SOLUTION TO WORKED EXAMPLE

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There is a new requirement for a timber floor within a newly refurbished building. The clear headroom of the floor is 3.0m. It is proposed that 250mm x 250mm C24 timber posts would be used to support the timber floor. Assuming the posts are pinned at both ends and is fully braced in both directions, verify that one of the edge posts can support the applied actions. The characteristic applied actions on this post are 50mm eccentric, and is as follows:

- Permanent Actions = 15.6kN
- Variable Actions = 106kN

Geometric Properties

L = 3.0m

Effective width, L_e = 1.0×l = 1.0×3000 = 3000mm

b = 150mm; h = 150mm;

A = 250 × 250 =62500mm^2

$$I = \frac{bh^3}{12} = \frac{250 \times 250^3}{12} = 325.5 \times 10^6 mm^4$$

$$Z = \frac{bh^2}{6} = \frac{250 \times 250^2}{6} = 260.4 \times 10^4 mm^4$$

$$i = i_{yy} = i_{zz} = \sqrt{\frac{I}{A}} = \sqrt{\frac{325 \times 10^6}{62500}} = 72.11mm$$

$$slenderness\ ratio\ \lambda_y = \lambda_z = \frac{L_e}{i} = \frac{3000}{72.11} = 41.60$$

Design Actions

Applied Axial Action

$$\mathrm{P} = 1.35G_K + 1.5Q_K = (1.35 \times 15.6) + (1.5 \times 106) = 180.1kN$$

Design Compressive Stress

$$\sigma_{c,0,d} = \frac{P}{A} = \frac{180.1 \times 10^3}{62500} = 2.88N/mm^2$$

Applied Bending Moment

$$\mathrm{M} = (180.1 \times 0.05) = 9.00kN.m$$

Design Bending Stress

$$\sigma_{c,0,d} = \frac{M}{Z} = \frac{9 \times 10^6}{264 \times 10^4} = 3.41N/mm^2$$

Member Verification

Design for Compressive Stress

$$\lambda_{rel,y} = \lambda_{rel,z} = \frac{\lambda}{\pi}\sqrt{\frac{f_{c,0,k}}{E_{0.05}}} = \frac{41.60}{3.142}\sqrt{\frac{21}{7.4 \times 10^3}} = 0.71$$

$$> 1\ (Platic\ behaviour\ is\ not\ valid\ \&Post\ is\ slender)$$

$$k = k_y = k_z = 0.5[1 + \beta_v(\lambda_{rel} - 0.3) + \lambda_{rel}^2] = 0.5[1 + 0.2(0.71 - 0.3) + 0.71^2] = 0.79$$

$$k_c = k_{c,y} = k_{c,z} = \frac{1}{k + \sqrt{k + \lambda_{rel}^2}} = \frac{1}{0.79 + \sqrt{0.79^2 + 0.71^2}} = 0.54$$

$$f_{c,0,d} = k_c \times \frac{k_{mod} f_{c,0,k}}{\gamma_M} = 0.54 \times 0.7 \times \frac{21}{1.3} = 6.1N/mm^2$$

$$\sigma_{c,0,d}(2.88N//mm^2) \leq f_{c,0,d}(6.1N/mm^2)\ \boldsymbol{o.k}$$

Combined Actions review

$$f_{m,y,d} = \frac{k_{mod} f_{m,k}}{\gamma_M} = 0.7 \times \frac{24}{1.3} = 12.9 N/mm^2$$

Since column is slender, hence:

$$\left[\frac{2.88}{6.1}\right]^2 + 1.0\left(\frac{3.41}{12.9}\right) = 0.49 \leq 1 \quad \boldsymbol{o.k}$$