First Attempt	**Closed Book & Notes**
Note: **Attempt Four Questions.**		Dr. Bassman R. Muhammad

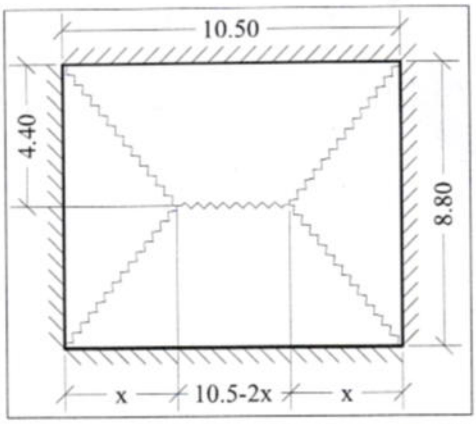
Q1: The tied column has $\ell_{ux} = 5.2$ m; $A_{st} = 8043$ mm^2; $f_y = 400$ MPa; $f'_c = 27$ MPa; $\psi_{topx} = \psi_{bottx} = 2$; storey stability index $Q_x = 0.2$, $P_u = 6300$ kN; top & bottom moments are equal causing single curvature: $M_{sx} = 590$ kN.m; $M_{nsx} = 342$ kN.m. Find if the column is SAFE per latest ACI 318M code?



Q2: A uniformly loaded isotropically reinforced concrete slab is supported as shown in the figure. Using the yield line analysis, find the nominal and factored collapse loads w_n & w_u. The plastic moments of resistance per meter width of the top and bottom bars are 40 and 30 kN.m/m respectively.



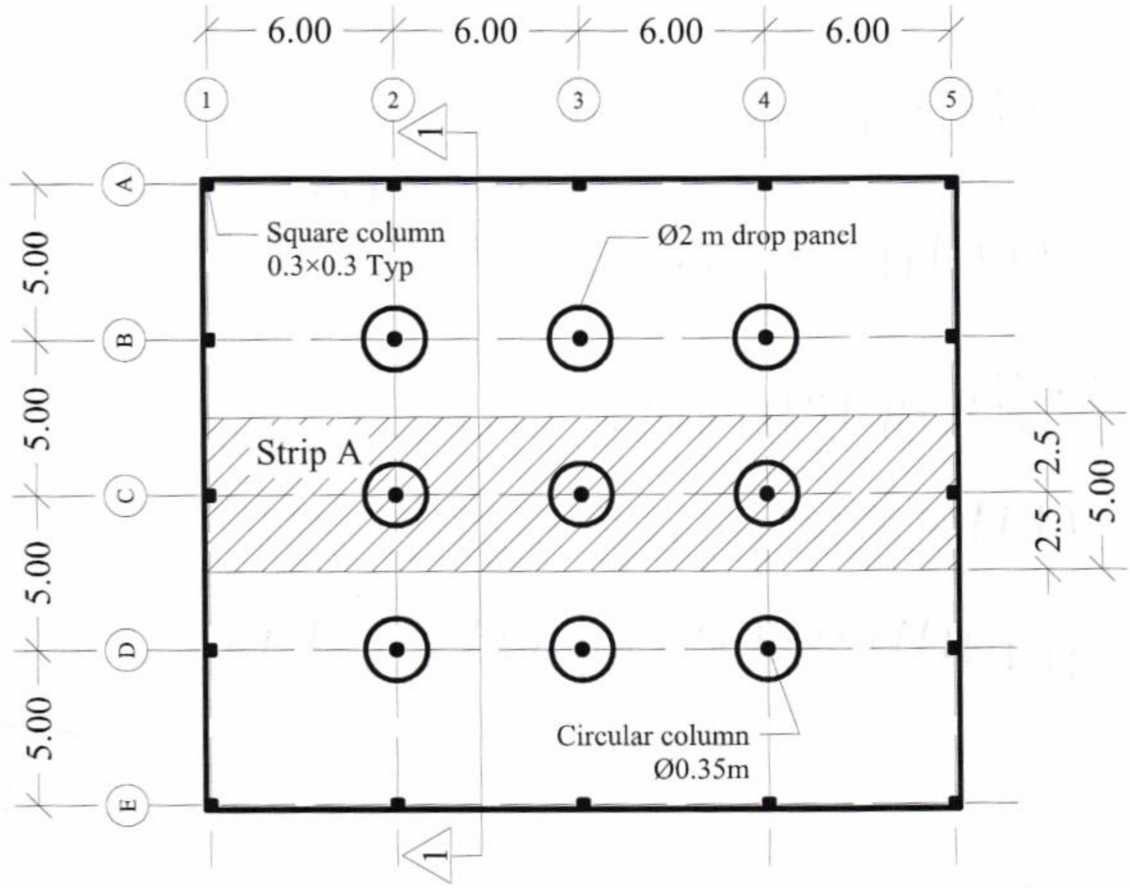
Q3: The uniformly loaded isotropically reinforced concrete slab is simply supported at its four-edges, as shown in the figure. The nominal resistance moment $m_n = 26$ kN.m/m. Using yield line analysis (virtual work ITERATION); calculate the uniform load values w_n & w_u (in kN/m^2).



