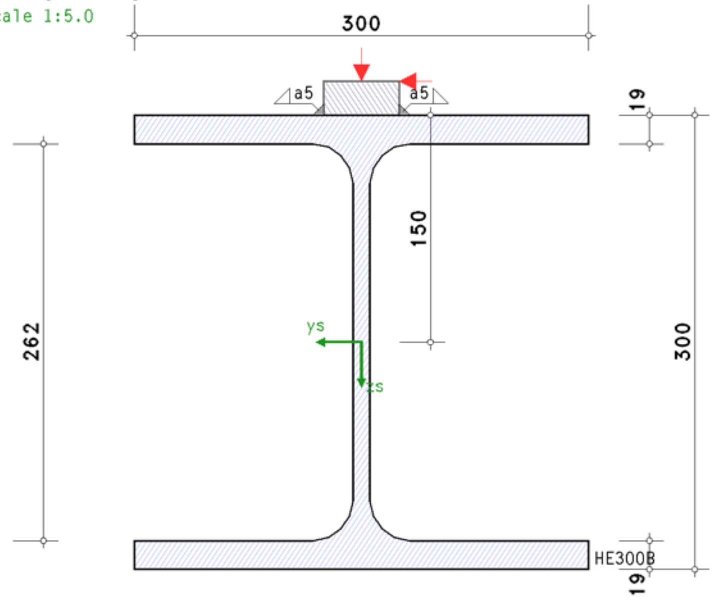
detailed problems acc. to Eurocode 3, EC 3-6 (12.10), NA: Deutschland

4H-EC3LK version: 11/2016-1f

1. input report

scale 1:5.0



steel grade

steel grade S235

cross-section

beam: section HE300B

crane gantry

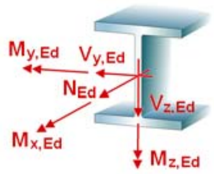
crane rail of flat steel, shear-resistant joined with the girder

connection with fillet welds: weld thickness a_w = 5.0 mm, intermittent weld with section length l_w = 60.0 mm (staggered)

crane rail: width b_r = 50.0 mm, height h = 30.0 mm, 25% wear

height, cross-sectional area, moments of inertia of fretted rail h_r = 22.5 mm, A_r = 11.25 cm², I_{yr} = 4.75 cm⁴, I_{tr} = 14.18 cm⁴

loading



internal forces and moments at limit state of serviceability (SLS):

Lk 1: $M_{y,Ed}$ = -129.8 kNm, $V_{z,Ed}$ = 175.5 kN

transverse loading on upper edge of cross-section:

vertical wheel pressure $F_{z,Ed,SLS}$ = 113.70 kN

horizontal wheel pressure $H_{Ed,SLS}$ = 17.40 kN

partial safety factors for material

resistance of bolts, welds, plates in bearing γ_{M2} = 1.25

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

2. verification der local loading due to crane gantry

cross-sectional properties

A = 149.08 cm², z_s = 150.0 mm, I_y = 25165.90 cm⁴, y_s = 0.0 mm, I_z = 8562.83 cm⁴

effective loading length from crane gantry

effective width $b_{eff} = b_r + h_r + t_{fo}$ = 91.5 mm $\leq b_{fo}$

moment of inertia of crane rail with beam flange I_{rf} = 39.38 cm⁴

effective length $l_{eff} = 3.25 \cdot (I_{rf}/t_w)^{1/3}$ = 107.1 mm

length of local loading

refering to outer edge of flange $s_s = l_{eff} - 2 \cdot t_f$ = 69.1 mm / auf den webanschnitt $s_w = l_{eff} + 2 \cdot r$ = 161.1 mm

2.1. elastic behaviour (SLS)

permissible stresses

$\sigma_{Rd} = f_y/\gamma_{M,ser}$ = 235.0 N/mm², $\tau_{Rd} = f_y/(3^{1/2} \cdot \gamma_{M,ser})$ = 135.7 N/mm²

wheel pressure at top edge of the web

local normal stress $\sigma_{oz,Ed} = -F_{z,Ed}/(t_w \cdot s_w)$ = -64.2 N/mm², $F_{z,Ed}$ = 113.7 kN, s_w = 161.1 mm

$|\sigma_{oz,Ed}|$ = 64.2 N/mm² < σ_{Rd} = 235.0 N/mm² ⇒ U = 0.273 < 1 ok

associated local shear stress $\tau_{oxz,Ed} = 0.2 \cdot \sigma_{oz,Ed}$ = -12.8 N/mm²

