**TALAT Lecture 2301**

# Design of Members

# Axial Force

# Example 5.5 : Axial force resistance of laced column

3 pages

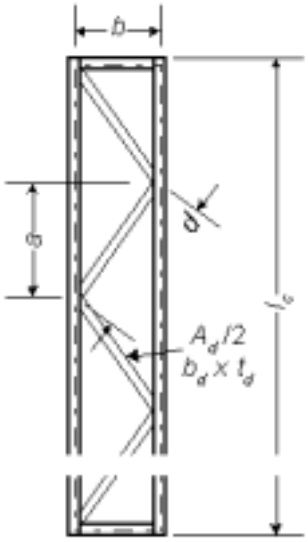
Advanced Level

**prepared by Torsten Höglund, Royal Institute of Technology, Stockholm**

**Date of Issue: 1999**

# Example 5.5. Axial force resistance of laced column

| | | | | | |
|---|---|---|---|---|---|
| | Width | $b := 400 \cdot mm$ | | $f_o := 200 \cdot MPa$ | $kN \equiv 1000 \cdot newton$ |
| | Longitudinal members | $d_o := 30 \cdot mm$ | $d_i := 20 \cdot mm$ | $E := 70000 \cdot MPa$ | $MPa \equiv 10^6 \cdot Pa$ |
| | Lacing | $b_d := 40 \cdot mm$ | $t_d := 10 \cdot mm$ | $\gamma_{M1} := 1.0$ | |
| | $a := 500 \cdot mm$ | $d := \sqrt{a^2 + b^2}$ | $d = 640.3 \cdot mm$ | | |
| | Effective length | $l_c := 5 \cdot m$ | $\frac{l_c}{a} = 10$ | | |
| | Axial force | $N_{Ed} := 270 \cdot kN$ | | | |




## 5.4.3 Slenderness parameters

**Single main member**

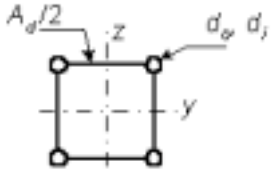
$$A_l := \pi \cdot \frac{d_o^2 - d_i^2}{4} \qquad A_l = 392.699 \cdot mm^2$$

$$I_l := \pi \cdot \frac{d_o^4 - d_i^4}{64} \qquad I_l = 3.191 \cdot 10^4 \cdot mm^4$$

$$i_l := \sqrt{\frac{I_l}{A_l}} \qquad i_l = 9.014 \cdot mm$$

Effective length $2 \cdot a$

$$\lambda_1 := \frac{2 \cdot a}{i_l} \cdot \frac{1}{\pi} \cdot \sqrt{\frac{f_o}{E}} \qquad \lambda_1 = 1.888$$




**Four main member**

$$A := 4 \cdot A_l \qquad A = 1.571 \cdot 10^3 \cdot mm^2$$

$$I := 4 \cdot I_l + 4 \cdot A_l \cdot \left(\frac{b}{2}\right)^2 \qquad I = 6.296 \cdot 10^7 \cdot mm^4$$

$$i := \sqrt{\frac{I}{A}} \qquad i = 200.2 \cdot mm$$

Effective length $l_c$

$$\lambda_o := \frac{l_c}{i} \cdot \frac{1}{\pi} \cdot \sqrt{\frac{f_o}{E}} \qquad \lambda_o = 0.425$$

**Lacing**

$$A_d := b_d \cdot t_d \qquad A_d = 400 \cdot mm^2$$

$$I_d := \frac{b_d \cdot t_d^3}{12} \qquad I_d = 3.333 \cdot 10^3 \cdot mm^4$$

Effective length $d$

$$i_d := \sqrt{\frac{I_d}{A_d}} \qquad i_d = 2.9 \cdot mm$$

$$\lambda_d := \frac{d}{i_d} \cdot \frac{1}{\pi} \cdot \sqrt{\frac{f_o}{E}} \qquad \lambda_d = 3.774$$

**Composite member**

$$\lambda_c := \sqrt{\lambda_o^2 + \frac{f_o \cdot A \cdot d^3}{E \cdot A_d \cdot a \cdot b^2}} \qquad \lambda_c = 0.466$$

5.8.4 **Flexural buckling, buttoned strut**

Table 5.5 and 5.6

$\alpha := 0.2 \quad \lambda_o := 0.1 \quad k_1 := 1 \quad k_2 := 1 \quad \lambda := \lambda_c \quad \lambda_c = 0.466$

(5.33)

$\phi := 0.5\cdot\left[1 + \alpha\cdot\left(\lambda - \lambda_o\right) + \lambda^2\right] \quad \chi := \frac{1}{\phi + \sqrt{\phi^2 - \lambda^2}} \quad \phi = 0.645 \quad \chi = 0.916$

5.8.3 (1)

$N_{b.Rd} := \chi\cdot k_1\cdot k_2\cdot\frac{f_o}{\gamma_{M1}}\cdot A \qquad N_{b.Rd} = 287.8\cdot kN$

5.8.4 **Flexural buckling, single longitudinal member**

Table 5.5 and 5.6

$\alpha := 0.2 \quad \lambda_o := 0.1 \quad k_1 := 1 \quad k_2 := 1 \quad \lambda := \lambda_l$

(5.33)

$\phi := 0.5\cdot\left[1 + \alpha\cdot\left(\lambda - \lambda_o\right) + \lambda^2\right] \quad \chi := \frac{1}{\phi + \sqrt{\phi^2 - \lambda^2}} \quad \phi = 2.46 \quad \chi = 0.248$

5.8.3 (1)

$N_{l.Rd} := \chi\cdot k_1\cdot k_2\cdot\frac{f_o}{\gamma_{M1}}\cdot A_l \qquad N_{l.Rd} = 19.4\cdot kN$

5.8.4 **Flexural buckling, lacing**

TALAT (5.22)

$q_\chi := \frac{0.015\cdot N_{Ed}}{l_c\cdot\left(1 - \frac{N_{Ed}\cdot\lambda_c^2}{0.9\cdot A\cdot f_o}\right)} \quad q_\chi = 1.022\cdot kN\cdot m^{-1} \quad V_\chi := \frac{q_\chi\cdot l_c}{2} \quad V_\chi = 2.555\cdot kN$

$N_l := V_\chi\cdot\frac{d}{b} \quad 0.02\cdot N_{b.Rd} = 5.757\cdot kN \quad N_l = 4.091\cdot kN$

$\lambda := \lambda_d$

(5.33)

$\phi := 0.5\cdot\left[1 + \alpha\cdot\left(\lambda - \lambda_o\right) + \lambda^2\right] \quad \chi := \frac{1}{\phi + \sqrt{\phi^2 - \lambda^2}} \quad \phi = 7.989 \quad \chi = 0.067$

5.8.3 (1)

$N_{l.Rd} := \chi\cdot k_1\cdot k_2\cdot\frac{f_o}{\gamma_{M1}}\cdot A_d \qquad N_{l.Rd} = 5.3\cdot kN \quad < N_l$ OK !