Structural Design from First Principles 1st edition Byfield Solutions Manual

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(a) $I_{core} = \frac{30\times 30^3}{12} - \frac{29\times 29^3}{12} = 8560\text{m}^4$

$I_{mega\text{-}column} = \frac{2.5\times 2.5^3}{12} = 3.25\text{m}^4$

$I_{combined-frame} = I_{core} + 4\left(I_{mega-column} + Area_{mega-column}.r^2\right)$

$= 8560 + 4\left(3.25 + (2.5^2 \times 30^2)\right) = 31073\text{m}^4$

(b) $E = 20{,}000\text{N/mm}^2 = 20\times 10^6\,\text{kN/m}^2$

$\Delta_{actual} = \frac{wL^4}{8EI} = \frac{2.0\times 62.5\times 360^4}{8\times 20\times 10^6\times 31073} = 0.422\text{m}$

(c) $\Delta_{max} = \frac{360}{500} = 0.720\text{m} > \Delta_{actual}$ therefore OK

CHAPTER 2

Q2.1 An I section beam supports a dead load of 11kN/m (inclusive of beam self-weight) and an imposed load 7kN/m, both unfactored.

(a) Determine the ULS load

(b) Determine the mid-span design moment if the beam spans 6m between simple supports

(c) Determine the plastic moment of resistance if the plastic section modulus is 1471cm^3 and the yield stress is 275N/mm^2

(d) Determine the effective length of the beam if the beam is laterally unrestrained along its length but torsionally restrained at the supports, with the load applied to the top flange (i.e. it is a destabilising load)

(e) Determine the elastic critical buckling moment if Young's modulus, E = 210000N/mm^2, shear modulus, G = 80770N/mm^2, the major axis second moment of area, I_y = 29380cm^4, minor axis second moment of area, I_z = 1452cm^4, and the torsional constant, I_t = 37.1cm^4

(f) Determine the lateral torsional buckling design moment

(g) Is the beam strong enough?

SOLUTION TO Q.2.1

(a) Design loading = $(1.35\times 11) = (1.5\times 7) = 25.4\text{kN/m}$

(b) Design moment, $M_{Ed} = \frac{wL^2}{8} = \frac{25.4\times 6^2}{8} = 114\text{kN.m}$

(c) $M_{pl,Rd} = f_y\, W_{pl.y} = 275\times 1471\times 10^3\times 10^{-6} = 404.5\text{kN.m}$

(d) Effective length = 1.2x6000mm = 7200mm

(e) $M_{cr} = \frac{\pi}{7200}\times 10^{-6}\sqrt{\frac{210000\times 1452\times 10^4\times 80770\times 37.1\times 10^4}{1-1452/29380}} = 135\text{kN.m}$

(f) $M_{b,Rd} = \frac{404.5\times 135}{404.5+135} = 101\text{kN.m}$

(g) $M_{Ed} > M_{b,Rd}$ therefore the strength is not sufficient

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