

POS. 167: SEESSELBERG, 12.4.4 (SLS)

detailed problems acc. to Eurocode 3

EC 3-6 (12.10), NA: Deutschland

steel grade

steel grade S 235

cross-section

beam: section HE360A

loading

Lk 1: EK 12

$$M_{y,Ed} = 129.4 \text{ kNm}, M_{z,Ed} = 4.6 \text{ kNm}$$

transverse loading on lower edge of cross-section:

design value of vertical wheel load $F_{z,Ed} = 9.23 \text{ kN}$ (per side)

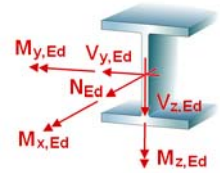
distance of wheel axles $a_R = 100.0 \text{ cm}$

distance of wheel from lateral edge of flange $n_y = 14.0 \text{ mm}$

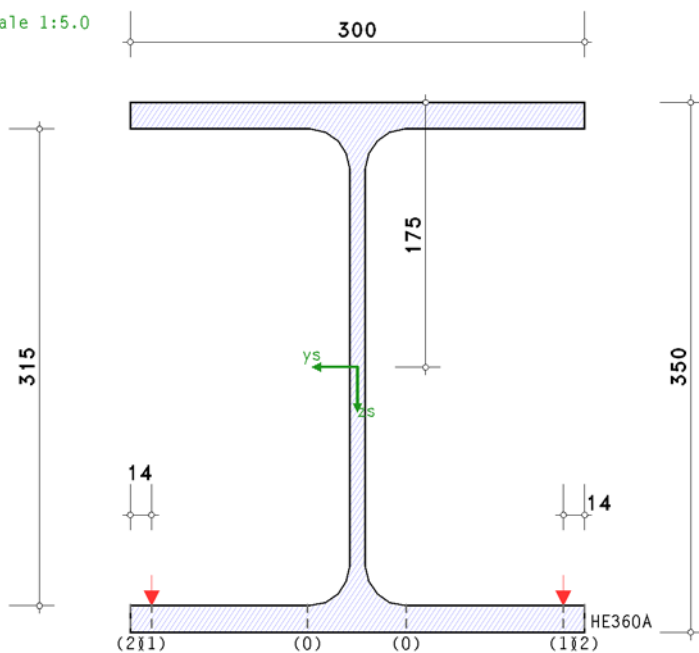
wheel at end of beam (unsupported lower flange, reinforced)

partial safety factors for material

serviceability $\gamma_{M,ser} = 1.00$



scale 1:5.0



Verification of Local Loading due to Crane Gantry

reinforcement of lower flange at end of beam: minimum dimensions $t_p = 17.5 \text{ mm} \times b_p = 300.0 \text{ mm}$

cross-sectional properties

$A = 142.76 \text{ cm}^2$, $z_s = 175.0 \text{ mm}$, $I_y = 33090.11 \text{ cm}^4$, $y_s = 0.0 \text{ mm}$, $I_z = 7886.85 \text{ cm}^4$

effective loading length from crane gantry

wheel at unsupported end of flange

effective length $l_{eff} = 2 \cdot (m+n) = 246.8 \text{ mm}$, $m = 109.4 \text{ mm}$, $n = 14.0 \text{ mm}$

local stresses from crane gantry at lower flange

$\sigma_{ux,Ed}(0) = 5.8 \text{ N/mm}^2$, $\sigma_{ux,Ed}(1) = 70.0 \text{ N/mm}^2$, $\sigma_{ux,Ed}(2) = 66.5 \text{ N/mm}^2$

$\sigma_{uy,Ed}(0) = -57.4 \text{ N/mm}^2$, $\sigma_{uy,Ed}(1) = 16.0 \text{ N/mm}^2$, $\sigma_{uy,Ed}(2) = 0.0 \text{ N/mm}^2$

75% of local stresses from crane gantry:

$\sigma_{ux,Ed}(0) = 4.3 \text{ N/mm}^2$, $\sigma_{ux,Ed}(1) = 52.5 \text{ N/mm}^2$, $\sigma_{ux,Ed}(2) = 49.9 \text{ N/mm}^2$

$\sigma_{uy,Ed}(0) = -43.1 \text{ N/mm}^2$, $\sigma_{uy,Ed}(1) = 12.0 \text{ N/mm}^2$, $\sigma_{uy,Ed}(2) = 0.0 \text{ N/mm}^2$

bending of lower flange

permissible stress: $\sigma_{Rd} = f_y / \gamma_{M,ser} = 235.0 \text{ N/mm}^2$, $\tau_{Rd} = f_y / (3^{1/2} \cdot \gamma_{M,ser}) = 135.7 \text{ N/mm}^2$

Lk 1:



