

TALAT Lecture 2301
Design of Members
Torsion

Example 8.3 : Torsion constants for deck profile

3 pages

Advanced Level

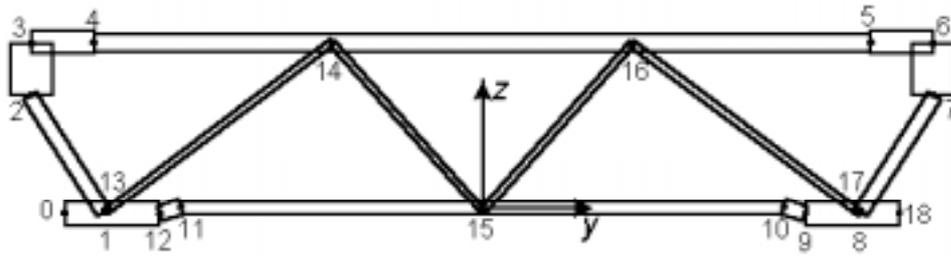
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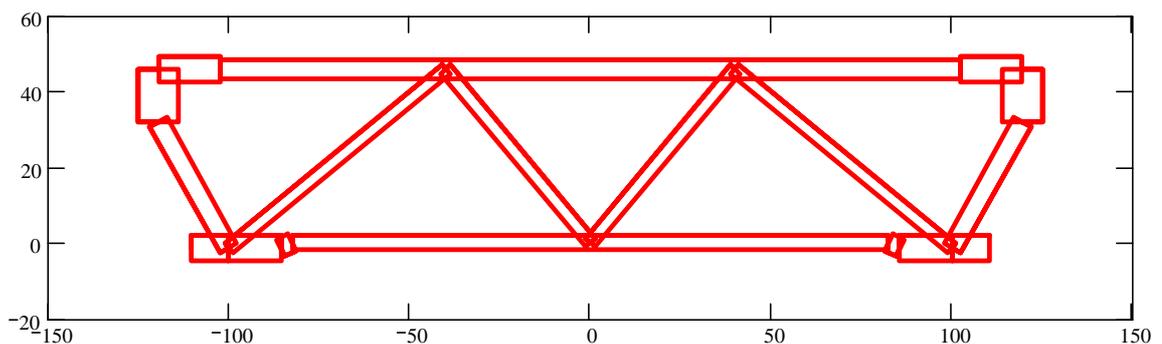
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Example 8.3. Torsion constants for deck profile

This example is a simplification of an aluminium profile used in a bridge deck.



| Nodes, co-ordinates, thickness | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | |
|--------------------------------------|------|--------|--------|--------|--------|-------|-------|-------|------|------|------|-------|-------|------|-------|-----|-------|------|-------|-----|
| $i :=$ | 0 | -110.5 | -119.5 | -119.5 | -102.5 | 102.5 | 119.5 | 119.5 | 100 | 85.5 | 82.5 | -82.5 | -85.5 | -100 | -40 | 0 | 40 | 100 | 110.5 | |
| $y :=$ | | -110.5 | -119.5 | -119.5 | -102.5 | 102.5 | 119.5 | 119.5 | 100 | 85.5 | 82.5 | -82.5 | -85.5 | -100 | -40 | 0 | 40 | 100 | 110.5 | |
| $z :=$ | -1.5 | -1.5 | 31.75 | 45.75 | 45.75 | 45.75 | 45.75 | 31.75 | -1.5 | -1.5 | 0 | 0 | -1.5 | -1.5 | 45.75 | 0 | 45.75 | -1.5 | -1.5 | |
| $t :=$ | 6.5 | 6.5 | 5.25 | 11 | 6.5 | 5 | 6.5 | 11 | 5.25 | 6.5 | 5 | 3.5 | 5 | 6.5 | 3.5 | 3.5 | 3.5 | 3.5 | 6.5 | 6.5 |



Nodes $i := 1.. rows(y) - 1$ $rows(y) - 1 = 18$

Area of cross section elements $dA_i := \left[t_i \cdot \sqrt{(y_i - y_{i-1})^2 + (z_i - z_{i-1})^2} \right]$

Cross section area $A := \sum_{i=1}^{rows(y)-1} dA_i$ $A = 3.855 \cdot 10^3 \cdot mm^2$

First moment of area. Gravity centre $S_y := \sum_{i=1}^{rows(y)-1} (z_i + z_{i-1}) \cdot \frac{dA_i}{2}$ $z_{gc} := \frac{S_y}{A}$
 $z_{gc} = 24.932 \cdot mm$

Second moment of area $I_y := \sum_{i=1}^{rows(y)-1} \left[(z_i)^2 + (z_{i-1})^2 + z_i \cdot z_{i-1} \right] \cdot \frac{dA_i}{3}$ $I_y := I_y - A \cdot z_{gc}^2$
 $I_y = 1.468 \cdot 10^6 \cdot mm^4$

First moment of area. Gravity centre $S_z := \sum_{i=1}^{rows(y)-1} (y_i + y_{i-1}) \cdot \frac{dA_i}{2}$ $y_{gc} := \frac{S_z}{A}$
 $y_{gc} = 0 \cdot m$

Second moment of area $I_z := \sum_{i=1}^{rows(y)-1} \left[(y_i)^2 + (y_{i-1})^2 + y_i \cdot y_{i-1} \right] \cdot \frac{dA_i}{3}$ $I_z := I_z - A \cdot y_{gc}^2$
 $I_z = 2.33 \cdot 10^7 \cdot mm^4$

When calculating torsion constants the interior branches are omitted

Area within mid-line $A_v := \sum_{i=2}^{13} 0.5 \cdot (y_i - y_{i-1}) \cdot (z_i + z_{i-1})$ $A_v = 1.039 \cdot 10^4 \cdot mm^2$

Sum of I/t $Dn := \sum_{i=2}^{13} \left[\text{if } t_i > 0 \cdot mm, \frac{\sqrt{(y_i - y_{i-1})^2 + (z_i - z_{i-1})^2}}{t_i}, 0 \right]$ $Dn = 116.407$

Torsion constant $I_v := \frac{4 \cdot A_v^2}{Dn}$ $I_v = 3.711 \cdot 10^6 \cdot mm^4$

Correct value incl. branches: $I_{vc} = 3.713 \cdot 10^6 \cdot mm^4$

Torsion resistance $i := 0.. 13$ $t_{m_i} := \text{if}(t_i > 0 \cdot mm, t_i, 100 \cdot mm)$
 $W_v := 2 \cdot A_v \cdot \min(t_m)$ $\min(t_m) = 3.5 \cdot mm$ $W_v = 7.275 \cdot 10^4 \cdot mm^3$