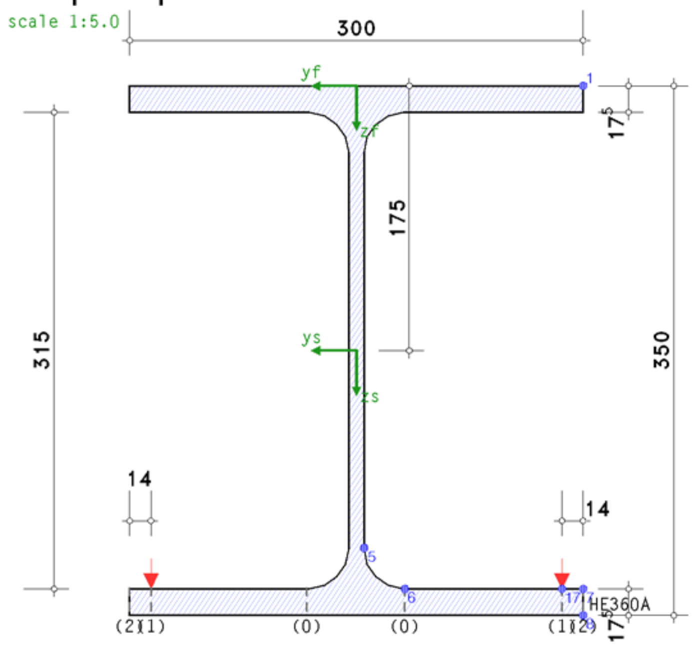
POS. 131: SEESSELBERG 12.4.8

detailed problems acc. to Eurocode 3, EC 3-1-9 (12.10), NA: Deutschland 4H-EC3EM version: 11/2016-1g

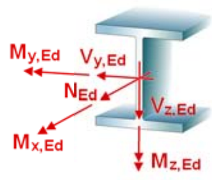
1. input report



local loading by eine crane gantry
steel grade
steel grade S235
cross-section
beam: section HE360A
parameters
damage equivalent stress factors for crane class S1: $\lambda_\sigma = 0.250$, $\lambda_\tau = 0.436$, crane class S2: $\lambda_{\sigma+} = 0.315$, $\lambda_{\tau+} = 0.500$
notch class / valid notch stresses bei $N = 2 \cdot 10^6$ cycles:

Pt.	y_f mm	z_f mm	$\Delta\sigma_{x,Rd}$ N/mm²	$\Delta\tau_{Rd}$ N/mm²	$\Delta\sigma_{z,Rd}$ N/mm²	notch point	EC 3-1-9, tab.
1	-150.0	0.0	160.0	0.0	0.0	at top flange	8.1(2)
5	-5.0	305.5	160.0	100.0	160.0	at beam web	8.1(2) 8.1(6) 8.10(1)
6	-32.0	332.5	160.0	0.0	0.0	at bottom flange	8.1(2)
7	-150.0	332.5	160.0	0.0	0.0	at bottom flange	8.1(2)
8	-150.0	350.0	160.0	0.0	0.0	at bottom flange	8.1(2)
17	-136.0	332.5	160.0	0.0	0.0	due to crane gantry	8.1(2)

loading



Lk 1: EK 12
$M_{y,Ed} = 129.4$ kNm, $M_{z,Ed} = 4.6$ kNm
Lk 2: $M_{y,Ed} = 0.0$ kNm, $M_{z,Ed} = 0.0$ kNm
transverse loading on bottom flange:
vertical wheel pressure $F_{z,Ed} = 9.2$ kN
distance of wheel axles $a_R = 100.0$ cm
distance of wheel from lateral edge of flange $n_y = 14.0$ mm
wheel at end of beam (supported lower flange), distance of the wheel from end of girder $x_e = 20.0$ cm
material safety factor
fatigue strength $\gamma_{Mf} = 1.60$

2. fatigue design

check of stress ranges.

cross-sectional properties
$A = 142.76$ cm², $z_s = 175.0$ mm, $I_y = 33090.11$ cm⁴, $y_s = 0.0$ mm, $I_z = 7886.85$ cm⁴

effective loading length from crane gantry
minimum distance of crane gantry wheel to the end of beam not ensured $x_e = 200.0$ mm $< b_{fu} = 300.0$ mm !!
wheel at distance $x_e = 200.0$ mm $\leq 2 \cdot 2^{1/2} \cdot (m+n) = 349.0$ mm from supported end of flange
effective length $l_{eff} = 2 \cdot 2^{1/2} \cdot (m+n) + x_e + 2 \cdot (m+n)^2 / x_e = 701.3$ mm

m = 109.4 mm, n = 14.0 mm (for x_w = 1000.0 mm > $2 \cdot 2^{1/2} \cdot (m+n) + x_e + 2 \cdot (m+n)^2 / x_e$ = 701.3 mm)

local stresses from crane gantry at lower flange (SLS)

