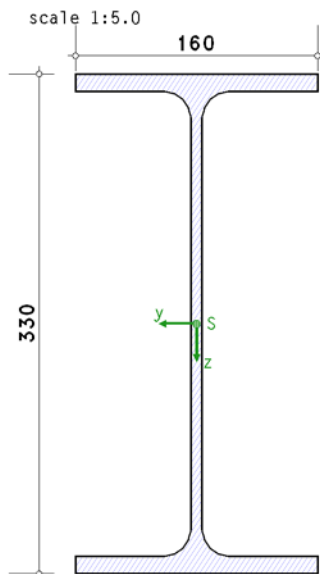


POS. 22: KINDMANN/KRÜGER 2.9.2

verification of cross-section EC 3-1-8 (12.10), NA: Deutschland

1. input report



steel

steel grade S235

material safety factor

resistance of cross-sections $\gamma_{M0} = 1.00$

geometry

section IPE330

resistance

elastic verification, calculation as thin-walled cross-section

plastic verification acc. to EC 3-1-1, 6.2

valid normal, shear-, equivalent stress: $\sigma_{x,Rd} = 235.0 \text{ N/mm}^2$, $\tau_{Rd} = 135.7 \text{ N/mm}^2$, $\sigma_{v,Rd} = 235.0 \text{ N/mm}^2$

internal forces and moments referring to local axes of cross-section

σ -generating forces (N, M) work at centroid, τ -generating forces (V, T_t) work at shear center

Lk 1: Feldmitte

$M_{y,Ed} = 168.70 \text{ kNm}$

Lk 2: Auflager

$V_{z,Ed} = 107.10 \text{ kN}$

notes

buckling is not investigated.

2. Lk 1: Feldmitte

2.1. verification of cross-section

internal forces and moments: $M_y = 168.70 \text{ kNm}$

2.1.1. elastic verification

elastic verification for $M_y = 168.70 \text{ kNm}$

elastic stresses: $\max |\sigma_x| = 236.50 \text{ N/mm}^2$, $\max \tau = 0.00 \text{ N/mm}^2$, $\max \sigma_v = 236.50 \text{ N/mm}^2$

$\max \sigma_x$ bei $y = 80.0 \text{ mm}$, $z = 165.0 \text{ mm}$: $\sigma_x = 236.50 \text{ N/mm}^2$, $\tau = 0.00 \text{ N/mm}^2$, $\sigma_v = 236.50 \text{ N/mm}^2$

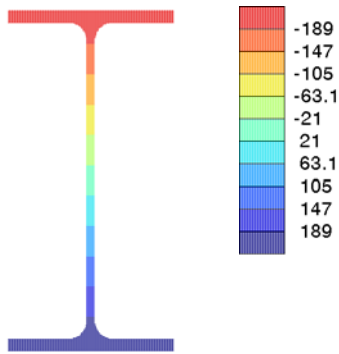
$\min \sigma_x$ bei $y = 80.0 \text{ mm}$, $z = -165.0 \text{ mm}$: $\sigma_x = -236.50 \text{ N/mm}^2$, $\tau = 0.00 \text{ N/mm}^2$, $\sigma_v = 236.50 \text{ N/mm}^2$

$\max \sigma_v$ bei $y = 80.0 \text{ mm}$, $z = -165.0 \text{ mm}$: $\sigma_x = -236.50 \text{ N/mm}^2$, $\tau = 0.00 \text{ N/mm}^2$, $\sigma_v = 236.50 \text{ N/mm}^2$

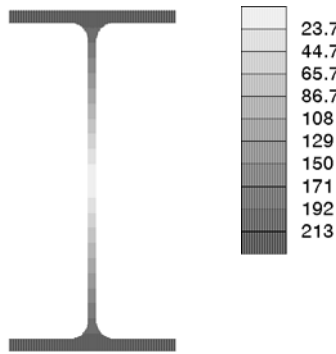
valid equivalent stress: $\sigma_{v,Rd} = 235.0 \text{ N/mm}^2$

verification: $\sigma_v = 236.50 \text{ N/mm}^2 > \sigma_{v,Rd} = 235.00 \text{ N/mm}^2 \Rightarrow U_\sigma = 1.006 > 1$ **fault !!**

