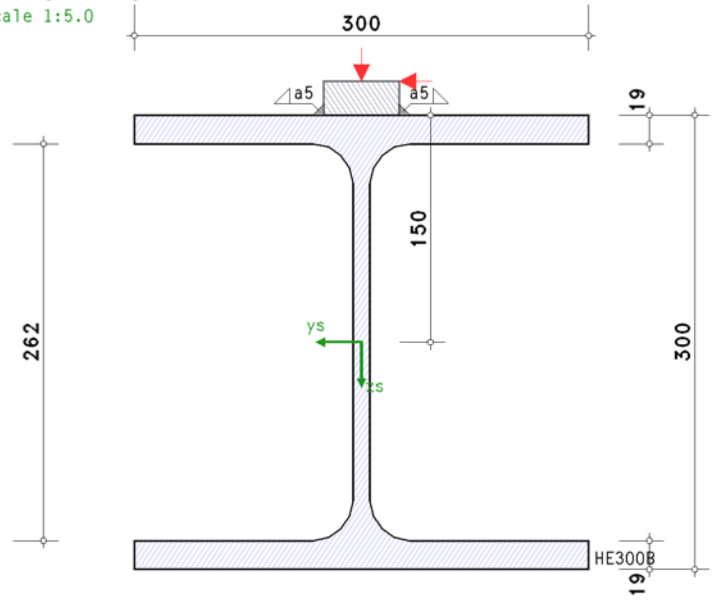
detailed problems acc. to Eurocode 3, EC 3-6 (12.10), NA: Deutschland

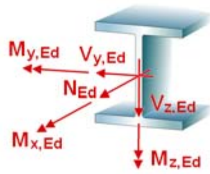
4H-EC3LK version: 11/2016-1f

## 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 (continuous)
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 resistance (ULS):
Lk 1: $M_{y,Ed}$ = 100.0 kNm, $V_{z,Ed}$ = 130.0 kN
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 $F_{z,Ed,ULS}$ = 100.00 kN, $F_{z,Ed,SLS}$ = 113.70 kN
horizontal wheel pressure $H_{Ed,SLS}$ = 17.40 kN, $H_{Ed,ULS}$ = 15.00 kN




**partial safety factors for material**
resistance of cross-sections $\gamma_{M0}$ = 1.00
resistance of bolts, welds, plates in bearing $\gamma_{M2}$ = 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:
$l_{eff} = 3.25 \cdot (I_{rf}/t_w)^{1/3}$ = 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. compression of web (ULS)

permissible stresses: $\sigma_{Rd} = f_y/\gamma_{M0}$ = 235.0 N/mm², $\tau_{Rd} = f_y/(3^{1/2} \cdot \gamma_{M0})$ = 135.7 N/mm²

wheel pressure at first cut of web:
local stresses $\sigma_{oz,Ed}$ = -56.4 N/mm², $\tau_{oxz,Ed}$ = -11.3 N/mm²
$|\sigma_{oz,Ed}|$ = 56.4 N/mm² < $\sigma_{Rd}$ = 235.0 N/mm² ⇒ U = 0.240 < 1 ok
$|\tau_{oxz,Ed}|$ = 11.3 N/mm² < $\tau_{Rd}$ = 135.7 N/mm² ⇒ U = 0.083 < 1 ok

stresses at first cut of web:

Lk 1: $M_{y,Ed}$ = 100.0 kNm, $V_{z,Ed}$ = 130.0 kN
stresses $\sigma_{x,Ed}$ = -56.4 N/mm², $\tau_{xz,Ed}$ = -11.3 N/mm²
$|\sigma_{x,Ed}|$ = 41.3 N/mm² < $\sigma_{Rd}$ = 235.0 N/mm² ⇒ U = 0.176 < 1 ok
$|\tau_{xz,Ed}|+|\tau_{oxz,Ed}|$ = 38.7 N/mm² < $\tau_{Rd}$ = 135.7 N/mm² ⇒ U = 0.285 < 1 ok
$\sigma_v$ = 84.0 N/mm² < $\sigma_{Rd}$ = 235.0 N/mm² ⇒ U = 0.357 < 1 ok

