CE382 - REINFORCED CONCRETE FUNDAMENTALS

$f_{cd} = 13$ MPa

$f_{yd} = 365$ MPa

Interior

$N_d = 1.4 \times 200 + 1.6 \times 150 = 520$ kN

$V_d = 1.4 \times 10 + 1.6 \times 16 = 33.6$ kN

$M_2 = 1.4 \times 0 + 1.6 \times 8 = 12.8$ kN.m

Exterior

$N_d = 1.4 \times 100 + 1.6 \times 50 = 220$ kN

$V_d = 1.4 \times 15 + 1.6 \times 18 = 63.8$ kN

$M_2 = 1.4 \times 15 + 1.6 \times 10 = 37$ kN.m

For 3m (Interior columns): $I_g/L = \frac{1}{12} \times 500^4 / 3000 = 1736 \times 10^3$ mm^3

For 3m (Exterior columns): $I_g/L = \frac{1}{12} \times 400^4 / 3000 = 711 \times 10^3$ mm^3

For 4m (Interior columns): $I_g/L = \frac{1}{12} \times 500^4 / 4000 = 1302 \times 10^3$ mm^3

For 4m (Exterior columns): $I_g/L = \frac{1}{12} \times 400^4 / 400 = 533 \times 10^3$ mm^3

For 6m beam: $I_{cr}/L = \frac{1}{12} \times 250 \times 500^3 / 6000 = 651 \times 10^3$ mm^3

For 5m beam: $I_{cr}/L = \frac{1}{12} \times 250 \times 500^3 / 5000 = 521 \times 10^3$ mm^3

Check sway frame; $\psi = 1.5 \times 5 \times \frac{(4 \times 520 + 2 \times 220)}{3000 \times [4 \times 33.6 + 2 \times 63.8]} = 0.024 < 0.05$

Non-sway frame. ✓

Sidesway is prevented.

Interior

$e = \frac{M_2}{N_d} = \frac{12800}{520} = 24.6 < e_{min} = 0.03 \times 500 + 15 = 30$ mm

$M_2 = e_{min} \times N_d = 30 \times 520 = 15.6$ kN.m

$\alpha_1 = \frac{1736 + 1302}{651 + 521} = 2.6$, $\alpha_2 = \frac{2 \times 1736}{651 + 521} = 3 \longrightarrow \alpha_n = 2.8$

$k = 0.7 + 0.1 \alpha_n = 0.98$

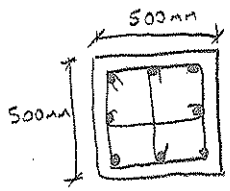
$l_n = 3000 - 500 = 2500$ mm $\longrightarrow l_k = 2500 \times 0.98 = 2450$ mm

$\frac{l_k}{i} = \frac{2450}{0.3 \times 500} = 16.3 \leq 34 - 12\left(\frac{M_1}{M_2}\right)$ short column!

$M_d = M_2 = 15.6$ kN.m

$\frac{N_d}{bhf_{cd}} = 0.16$, $\frac{M_d}{bh^2 f_{cd}} = 0.0036 \longrightarrow \rho_{tm} = 0.025$

$m = \frac{f_{yd}}{f_{cd}} = \frac{365}{13} = 28.08 \longrightarrow \rho_t \cong \rho_{min}$



$A_{st} = 0.28 \times \frac{13}{365} \times 500^2 = 2436$ mm^2 — Use $8\varnothing 20$: $8 \times 315 = 2520$ mm$^2 > A_{s,req}$

Exterior

$e = \frac{M_2}{N_d} = \frac{37000}{220} = 168.2 > e_{min}$ ✓

$\alpha_1 = \frac{711+533}{651} = 1.3$, $\alpha_2 = \frac{2\times711}{651} = 2.18$ ——— $\alpha_m = 2.04$

$k = 0.7 + 0.1\,\alpha_m = 0.904$

$l_n = 2500\ mm$ $l_k = 2500 \times 0.904 = 2260\ mm$

$\frac{l_k}{i} = \frac{2260}{0.3\times400} = 18.3 \leq 34 - 12\left(\frac{M_1}{M_2}\right)$ short column!

$M_d = M_d = 37\ kN.m$

$\frac{N_d}{bhf_{cd}} = 0.11$, $\frac{M_d}{bhf_{cd}} = 0.045$ ——— $\rho_{tm} = 0.28$ $n = \frac{365}{13}$

$\rho_t = 0.28 / \frac{365}{13} = 0.00337 \cong \rho_{min}$

$A_{st} = 0.28 \times \frac{13}{365} \times 400^2 = 1535\ mm^2$ ——— Use $6\,\emptyset20$: $6\times315 = 1890\ mm^2 > A_{s,req}$