University of Al-Mustansiriyah- College of Engineering- Civil Engineering Department-4th Stage

2nd Semester-Quiz #1

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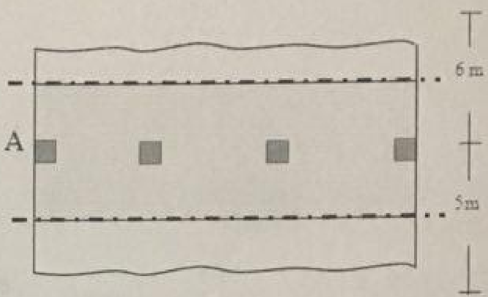
Q-1 / For the EF shown in Figure (1), find the equivalent column stiffness (K_{ec}) for upper and lower columns at joint (A) if:-
Slab thickness=175mm, Upper columns =400x400mm
Lower columns =450x450mm
Intermediate floor, story height=3.5m
$f_c' = 30MPa$, $f_y = 400MPa$

Figure (1)



Slab depth	Uniform load FEM= Coeff.($wl_2l_1^2$)		Stiffness factor		Carryover factor	
C_{1A}/ℓ_1	M_{AB}	M_{BA}	k_{AB}	k_{BA}	COF_{AB}	COF_{BA}
0.00	0.083	0.083	4.00	4.00	0.500	0.500
0.05	0.100	0.075	4.91	4.21	0.496	0.579
0.10	0.118	0.068	6.09	4.44	0.486	0.667
0.15	0.135	0.060	7.64	4.71	0.471	0.765
0.20	0.153	0.053	9.69	5.00	0.452	0.875
0.25	0.172	0.047	12.44	5.33	0.429	1.000

$$K_t = \sum \frac{9E_{cs}C}{l_2(1-\frac{c_2}{l_2})^3} \qquad \frac{1}{K_{ec}} = \frac{1}{\sum K_c} + \frac{1}{K_t}$$

$$C = \sum (1-0.63\frac{x}{y})\frac{x^3 y}{3}$$

Solution / Column stiffness

$$\frac{C1A}{L_1} = \frac{175}{3500} = 0.05 \longrightarrow K_{AB} = 4.91, \quad K_{BA} = 4.21$$ (1/10)

(1/10)

$$K_{c\,Top} = K_{c\,BA} = k_{BA}\frac{E_c I_c}{L_c} = \frac{4700\sqrt{30} \times \frac{(400)^4}{12}}{3500} \times 4.21 = 6.606 \times 10^{10} \text{ N.mm}$$

$$K_{c\,Bottom} = K_{c\,AB} = K_{AB}\frac{E_c I_c}{L_c} = \frac{4700\sqrt{30} \times \frac{(450)^4}{12}}{3500} \times 4.91 = 1.234 \times 10^{11} \text{ N.mm}$$ (1/10)

$$\sum K_c = 6.606 \times 10^{10} + 1.234 \times 10^{11} = 1.895 \times 10^{11} \text{ N.mm}$$

* Torsional member (1/10)

Section: 450mm × 175mm

$$C = (1-0.63\frac{175}{450})\frac{(175)^3 \times 450}{3} = 6.0695 \times 10^8 \text{ mm}^4$$

(2/10)

$$K_t = 9 \times 4700\sqrt{30} \times 6.0695 \times 10^8 \left[\frac{1}{5000(1-\frac{450}{5000})^3} + \frac{1}{6000(1-\frac{450}{6000})^3}\right]$$

$$= 1.406 \times 10^{14}(2.654 \times 10^{-4} + 2.106 \times 10^{-4}) = 6.693 \times 10^{10} \text{ N.mm}$$

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(2/10)

$$\frac{1}{K_{ec}} = \frac{1}{6.693 \times 10^{10}} + \frac{1}{1.895 \times 10^{11}} \Rightarrow K_{ec} = 4.95 \times 10^{10} \text{ N.mm}$$

$$K_{ec\,Top} = \frac{K_{c\,Top}}{\sum K_c} * K_{ec} = \frac{6.606 \times 10^{10}}{1.895 \times 10^{11}} \times 4.95 * 10^{10} = 1.72 \times 10^{10} \text{ N.mm}$$

(1/10)

$$K_{ec\ Bottom} = \frac{K_{c\ Bottom}}{\sum K_c} \times K_{ec} = \frac{1.234\times10^{11}}{1.895\times10^{11}}\ 4.95\times10^{10}$$

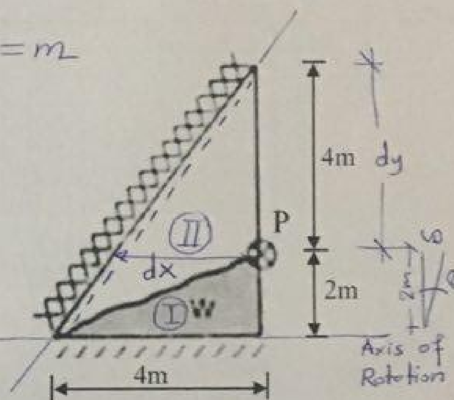
(1/10)

$$= 3.22\times10^{10}\ N.mm$$

Answer

13/3/2019

Q-2/ Use yield line theory with virtual work method to **find the concentrated collapse load (P)** for the isotropically slab shown in Figure. The slab is designed to carry a UDL of (W=3 kN/m²) **at the shaded area**



$$m^+ = m^- = m$$

$$EW = P*\delta + \frac{1}{2}\omega\times4\times2\times\frac{\delta}{3}$$

$$= P*1 + \frac{4}{3}\omega$$

(2/10)

$$EW = P + \frac{4}{3}\times3 = P+4$$

$$IW_{(I)} = m*l*\theta = m^+*l*\frac{\delta}{2}$$

$$= m^+*4*\frac{1}{2} = 2m$$

(2/10)

$$IW_{(II)} = \left[m^+\times l_x*\frac{1}{dy} + m^+\times l_y\times\frac{1}{dx}\right]$$

$$+\left[m^-\times l_x*\frac{1}{dy} + m^-\times l_y\times\frac{1}{dx}\right]$$

(2/10)

$$\frac{4}{6} = \frac{dx}{4}$$

$$dx = \frac{16}{6} \approx 2.67m$$

$$= \left[m^+\times4\times\frac{1}{4} + m^+\times2\times\frac{1}{(\frac{16}{6})}\right] + \left[m^-\times4\times\frac{1}{4} + m^-\times6\times\frac{1}{(\frac{16}{6})}\right]$$

$$= m^+ + \frac{3}{4}m^+ + m^- + \frac{9}{4}m^-$$

(2/10)

$$= 5m$$

$$IW_{Total} = 2m + 5m = 7m$$

$$EW = IW$$

$$P+4 = 7m$$

(2/10)

$$\therefore \boxed{P = 7m - 4}$$

Answer

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