

**TALAT Lecture 2301**

**Design of Members**

**Concentrated Load**

**Example 7.1 : Concentrated force**

4 pages

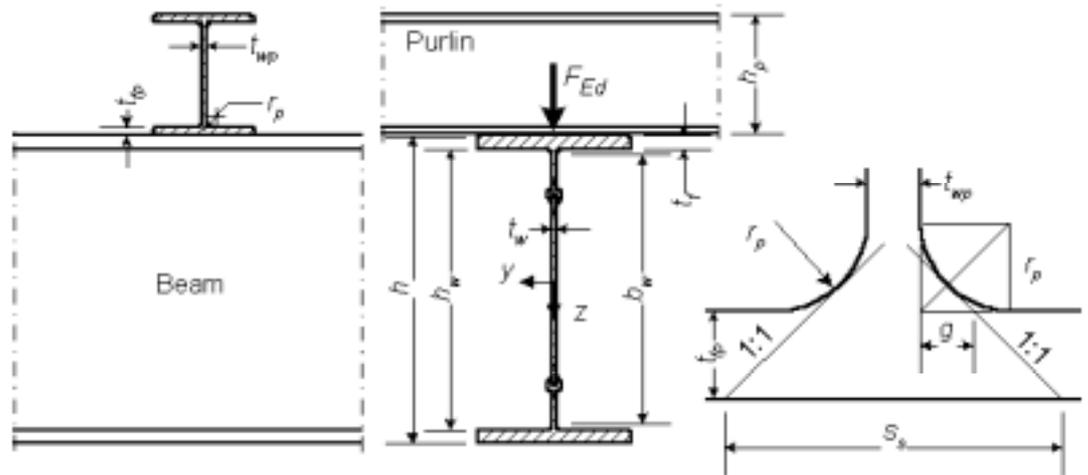
Advanced Level

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

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## Example 7.1. Concentrated force



### Dimensions and material properties

#### Beam:

|                   |                             |
|-------------------|-----------------------------|
| Section height:   | $h := 570 \cdot \text{mm}$  |
| Flange width:     | $b := 160 \cdot \text{mm}$  |
| Flange thickness: | $t_f := 16 \cdot \text{mm}$ |
| Web thickness:    | $t_w := 5 \cdot \text{mm}$  |
| Fillet radius:    | $r := 4 \cdot \text{mm}$    |
| Overall length:   | $L := 10 \cdot \text{m}$    |

#### Purlin (p):

|                           |                                |
|---------------------------|--------------------------------|
| Section height:           | $h_p := 180 \cdot \text{mm}$   |
| Flange width:             | $b_p := 12 \cdot \text{mm}$    |
| Flange thickness:         | $t_{fp} := 12 \cdot \text{mm}$ |
| Web thickness:            | $t_{wp} := 5 \cdot \text{mm}$  |
| Fillet radius:            | $r_p := 5 \cdot \text{mm}$     |
| Distance between purlins: | $c_p := 1.2 \cdot \text{m}$    |