Vertikallast $F_{z,Ed}$ = 9.2 kN

$\sigma_{ux,Ed}'(0)$ = 5.8 N/mm² with c_{x0} = 0.192, $\sigma_{uy,Ed}'(0)$ = -57.4 N/mm² with c_{y0} = -1.905
$\sigma_{ux,Ed}'(1)$ = 70.0 N/mm² with c_{x1} = 2.323, $\sigma_{uy,Ed}'(1)$ = 16.0 N/mm² with c_{y1} = 0.532
$\sigma_{ux,Ed}'(2)$ = 66.5 N/mm² with c_{x2} = 2.208, $\sigma_{uy,Ed}'(2)$ = 0.0 N/mm² with c_{y2} = 0.000

local stresses:
$\sigma_{ux,Ed}(0)$ = 5.8 N/mm², $\sigma_{ux,Ed}(1)$ = 70.0 N/mm², $\sigma_{ux,Ed}(2)$ = 66.5 N/mm²
$\sigma_{uy,Ed}(0)$ = -57.4 N/mm², $\sigma_{uy,Ed}(1)$ = 16.0 N/mm², $\sigma_{uy,Ed}(2)$ = 0.0 N/mm²

75% of local stresses from crane gantry:
$\sigma_{ux,Ed}(0)$ = 4.3 N/mm², $\sigma_{ux,Ed}(1)$ = 52.5 N/mm², $\sigma_{ux,Ed}(2)$ = 49.9 N/mm²
$\sigma_{uy,Ed}(0)$ = -43.1 N/mm², $\sigma_{uy,Ed}(1)$ = 12.0 N/mm², $\sigma_{uy,Ed}(2)$ = 0.0 N/mm²

pt. 1:	y_f = -150.0 mm, z_f = 0.0 mm	stress range $\Delta\sigma_{x,Ed}$ = 59.7 N/mm² ≤ $1.5 \cdot f_y$ = 352.5 N/mm² ok
pt. 5:	y_f = -5.0 mm, z_f = 305.5 mm	stress range $\Delta\sigma_{x,Ed}$ = 51.3 N/mm² ≤ $1.5 \cdot f_y$ = 352.5 N/mm² ok
pt. 6:	y_f = -32.0 mm, z_f = 332.5 mm	stress range $\Delta\sigma_{x,Ed}$ = 63.5 N/mm² ≤ $1.5 \cdot f_y$ = 352.5 N/mm² ok
pt. 7:	y_f = -150.0 mm, z_f = 332.5 mm	stress range $\Delta\sigma_{x,Ed}$ = 70.3 N/mm² ≤ $1.5 \cdot f_y$ = 352.5 N/mm² ok
pt. 8:	y_f = -150.0 mm, z_f = 350.0 mm	stress range $\Delta\sigma_{x,Ed}$ = 77.2 N/mm² ≤ $1.5 \cdot f_y$ = 352.5 N/mm² ok
pt. 17:	y_f = -136.0 mm, z_f = 332.5 mm	stress range $\Delta\sigma_{x,Ed}$ = 69.5 N/mm² ≤ $1.5 \cdot f_y$ = 352.5 N/mm² ok

elastic stresses / stress ranges

$\Delta\sigma_{x,Ed} = \Delta\sigma_x + \sigma_{ux}$, $\Delta\tau_{Ed} = \Delta\tau$, $\Delta\sigma_{y,Ed} = |\sigma_{uy}|$

pt. 1:	y_f = -150.0 mm, z_f = 0.0 mm	Lk 1:	σ_x = -59.7 N/mm²
		2:	σ_x = 0.0 N/mm²
			$\Delta\sigma_{x,Ed}$ = 59.7 N/mm²
5:	y_f = -5.0 mm, z_f = 305.5 mm	Lk 1:	σ_x = 51.3 N/mm²
		2:	σ_x = 0.0 N/mm²
			$\Delta\sigma_{x,Ed}$ = 51.3 N/mm²
6:	y_f = -32.0 mm, z_f = 332.5 mm	Lk 1:	σ_x = 63.5 N/mm²
		2:	σ_x = 0.0 N/mm²
			$\Delta\sigma_{x,Ed}$ = 67.8 N/mm²
7:	y_f = -150.0 mm, z_f = 332.5 mm	Lk 1:	σ_x = 70.3 N/mm²
		2:	σ_x = 0.0 N/mm²
			$\Delta\sigma_{x,Ed}$ = 120.2 N/mm²
8:	y_f = -150.0 mm, z_f = 350.0 mm	Lk 1:	σ_x = 77.2 N/mm²
		2:	σ_x = 0.0 N/mm²
			$\Delta\sigma_{x,Ed}$ = 77.2 N/mm²
17:	y_f = -136.0 mm, z_f = 332.5 mm	Lk 1:	σ_x = 69.5 N/mm²
		2:	σ_x = 0.0 N/mm²
			$\Delta\sigma_{x,Ed}$ = 122.0 N/mm²