(0) stresses $\sigma_{x,Ed(0)} = 68.7 \text{ N/mm}^2$, $\tau_{Ed(0)} = 0.0 \text{ N/mm}^2$
 superposition $\sigma_x = \sigma_{x,Ed(0)} + \sigma_{ux,Ed(0)} = 73.1 \text{ N/mm}^2$, $\sigma_y = \sigma_{uy,Ed(0)} = 43.1 \text{ N/mm}^2$, $\tau = \tau_{Ed(0)} = 0.0 \text{ N/mm}^2$
 normal stress $\sigma_x = 73.1 \text{ N/mm}^2 < \sigma_{Rd} = 235.0 \text{ N/mm}^2 \Rightarrow U = 0.311 < 1$ **ok.**
 normal stress $\sigma_y = 43.1 \text{ N/mm}^2 < \sigma_{Rd} = 235.0 \text{ N/mm}^2 \Rightarrow U = 0.183 < 1$ **ok.**
 equivalent stressen $\sigma_{v1} = (\sigma_x^2 + 3 \cdot \tau^2)^{1/2} = 73.1 \text{ N/mm}^2$, $\sigma_{v2} = (\sigma_x^2 + \sigma_y^2 - \sigma_x \cdot \sigma_y + 3 \cdot \tau^2)^{1/2} = 101.7 \text{ N/mm}^2$
 equivalent stress $\sigma_{v1} = 73.1 \text{ N/mm}^2 < \sigma_{Rd} = 235.0 \text{ N/mm}^2 \Rightarrow U = 0.311 < 1$ **ok.**
 equivalent stress $\sigma_{v2} = 101.7 \text{ N/mm}^2 < \sigma_{Rd} = 235.0 \text{ N/mm}^2 \Rightarrow U = 0.433 < 1$ **ok.**
 utilization $U_{(0)} = 0.433 < 1$ **ok.**
 (1) stresses $\sigma_{x,Ed(1)} = 76.4 \text{ N/mm}^2$, $\tau_{Ed(1)} = 0.0 \text{ N/mm}^2$
 superposition $\sigma_x = \sigma_{x,Ed(1)} + \sigma_{ux,Ed(1)} = 128.9 \text{ N/mm}^2$, $\sigma_y = \sigma_{uy,Ed(1)} = 12.0 \text{ N/mm}^2$, $\tau = \tau_{Ed(1)} = 0.0 \text{ N/mm}^2$
 normal stress $\sigma_x = 128.9 \text{ N/mm}^2 < \sigma_{Rd} = 235.0 \text{ N/mm}^2 \Rightarrow U = 0.548 < 1$ **ok.**
 normal stress $\sigma_y = 12.0 \text{ N/mm}^2 < \sigma_{Rd} = 235.0 \text{ N/mm}^2 \Rightarrow U = 0.051 < 1$ **ok.**
 equivalent stressen $\sigma_{v1} = (\sigma_x^2 + 3 \cdot \tau^2)^{1/2} = 128.9 \text{ N/mm}^2$, $\sigma_{v2} = (\sigma_x^2 + \sigma_y^2 - \sigma_x \cdot \sigma_y + 3 \cdot \tau^2)^{1/2} = 123.3 \text{ N/mm}^2$
 equivalent stress $\sigma_{v1} = 128.9 \text{ N/mm}^2 < \sigma_{Rd} = 235.0 \text{ N/mm}^2 \Rightarrow U = 0.548 < 1$ **ok.**
 equivalent stress $\sigma_{v2} = 123.3 \text{ N/mm}^2 < \sigma_{Rd} = 235.0 \text{ N/mm}^2 \Rightarrow U = 0.525 < 1$ **ok.**
 utilization $U_{(1)} = 0.548 < 1$ **ok.**
 (2) stresses $\sigma_{x,Ed(2)} = 77.2 \text{ N/mm}^2$, $\tau_{Ed(2)} = 0.0 \text{ N/mm}^2$
 superposition $\sigma_x = \sigma_{x,Ed(2)} + \sigma_{ux,Ed(2)} = 127.1 \text{ N/mm}^2$, $\sigma_y = \sigma_{uy,Ed(2)} = 0.0 \text{ N/mm}^2$, $\tau = \tau_{Ed(2)} = 0.0 \text{ N/mm}^2$
 normal stress $\sigma_x = 127.1 \text{ N/mm}^2 < \sigma_{Rd} = 235.0 \text{ N/mm}^2 \Rightarrow U = 0.541 < 1$ **ok.**
 equivalent stressen $\sigma_{v1} = (\sigma_x^2 + 3 \cdot \tau^2)^{1/2} = 127.1 \text{ N/mm}^2$, $\sigma_{v2} = (\sigma_x^2 + \sigma_y^2 - \sigma_x \cdot \sigma_y + 3 \cdot \tau^2)^{1/2} = 127.1 \text{ N/mm}^2$
 equivalent stress $\sigma_{v1} = 127.1 \text{ N/mm}^2 < \sigma_{Rd} = 235.0 \text{ N/mm}^2 \Rightarrow U = 0.541 < 1$ **ok.**
 equivalent stress $\sigma_{v2} = 127.1 \text{ N/mm}^2 < \sigma_{Rd} = 235.0 \text{ N/mm}^2 \Rightarrow U = 0.541 < 1$ **ok.**
 utilization $U_{(2)} = 0.541 < 1$ **ok.**

Final Result

maximum utilization: $\max U = 0.548 < 1$ **ok.**

verification succeeded