$|\tau_{oxz,Ed}| = 12.8\ N/mm^2 < \tau_{Rd} = 135.7\ N/mm^2 \Rightarrow U = 0.095 < 1$ ok

stresses at top edge of the web
Lk 1: $M_{y,Ed} = -129.8$ kNm, $V_{z,Ed} = 175.5$ kN
normal stress $\sigma_{x,Ed} = 53.6\ N/mm^2$
$|\sigma_{x,Ed}| = 53.6\ N/mm^2 < \sigma_{Rd} = 235.0\ N/mm^2 \Rightarrow U = 0.228 < 1$ ok
shear stress $\tau_{xz,Ed} = 37.0\ N/mm^2$
$|\tau_{xz,Ed}|+|\tau_{oxz,Ed}| = 49.8\ N/mm^2 < \tau_{Rd} = 135.7\ N/mm^2 \Rightarrow U = 0.367 < 1$ ok
equivalent stress $\sigma_v = (\sigma_{x,Ed}^2+\sigma_{oz,Ed}^2-\sigma_{x,Ed}\cdot\sigma_{oz,Ed}+3\cdot(|\tau_{xz,Ed}|+|\tau_{oxz,Ed}|)^2)^{1/2} = 133.7\ N/mm^2$
$\sigma_v = 133.7\ N/mm^2 < \sigma_{Rd} = 235.0\ N/mm^2 \Rightarrow U = 0.569 < 1$ ok

maximum utilization: max $U_{SLS} = 0.569 < 1$ ok

2.2. welds of crane rail at outer edge of flange (intermittent welds, staggered arrangement)

$N_{Ed} = -F_{z,Ed}/2 = -56.9$ kN, $V_{Ed} = -1.15\cdot H_{Ed} = -20.0$ kN
effective weld length $l_{eff} = l_w = 69.1$ mm
forces on the design area of the weld: $F_{Ed}(\sigma_s) = 7.87$ kN/cm $F_{Ed}(\tau_s) = 3.77$ kN/cm
stresses on the design area of the weld: $\sigma_s = 15.73\ kN/cm^2$ $\tau_s = 7.53\ kN/cm^2$
$\sigma_{1,w,Ed} = (\sigma_s^2 + 3\cdot(\tau_s^2 + \tau_p^2))^{1/2} = 20.44\ kN/cm^2$
resistance of a weld (req.1): $f_{1w,d} = f_u / (\beta_w\cdot\gamma_{M2}) = 36.00\ kN/cm^2$
$\sigma_{1,w,Ed} = 20.44\ kN/cm^2 < f_{1w,d} = 36.00\ kN/cm^2 \Rightarrow U = 0.568 < 1$ ok
$\sigma_{2,w,Ed} = |\sigma_s| = 15.73\ kN/cm^2$
resistance of a weld (req.2): $f_{2w,d} = 0.9\cdot f_u / \gamma_{M2} = 25.92\ kN/cm^2$
$\sigma_{2,w,Ed} = 15.73\ kN/cm^2 < f_{2w,d} = 25.92\ kN/cm^2 \Rightarrow U = 0.607 < 1$ ok
$N_{Ed} = -56.9$ kN , $V_{Ed} = 1.15\cdot H_{Ed} = 20.0$ kN
effective weld length $l_{eff} = l_w = 69.1$ mm
forces on the design area of the weld: $F_{Ed}(\sigma_s) = 7.87$ kN/cm $F_{Ed}(\tau_s) = 3.77$ kN/cm
stresses on the design area of the weld: $\sigma_s = 15.73\ kN/cm^2$ $\tau_s = 7.53\ kN/cm^2$
$\sigma_{1,w,Ed} = (\sigma_s^2 + 3\cdot(\tau_s^2 + \tau_p^2))^{1/2} = 20.44\ kN/cm^2$
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$\sigma_{2,w,Ed} = |\sigma_s| = 15.73\ kN/cm^2$
resistance of a weld (req.2): $f_{2w,d} = 0.9\cdot f_u / \gamma_{M2} = 25.92\ kN/cm^2$
$\sigma_{2,w,Ed} = 15.73\ kN/cm^2 < f_{2w,d} = 25.92\ kN/cm^2 \Rightarrow U = 0.607 < 1$ ok

3. final result

maximum utilization: max $U = 0.607 < 1$ ok

verification succeeded