equivalent constand amplitude stress range

$\Delta\sigma_{x,f} = \Delta\sigma_{x,Ed} \cdot \lambda_\sigma$, $\Delta\tau_f = \Delta\tau_{Ed} \cdot \lambda_\tau$, $\Delta\sigma_{y,f} = \Delta\sigma_{y,Ed} \cdot \lambda_\sigma$

pt. 1:	y_f = -150.0 mm, z_f = 0.0 mm	$\Delta\sigma_{x,f}$ = 14.9 N/mm²
5:	y_f = -5.0 mm, z_f = 305.5 mm	$\Delta\sigma_{x,f}$ = 12.8 N/mm²
6:	y_f = -32.0 mm, z_f = 332.5 mm	$\Delta\sigma_{x,f}$ = 16.9 N/mm²
7:	y_f = -150.0 mm, z_f = 332.5 mm	$\Delta\sigma_{x,f}$ = 30.1 N/mm²
8:	y_f = -150.0 mm, z_f = 350.0 mm	$\Delta\sigma_{x,f}$ = 19.3 N/mm²
17:	y_f = -136.0 mm, z_f = 332.5 mm	$\Delta\sigma_{x,f}$ = 30.5 N/mm²

valid notch stresses

$\Delta\sigma_{x,Rd,f} = \Delta\sigma_{x,Rd}/\gamma_{Mf}$, $\Delta\tau_{Rd,f} = \Delta\tau_{Rd}/\gamma_{Mf}$, $\Delta\sigma_{y,Rd,f} = \Delta\sigma_{y,Rd}/\lambda_{Mf}$

pt. 1:	y_f = -150.0 mm, z_f = 0.0 mm	$\Delta\sigma_{x,Rd,f}$ = 100.0 N/mm²
5:	y_f = -5.0 mm, z_f = 305.5 mm	$\Delta\sigma_{x,Rd,f}$ = 100.0 N/mm²
6:	y_f = -32.0 mm, z_f = 332.5 mm	$\Delta\sigma_{x,Rd,f}$ = 100.0 N/mm²
7:	y_f = -150.0 mm, z_f = 332.5 mm	$\Delta\sigma_{x,Rd,f}$ = 100.0 N/mm²
8:	y_f = -150.0 mm, z_f = 350.0 mm	$\Delta\sigma_{x,Rd,f}$ = 100.0 N/mm²
17:	y_f = -136.0 mm, z_f = 332.5 mm	$\Delta\sigma_{x,Rd,f}$ = 100.0 N/mm²

verification of notch stresses

pt. 1:	y = -150.0 mm, z = 0.0 mm	$\Delta\sigma_{x,f}$ = 14.9 N/mm² < $\Delta\sigma_{x,Rd,f}$ = 100.0 N/mm² ⇒ $U_{\Delta\sigma x}$ = 0.149	ok
5:	y = -5.0 mm, z = 305.5 mm	$\Delta\sigma_{x,f}$ = 12.8 N/mm² < $\Delta\sigma_{x,Rd,f}$ = 100.0 N/mm² ⇒ $U_{\Delta\sigma x}$ = 0.128	ok
6:	y = -32.0 mm, z = 332.5 mm	$\Delta\sigma_{x,f}$ = 16.9 N/mm² < $\Delta\sigma_{x,Rd,f}$ = 100.0 N/mm² ⇒ $U_{\Delta\sigma x}$ = 0.169	ok
7:	y = -150.0 mm, z = 332.5 mm	$\Delta\sigma_{x,f}$ = 30.1 N/mm² < $\Delta\sigma_{x,Rd,f}$ = 100.0 N/mm² ⇒ $U_{\Delta\sigma x}$ = 0.301	ok
8:	y = -150.0 mm, z = 350.0 mm	$\Delta\sigma_{x,f}$ = 19.3 N/mm² < $\Delta\sigma_{x,Rd,f}$ = 100.0 N/mm² ⇒ $U_{\Delta\sigma x}$ = 0.193	ok
17:	y = -136.0 mm, z = 332.5 mm	$\Delta\sigma_{x,f}$ = 30.5 N/mm² < $\Delta\sigma_{x,Rd,f}$ = 100.0 N/mm² ⇒ $U_{\Delta\sigma x}$ = 0.305	ok

3. final result

fatigue design [pt. 17]: max U = 0.305 < 1 ok

verification succeeded