

## Braced panel vertical post and bracing design in long term-duration loading

|   |                                   |
|---|-----------------------------------|
| Wood type:  | C24                               |
| Braced panel height:  | $H := 3.0 \text{ m}$              |
| Braced panel width:   | $B := 0.8 \text{ m}$              |
| Bracing angle:  | $\alpha := 63.44 \text{ deg}$     |
| Width of wooden element:                                    | $b := 45 \text{ mm}$              |
| Height of wooden element:                                   | $h := 95 \text{ mm}$              |
| Buckling length about x axis (minus minimal lintel height): | $l_x := 2.886 \text{ m}$          |
| Buckling length about y axis:                               | $l_y := 0.628 \text{ m}$          |
| Factor for support condition at the ends of the element:    | $\mu_x := 1 \quad \mu_y := 1$     |
| Factor for solid timber straightness:                       | $\beta_c := 0.2$                  |
| Charac. wood bending strength:                              | $f_{m,k} := 24 \text{ MPa}$       |
| Charac. wood compression strength parallel to the grain:    | $f_{c,0,k} := 21 \text{ MPa}$     |
| Charac. wood tension strength parallel to the grain:        | $f_{t,0,k} := 14 \text{ MPa}$     |
| Wood modulus of elasticity parallel to the grain:           | $E_{0,05} := 7400 \text{ MPa}$    |
| Wood modulus of mean elasticity parallel to the grain:      | $E_{0,mean} := 11000 \text{ MPa}$ |
| Factor for duration loading and service:                    | $k_{mod} := 0.6$                  |
| Factor for load shearing:                                   | $k_{sys} := 1.0$                  |
| Deformation factor for for solid timber class 1:            | $k_{def} := 0.6$                  |
| Partial factor for wood properties:                         | $\gamma_M := 1.30$                |

## Rectangular panel member design for compression

Design wood compression strength:

$$f_{c.0.d} := \frac{k_{mod} \cdot f_{c.0.k}}{\gamma_M} = 9.692 \frac{N}{mm^2}$$

Cross-sectional area:

$$A := b \cdot h = 42.75 \text{ cm}^2$$

Second moment of area:

$$I_x := \frac{h^3 \cdot b}{12} = 321.516 \text{ cm}^4 \quad I_y := \frac{h \cdot b^3}{12} = 72.141 \text{ cm}^4$$

Radius of gyration:

$$i_x := \sqrt{\frac{I_x}{A}} = 27.424 \text{ mm} \quad i_y := \sqrt{\frac{I_y}{A}} = 12.99 \text{ mm} \quad i := \min(i_x, i_y) = 12.99 \text{ mm}$$

Design element length:

$$l_{ef,x} := \mu_x \cdot l_x = 2.886 \text{ m} \quad l_{ef,y} := \mu_y \cdot l_y = 0.628 \text{ m}$$

Slenderness ratio:

$$\lambda_x := \frac{l_{ef,x}}{i_x} = 105.236 \quad \lambda_y := \frac{l_{ef,y}}{i_y} = 48.343 \quad \lambda := \max(\lambda_x, \lambda_y) = 105.236$$

Relative slenderness:

$$\lambda_{rel} := \frac{\lambda}{\pi} \cdot \sqrt{\frac{f_{c.0.k}}{E_{0.05}}} = 1.784$$

Instability factor:

$$k := 0.5 \cdot (1 + \beta_c \cdot (\lambda_{rel} - 0.3) + \lambda_{rel}^2) = 2.241$$

$$k_c := \frac{1}{k + \sqrt{k^2 - \lambda_{rel}^2}} = 0.278$$

Design buckling strength:

$$k_c \cdot f_{c.0.d} = 2.696 \frac{N}{mm^2}$$

Compressive stress/Design buckling strength equation :

$$N_{c,d} := f_{c,0,k} \cdot A \cdot k_c = 24.968 \text{ kN}$$

$$N_{c,d} := f_{c,0,d} \cdot A \cdot k_c = 11.524 \text{ kN}$$

### Rectangular panel member design for tension

$$f_{t,0,d} := \frac{f_{t,0,k} \cdot k_{mod}}{\gamma_M} = 6.462 \frac{\text{N}}{\text{mm}^2}$$

$$N_{T,d} := f_{t,0,d} \cdot A = 27.623 \text{ kN}$$

Vertical design loads:  $F_{v,d} := 0 \text{ kN}$

#### Compression

$$F_{h,d,1} := \frac{N_{c,d} \cdot \cos(\alpha) - F_{v,d} \cdot \cos(\alpha)}{\sin(\alpha)} = 5.761 \text{ kN}$$

$$F_{h,d,2} := N_{c,d} \cdot \cos(\alpha) = 5.153 \text{ kN}$$

$$F_{h,d,c} := \min(F_{h,d,1}, F_{h,d,2}) = 5.153 \text{ kN}$$

#### Tension

$$F_{h,d,4} := N_{T,d} \cdot \cos(\alpha) = 12.351 \text{ kN}$$

$$F_{h,d,3} := -\left( \frac{F_{v,d} \cdot \cos(\alpha) - N_{T,d} \cdot \cos(\alpha)}{2 \cdot \sin(\alpha)} \right) = 6.904 \text{ kN}$$

$$F_{h,d,t} := \min(F_{h,d,3}, F_{h,d,4}) = 6.904 \text{ kN}$$

#### Maximal lateral load

$$F_{h,d} := \min(F_{h,d,c}, F_{h,d,t}) = 5.153 \text{ kN}$$

### Compression

$$N_{1,2} := F_{v,d} + \frac{F_{h,d} \cdot \sin(\alpha)}{\cos(\alpha)} = 10.308 \text{ kN}$$

$$N_{1,5} := \frac{F_{h,d}}{\cos(\alpha)} = 11.524 \text{ kN}$$

$$N_{2,3} := F_{h,d} = 5.153 \text{ kN}$$

### Tension

$$N_{2,5} := \frac{-F_{h,d}}{\cos(\alpha)} = -11.524 \text{ kN}$$

$$N_{3,5} := F_{v,d} = 0 \text{ kN}$$

$$N_{4,5} := F_{v,d} - \frac{F_{h,d} \cdot \sin(\alpha)}{\cos(\alpha)} \cdot 2 = -20.615 \text{ kN}$$

### Reactions

$$R_{1y} := F_{v,d} - \frac{F_{h,d} \cdot \sin(\alpha)}{\cos(\alpha)} \cdot 2 = -20.615 \text{ kN}$$

$$R_{2y} := F_{v,d} + \frac{F_{h,d} \cdot \sin(\alpha)}{\cos(\alpha)} \cdot 2 = 20.615 \text{ kN}$$

$$R_{1x} := F_{h,d} = 5.153 \text{ kN}$$

$$R_{2x} := 0$$

$$F_{h,d} = 5.153 \text{ kN}$$