maximum utilization: max $U_{ULS}$ = 0.357 < 1 ok

### 2.2. 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 stresses $\sigma_{oz,Ed}$ = -64.2 N/mm², $\tau_{oxz,Ed}$ = -12.8 N/mm²
$|\sigma_{oz,Ed}|$ = 64.2 N/mm² < $\sigma_{Rd}$ = 235.0 N/mm² ⇒ U = 0.273 < 1 ok
$|\tau_{oxz,Ed}|$ = 12.8 N/mm² < $\tau_{Rd}$ = 135.7 N/mm² ⇒ 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
stresses $\sigma_{x,Ed}$ = -64.2 N/mm², $\tau_{xz,Ed}$ = -12.8 N/mm²
$|\sigma_{x,Ed}|$ = 53.6 N/mm² < $\sigma_{Rd}$ = 235.0 N/mm² ⇒ U = 0.228 < 1 ok
$|\tau_{xz,Ed}|+|\tau_{oxz,Ed}|$ = 49.8 N/mm² < $\tau_{Rd}$ = 135.7 N/mm² ⇒ U = 0.367 < 1 ok
$\sigma_v$ = 104.9 N/mm² < $\sigma_{Rd}$ = 235.0 N/mm² ⇒ U = 0.446 < 1 ok

maximum utilization: max $U_{SLS}$ = 0.446 < 1 ok

### 2.3. welds of crane rail at outer edge of flange

$N_{Ed} = -F_{z,Ed}/2$ = -50.0 kN, $V_{Ed} = -H_{Ed}/2$ = -7.5 kN
effective weld length $l_{eff} = l_w$ = 69.1 mm
$\sigma_{1,w,Ed}$ = 19.11 kN/cm² < $f_{1w,d}$ = 36.00 kN/cm² ⇒ U = 0.531 < 1 ok
$\sigma_{2,w,Ed}$ = 11.77 kN/cm² < $f_{2w,d}$ = 25.92 kN/cm² ⇒ U = 0.454 < 1 ok
$N_{Ed}$ = -50.0 kN , $V_{Ed} = H_{Ed}/2$ = 7.5 kN
effective weld length $l_{eff} = l_w$ = 69.1 mm
$\sigma_{1,w,Ed}$ = 19.11 kN/cm² < $f_{1w,d}$ = 36.00 kN/cm² ⇒ U = 0.531 < 1 ok
$\sigma_{2,w,Ed}$ = 11.77 kN/cm² < $f_{2w,d}$ = 25.92 kN/cm² ⇒ U = 0.454 < 1 ok

## 3. final result

**maximum utilization:** max U = 0.531 < 1 ok

verification succeeded

## 4. Regulations

DIN EN 1990, Eurocode 0: Grundlagen der Tragwerksplanung;
Deutsche Fassung EN 1990:2002 + A1:2005 + A1:2005/AC:2010, Ausgabe Dezember 2010
DIN EN 1990/NA, Nationaler Anhang zur DIN EN 1990, Ausgabe Dezember 2010

DIN EN 1993-1-1, Eurocode 3: Bemessung und Konstruktion von Stahlbauten -
Teil 1-1: Allgemeine Bemessungsregeln und Regeln für den Hochbau;
Deutsche Fassung EN 1993-1-1:2005 + AC:2009, Ausgabe Dezember 2010
DIN EN 1993-1-1/A1, Ergänzungen zur DIN EN 1993-1-1, Ausgabe Juli 2014
DIN EN 1993-1-1/NA, Nationaler Anhang zur DIN EN 1993-1-1, Ausgabe September 2017

DIN EN 1993-6, Eurocode 3: Bemessung und Konstruktion von Stahlbauten - Teil 6: Kranbahnen;
Deutsche Fassung EN 1993-6:2007 + AC:2009, Ausgabe Dezember 2010
DIN EN 1993-6/NA, Nationaler Anhang zur DIN EN 1993-6, Ausgabe Dezember 2010