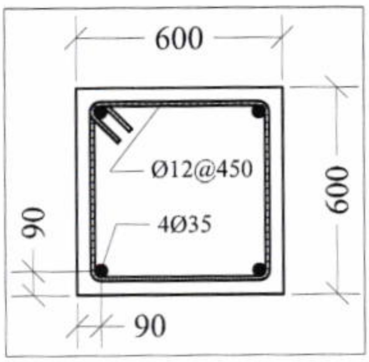
Q4: The flat plate carries service loading: total D = 7.5 kN/m^2 (including the slab self-weight) & L = 2.1 kN/m^2. Interior columns are circular of 350 mm in diameter; edge columns are square of 300 × 300 mm. f'_c = 27 N/mm^2, f_y = 350 N/mm^2; Slab thickness is 210 mm; drop panel thickness = 60 mm (ie total slab thickness under drop panel = 270 mm). Using the latest ACI 318M Direct Design Method, find:

a- For the shaded area of E-W strip A, the required spacing of Ø12 mm bottom bars in the column strip across line 1-1 (for positive moment only); and

b- Check two-way shear (punching shear) for interior columns.



Q5: The short tied 600 x 600 mm column has four 35 mm longitudinal bars. f_y = 400 MPa; f'_c =25 MPa; P_u = 2850 kN; M_{uy} = 310 kN.m. Using the Bresler Reciprocal Method, calculate the allowable value of the factored bending moment M_{ux}.



Good Luck and Wish You Success

Reinforced Concrete Structures
Final Exam - First Attempt - 2024
Solutions

Q.1 $Q_x > 0.05 \rightarrow$ sway frame ; $K = 1.6$

$\left(\frac{k l_u}{r}\right)_x = \frac{1.6 * 5.2}{0.3 * 0.9} = 30.8 > 22$ (check δ_s)

$\delta_{s_x} = \frac{1}{1 - Q_x} = \frac{1}{1 - 0.2} = 1.25$; $M_2 = 1.25 * 590 + 342 = 1079.5$ kN.m

$\left(\frac{e}{h}\right)_x = \frac{1079.5 * 1000 / 6300}{900} = 0.19$

$\rho_t m = \frac{10 * 32^2 \pi / 4}{900 * 600} * \frac{400}{0.85 * 27} = 0.26$

$\gamma_x = \frac{900 - 2 * 90}{900} = 0.8 \Rightarrow \alpha = 0.5 = \frac{0.7 P_n * 1000}{27 * 600 * 900}$

$\therefore P_{n_{prov.}} = 10414.28 \Rightarrow P_u = 0.65 P_n = 6769.28$ kN $> 6300 \Rightarrow$ O.K

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Q2: External work $= \frac{1}{3} \frac{6*4}{2} * \delta w_n = 4 w_n$

Internal work $= (3*2*40)\frac{\delta}{4-x} + (30*3*2)\frac{\delta}{4-x}$

$$+ 30*5 \frac{\delta}{0.6x} * 2 = \frac{2000-80x}{4x-x^2}$$

$\therefore w_n = \frac{1}{4} \frac{2000-80x}{4x-x^2}$

$\frac{\partial w}{\partial x} = 0 \Rightarrow (2000-80x)(4-2x) + (4x-x^2)(80) = 0$

$\therefore x = 2.087 \Rightarrow w_n = 114.78\ kN/m^2$ & $w_u = 103.302\ kN/m^2$

Q3: External work $= w_n \delta [\frac{8.8x}{2*3} * 2 + \frac{4.4*x}{2*3} * 4 + (10.5-2x)*4.4 * \frac{1}{2} * 2]$

External work $= \frac{138.6 - 8.8x}{3} w_n \delta$

Internal work $= (26*10.5\frac{\delta}{4.4} + 26*8.8\frac{\delta}{x})*2 = 52\delta \frac{10.5x + 38.72}{4.4x}$

$\therefore w_n = \frac{390}{11} \frac{10.5x + 38.72}{138.6x - 8.8x^2}$

$\therefore x = 4.7m$ & $w_u = 6.15\ kN/m^2$

x	w_n
3	7.3
3.5	7.1
4	6.94
4.5	6.84
5	6.83
4.6	6.83

Q4: CS width $= \frac{5}{4} * 2 = 2.5$ m

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$\ell_{cs}^{+} = 0.6$, column size equivalent $= (0.35^2 \pi/4)^{0.5} = 0.31$ m

$\ell_n = 6 - 0.31 = 5.7$ m ; $W_u = 1.2 * 7.5 + 1.6 * 2.1 = 12.36 \frac{kN}{m^2}$

$M_u = \frac{12.36 * 5 * 5.7^2}{8} * 0.35 * \frac{0.6}{2.5} = 21.1$ kN.m/m

$M_{ureq} = 21.1/0.9 = 23.43$ kN.m/m

$d = 210 - 20 - 12/2 = 184$ mm ; $f'_c = 22.95$ MPa

$\therefore a/d = 1 - \sqrt{1 - \frac{2 * 23.43 * 10^6}{22.95 * 1000 * 184^2}} = 0.03 \Rightarrow a = 5.63$ mm

$A_s = 369.4\ mm^2/m$; $A_{s\,min} = 420\ mm^2$ (controls)

$\therefore S = \frac{12^2 \pi/4 * 1000}{420} = 269$ mm ; $S_{max} = 2h = 820$ mm

use ϕ 12 @ 270 mm c/c