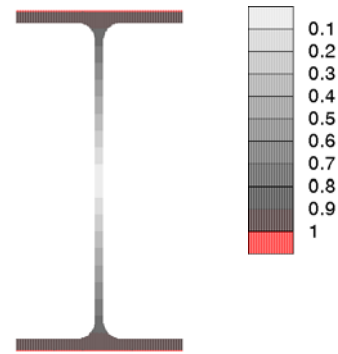
normal stresses σ_x [N/mm²]
min $\sigma_x = -236.5$, max $\sigma_x = 236.5$



equivalent stresses σ_v [N/mm²]
max $\sigma_v = 236.5$



utilization U_σ
max $U_\sigma = 1.006$



stresses, utilizations

y mm	z mm	σ_x N/mm ²	σ_v N/mm ²	U_σ
0.0	0.0	-236.52	236.52	1.006 > 1
-80.0	0.0	-236.52	236.52	1.006 > 1
0.0	330.0	236.52	236.52	1.006 > 1

y,z: node coordinates; σ_x, σ_v : stresses; U_σ : stress utilization

2.1.2. plastic verification

plastic verification for $M_y = 168.70$ kNm

plate buckling: section class of the section $1 \leq 2$ **ok**

plastic values: $M_{pl,y,Rd} = W_{pl,y} \cdot f_y / \gamma_{M0} = 189.00$ kNm

bending

verification: $|M_{y,Ed}| / M_{pl,y,Rd} = 0.893 < 1$ **ok**

3. Lk 2: Auflager

3.1. verification of cross-section

internal forces and moments: $V_z = 107.10$ kN

3.1.1. elastic verification

elastic verification for $V_z = 107.10$ kN

elastic stresses: max $|\sigma_x| = 0.00$ N/mm², max $\tau = 48.82$ N/mm², max $\sigma_v = 84.56$ N/mm²

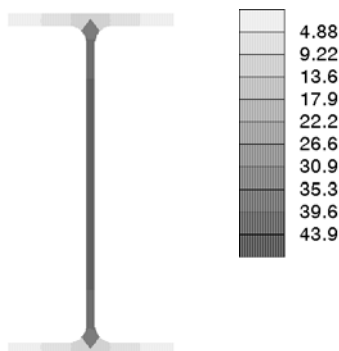
max τ bei $y = 0.0$ mm, $z = 0.0$ mm: $\sigma_x = 0.00$ N/mm², $\tau = 48.82$ N/mm², $\sigma_v = 84.56$ N/mm²

max σ_v bei $y = 0.0$ mm, $z = 0.0$ mm: $\sigma_x = 0.00$ N/mm², $\tau = 48.82$ N/mm², $\sigma_v = 84.56$ N/mm²

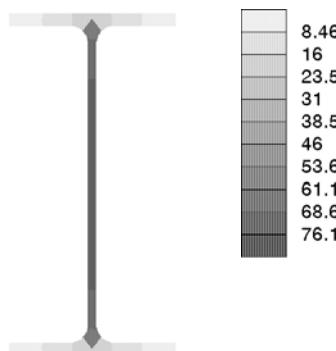
valid equivalent stress: $\sigma_{v,Rd} = 235.0$ N/mm²

verification: $\sigma_v = 84.56$ N/mm² < $\sigma_{v,Rd} = 235.00$ N/mm² $\Rightarrow U_\sigma = 0.360 < 1$ **ok**

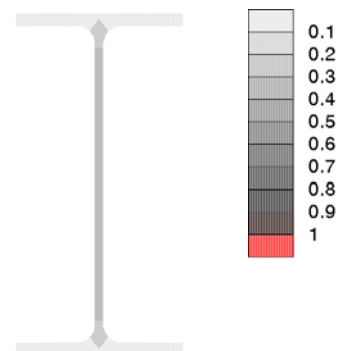
shear stresses τ [N/mm²]
max $\tau = 48.8$



equivalent stresses σ_v [N/mm²]
max $\sigma_v = 84.6$



utilization U_σ
max $U_\sigma = 0.360$



stresses, utilizations

y mm	z mm	τ N/mm ²	σ_v N/mm ²	U_σ
-76.3	165.0	48.82	84.56	0.360
-83.8	165.0	48.82	84.56	0.360
-80.0	165.0	48.82	84.56	0.360

y,z: node coordinates; τ, σ_v : stresses; U_σ : stress utilization

3.1.2. plastic verification

plastic verification for $V_z = 107.10 \text{ kN}$

shear buckling: $h_p/t_p = 40.93 \leq 72 \cdot \varepsilon/\eta = 60.00$ **ok**

plastic values: $V_{pl,z,Rd} = A_{vz} \cdot f_y / (3^{1/2} \cdot \gamma_{M0}) = 418.00 \text{ kN}$

shear force

verification: $|V_{z,Ed}|/V_{pl,z,Rd} = 0.256 < 1$ **ok**

4. final result

maximum utilization [Lk 1]: resistance max $U = 1.006 > 1$ **fault !!**

resistance not ensured !!