

POSITION 3: SCHNEIDER BT 8.38

1. Input parameters

1.1. General statements

results acc. to DIN EN 1993:2010, Germany

verification of classification of the cross-section (width to thickness ratio)

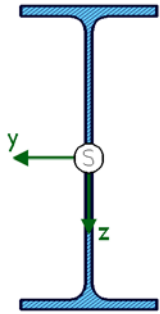
torsional-flexural buckling by the method of fictitious bars acc. to EN 1993-1-1 6.3.2 only M_y

1.2. Cross-section

material: S235 (St37)

section: IPE400

section scale 1:10



1.3. Section properties (referring to centroid S)

$I_y = 23130 \text{ cm}^4$, $I_z = 1320 \text{ cm}^4$, $I_w = 490000.0 \text{ cm}^6$, $I_t = 51.40 \text{ cm}^4$

$W_y = 1160.00 \text{ cm}^3$, $W_z = 146.00 \text{ cm}^3$, $W_{p1,y} = 1307.00 \text{ cm}^3$, $W_{p1,z} = 229.00 \text{ cm}^3$

$z_{m,y} = 0 \text{ mm}$, $z_{m,z} = 0 \text{ mm}$, $A = 8450 \text{ mm}^2$, cross-section is susceptible to torsional deformations

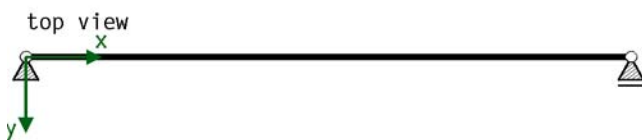
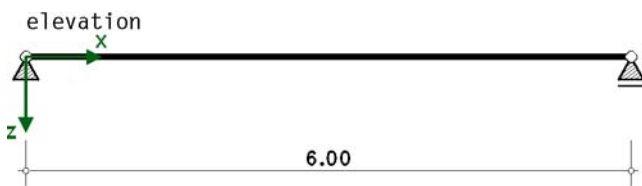
1.4. Load application point (referring to centroid S)

$z_{\text{load}} = -200 \text{ mm}$ (top edge of cross-section),

1.5. Structural system

all supports with fork conditions, beam length 6.000 [m]

no support in z-direction, no support in y-direction



1.6. Buckling factors

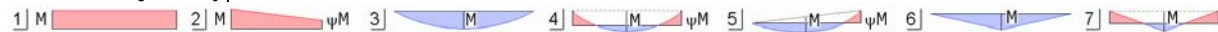
about the y-axis: $\beta_z = 1.000$, about the z-axis: $\beta_y = 1.000$

warping restraint intensity $\beta_0 = 1.000$

1.7. Combinations of design internal forces

| Nr | N _d kN | M _{0y,d} kNm | type | ψ _y | k _{c,y} | ζ _y | A |
|----|----------------------|--------------------------|------|----------------|------------------|----------------|---|
| 1 | 0.00 | 112.50 | 3 | 1.000 | 0.940 | 1.128 | |

moment diagram types



2. Verifications acc. to DIN EN 1993, Germany

DIN EN 1993-1-1 (EC 3)

| chapter | value | definition |
|------------|--|--|
| 6.1(1) | permanent/transient sit. γ _{M0} = 1.00 γ _{M1} = 1.10 γ _{M2} = 1.25 | partial factors for structural steel Cross-section failure instability fracture cross-sections in tension |
| 6.3.2.2(2) | accidental situation γ _{M0} = 1.00 γ _{M1} = 1.00 γ _{M2} = 1.15 | partial factors for structural steel Cross-section failure instability fracture cross-sections in tension |
| 6.3.2.2(2) | factor f for modifying of χ _{LT} : setting | buckling curve torsional-flexural buckling general case |

2.1. Classification of cross-sections acc. to DIN EN 1993-1-1, 5.5.2

2.1.1. Load combination 1 ⇒ class of cross-section 1

| Nr | c mm | t mm | c/t | ε | σ ₁ N/mm ² | σ ₂ N/mm ² | Tab 5.2 | α | ψ | k _σ | class |
|----|---------|---------|-------|-------|-------------------------------------|-------------------------------------|------------|-----|-----|----------------|-------|
| 1 | 64.7 | 13.5 | 4.79 | 1.000 | -0.94 | -0.94 | ones. 1/1 | --- | --- | --- | 1 |
| 2 | 64.7 | 13.5 | 4.79 | 1.000 | -0.94 | -0.94 | ones. 1/1 | --- | --- | --- | 1 |
| 3 | 331.0 | 8.6 | 38.49 | 1.000 | -0.94 | 0.94 | double 1/1 | --- | --- | --- | 1 |
| 4 | 64.7 | 13.5 | 4.79 | 1.000 | 0.94 | 0.94 | ----- | --- | --- | --- | --- |
| 5 | 64.7 | 13.5 | 4.79 | 1.000 | 0.94 | 0.94 | ----- | --- | --- | --- | --- |

verification is done in the predefined class of cross-section 2, U = 0.479

2.2. Torsional-flexural buckling acc. to DIN EN 1993-1-1 6.3.2 about the y-y-axis

c² = 91906 mm², buckling curve c ⇒ α_{LT} = 0.49, N_{cr} = 759.96 kN

2.2.1. Utilizations

| Nr | M _{cr} kNm | λ _{LT} | f | Φ _{LT} | χ _{LT} -m | M _{Ed} kNm | M _{b,Rd} kNm | U |
|----|------------------------|-----------------|-------|-----------------|-----------------------|------------------------|--------------------------|--------------|
| 1 | 187.94 | 1.278 | 0.984 | 1.328 | 0.485 | 112.50 | 137.68 | 0.817 |

max U = 0.817 ≤ 1 ⇒ verification successful!

the total utilization is: U = 0.817