Table 3.2b Alloy: **EN AW-6082 T6** EP/O  $t > 5 \text{ mm}$

$f_{0.2} := 260 \cdot \text{MPa}$

$f_u := 310 \cdot \text{MPa}$

(5.4), (5.5)  $f_o := f_{0.2}$

$f_a := f_u$

$E := 70000 \cdot \text{MPa}$

Partial safety factors:  $\gamma_{M1} 1.10$

S.I. units

$\text{kN} \equiv 1000 \cdot \text{newton}$

$\text{kNm} \equiv \text{kN} \cdot \text{m}$

$\text{MPa} \equiv 1000000 \cdot \text{Pa}$

## Concentrated force resistance of beam

|                       |   |   |
|-----------------------|---|---|
| 5.12.8                | $b_f := b$ $f_{of} := f_o$ $f_{ow} := f_o$<br>$h_w := h - 2 \cdot t_f$ $h_w = 538 \text{ mm}$ $a := L$  |   |
| Figure 5.24 and above | Length of stiff bearing<br>$g := (r_p \cdot \sqrt{2} - r_p) \cdot \sqrt{2}$<br>$s_s := t_{wp} + 2 \cdot g + 2 \cdot t_{fp}$   | $g = 2.9 \text{ mm}$<br>$s_s = 34.9 \text{ mm}$ |
| (5.109)               | Parameter $m_1$<br>$m_1 := \frac{f_{of} \cdot b_f}{f_{ow} \cdot t_w}$   | $m_1 = 32$                                      |
| Figure 5.24           | Buckling coefficient<br>$k_F := 6 + 2 \cdot \left(\frac{h_w}{a}\right)^2$   | $k_F = 6.01$                                    |
| (5.110)               | Parameter $m_2$<br>$m_2 := \text{if} \left[ \frac{(s_s + 4 \cdot t_f) \cdot h_w \cdot f_{ow}}{k_F \cdot E \cdot t_w^2} > 0.2, 0.02 \cdot \left(\frac{h_w}{t_f}\right)^2, 0 \right]$ | $m_2 = 22.6$                                    |
| (5.111)               | Effective loaded length $l_y$<br>$l_y := s_s + 2 \cdot t_f \cdot \left(1 + \sqrt{m_1 + m_2}\right)$   | $l_y = 303.3 \text{ mm}$                        |
| (5.108)               | Design resistance<br>$F_{Rd} := 0.57 \cdot t_w^2 \cdot \sqrt{\frac{k_F \cdot l_y \cdot f_{ow} \cdot E}{h_w}} \cdot \frac{1}{\gamma_{M1}}$   | $F_{Rd} = 101.7 \text{ kN}$                     |
|                       | $F_{Rd} := \text{if} \left[ F_{Rd} > \left(t_w \cdot l_y \cdot \frac{f_{ow}}{\gamma_{M1}}\right), \left(t_w \cdot l_y \cdot \frac{f_{ow}}{\gamma_{M1}}\right), F_{Rd} \right]$      | $F_{Rd} = 101.7 \text{ kN}$                     |

## 5.12.9 Flange induced buckling

|         |                                    |  |                 |     |
|---------|------------------------------------|--|-----------------|-----|
|         | Elastic moment resistance utilised | $k := 0.55$  | $f_{of} := f_o$ |     |
| (5.115) | $LS = \frac{h_w}{t_w} = 107.6$     | $RS = \frac{k \cdot E}{f_{of}} \cdot \sqrt{\frac{h_w \cdot t_w}{b \cdot t_f}} = 151.8$ | $LS < RS$       | OK! |

## Concentrated force resistance of purlin (upward)

|                       |  |   |
|-----------------------|--|---|
| 5.12.8                | $b_f := b_p$ $f_{of} := f_o$ $f_{ow} := f_o$<br>$h_{wp} := h_p - 2 \cdot t_{fp}$ $h_{wp} = 156 \text{ mm}$ $a_p := 10 \text{ m}$   |   |
| Figure 5.24 and above | Length of stiff bearing<br>$g := (r \cdot \sqrt{2} - r) \cdot \sqrt{2}$<br>$s_s := t_w + 2 \cdot g + 2 \cdot t_f$  | $g = 2.3 \text{ mm}$<br>$s_s = 41.7 \text{ mm}$ |
| (5.109)               | Parameter $m_1$<br>$m_1 := \frac{f_{of} \cdot b_f}{f_{ow} \cdot t_{wp}}$   | $m_1 = 2.4$                                     |
| Figure 5.24           | Buckling coefficient<br>$k_F := 6 + 2 \cdot \left( \frac{h_{wp}}{a_p} \right)^2$   | $k_F = 6$                                       |
| (5.110)               | Parameter $m_2$<br>$m_2 := \text{if} \left[ \frac{(s_s + 4 \cdot t_{fp}) \cdot h_{wp} \cdot f_{ow}}{k_F \cdot E \cdot t_{wp}^2} > 0.2, 0.02 \cdot \left( \frac{h_{wp}}{t_{fp}} \right)^2, 0 \right]$ | $m_2 = 3.4$                                     |
| (5.111)               | Effective loaded length $l_y$<br>$l_y := s_s + 2 \cdot t_{fp} \cdot \left( 1 + \sqrt{m_1 + m_2} \right)$   | $l_y = 123.4 \text{ mm}$                        |
| (5.108)               | Design resistance<br>$F_{Rd} := 0.57 \cdot t_{wp}^2 \cdot \sqrt{\frac{k_F \cdot l_y \cdot f_{ow} \cdot E}{h_{wp}}} \cdot \frac{1}{\gamma_{MI}}$  | $F_{Rd} = 120.4 \text{ kN}$                     |
|                       | $F_{Rd} := \text{if} \left[ F_{Rd} > \left( t_{wp} \cdot l_y \cdot \frac{f_{ow}}{\gamma_{MI}} \right), \left( t_{wp} \cdot l_y \cdot \frac{f_{ow}}{\gamma_{MI}} \right), F_{Rd} \right]$             | $F_{Rd} = 120.4 \text{ kN}$                     |