POS. 155: SEESSELBERG 10.7, 10-2, KRAN A

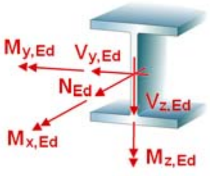
detailed problems acc. to Eurocode 3

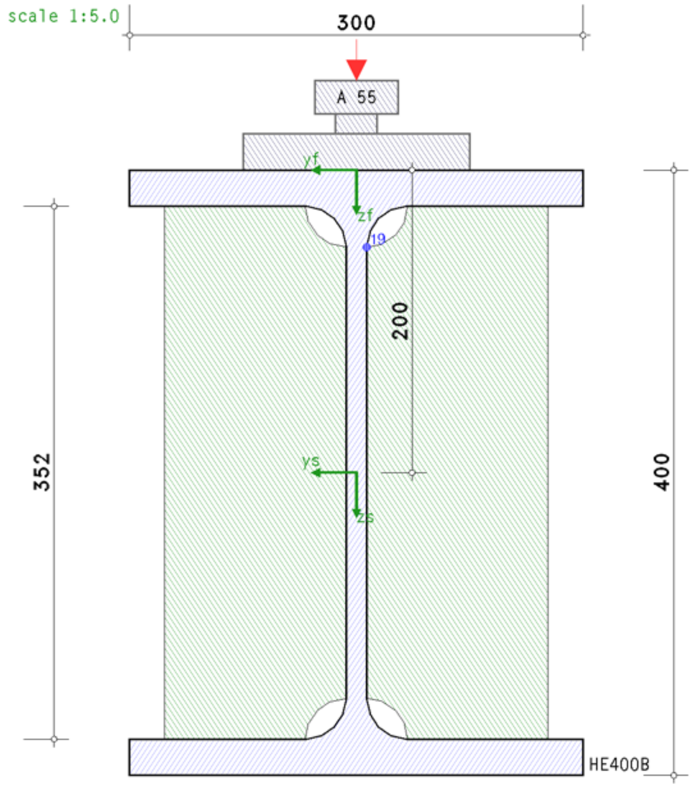
EC 3-1-9 (12.10), NA: Deutschland

steel grade
steel grade S 355
cross-section
beam: section HE400B
transverse stiffeners: section parameters (flat steel):
height h = 120.0 mm, thickness t = 20.0 mm
recess at transverse stiffener $c_{st,q}$ = 27.0 mm
crane gantry
A-crane rail 55, floating with fillet welds joined with the girder
crane rail: head width b_k = 55.0 mm, bottom width b_r = 150.0 mm, height of fretted rail h_r = 59.0 mm
moment of inertia, cross-sectional area of fretted rail I_{yr} = 134.00 cm^4, A_r = 37.30 cm^2
parameters
damage equivalent stress factors for crane class S2: λ_σ = 0.315, λ_τ = 0.500, crane class S3: $\lambda_{\sigma+}$ = 0.397, $\lambda_{\tau+}$ = 0.575
notch class / valid notch stresses:

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.
19	-6.8	51.0	80.0	100.0	100.0	due to transv.stiff.	8.4(7) 8.1(6) 8.2(7)

loading
Lk 1: $M_{y,Ed}$ = 301.0 kNm, $V_{z,Ed}$ = 290.0 kN
Lk 2: $M_{y,Ed}$ = -30.0 kNm, $V_{z,Ed}$ = 0.0 kN
transverse loading on top flange:
design value of vertical wheel load $F_{z,Ed}$ = 290.00 kN
material safety factor
design concept: damage tolerance, damage consequence: high ⇒ fatigue strength γ_{Mf} = 1.15





Fatigue Design

cross-sectional properties
$A = 197.78\ cm^2$, $z_s = 200.0$ mm, $I_y = 57680.93\ cm^4$, $y_s = 0.0$ mm, $I_z = 10819.05\ cm^4$

effective loading length from crane gantry
effective width $b_{eff} = b_r + h_r + t_{fo} = 233.0$ mm $\leq b_{fo}$
effective moment of inertia of beam flange $I_{f,eff} = b_{eff} \cdot t_{fo}^3/12 = 26.84\ cm^4$
moment of inertia of crane rail $I_r = 134.00\ cm^4$
effective length $l_{eff} = 3.25 \cdot ((I_r + I_{f,eff})/t_w)^{1/3} = 159.9$ mm

local stresses from crane gantry
effective loading length refered ...
... to outer edge of flange $s_s = l_{eff} - 2 \cdot t_f = 111.9$ mm / ... to web $s_w = l_{eff} + 2 \cdot r = 213.9$ mm
local stresses ...
... at crane rail $\sigma_{oz} = -191.9\ N/mm^2$, $\tau_o = 38.4\ N/mm^2$ / ... at weld $\sigma_{oz} = -259.1\ N/mm^2$, $\tau_o = 51.8\ N/mm^2$
... at beam web $\sigma_{oz} = -100.4\ N/mm^2$, $\tau_o = 20.1\ N/mm^2$

elastic stresses / stress ranges
$\Delta\sigma_{x,Ed} = \sigma_{x,max} - \sigma_{x,min}$, $\tau_{Ed} = \tau_{xz,max} - \tau_{xz,min} + 2 \cdot \tau_o$, $\Delta\sigma_{z,Ed} = -\sigma_{oz}$

pt. 19: $y_f = -6.8$ mm, $z_f = 51.0$ mm — Lk 1: $\sigma_x = -77.8\ N/mm^2$, $\tau_{xz} = 54.5\ N/mm^2$
2: $\sigma_x = 7.7\ N/mm^2$, $\tau_{xz} = 0.0\ N/mm^2$
$\Delta\sigma_{x,Ed} = 85.5\ N/mm^2$, $\Delta\tau_{Ed} = 94.6\ N/mm^2$, $\Delta\sigma_{z,Ed} = 100.4\ N/mm^2$

equivalent constand amplitude stress range
$\Delta\sigma_{x,f} = \Delta\sigma_{x,Ed} \cdot \lambda_\sigma$, $\Delta\tau_f = \Delta\tau_{Ed} \cdot \lambda_\tau$, $\Delta\sigma_{z,f} = \Delta\sigma_{z,Ed} \cdot \lambda_\sigma$

pt. 19: $y_f = -6.8$ mm, $z_f = 51.0$ mm ($\lambda_{\tau\sigma z+}$) $\Delta\sigma_{x,f} = 26.9\ N/mm^2$, $\Delta\tau_f = 54.4\ N/mm^2$, $\Delta\sigma_{z,f} = 39.9\ N/mm^2$

valid notch stresses
$\Delta\sigma_{x,Rd,f} = \Delta\sigma_{x,Rd}/\gamma_{Mf}$, $\Delta\tau_{Rd,f} = \Delta\tau_{Rd}/\gamma_{Mf}$, $\Delta\sigma_{z,Rd,f} = \Delta\sigma_{z,Rd}/\gamma_{Mf}$

pt. 19: $y_f = -6.8$ mm, $z_f = 51.0$ mm — $\Delta\sigma_{x,Rd,f} = 69.6\ N/mm^2$, $\Delta\tau_{Rd,f} = 87.0\ N/mm^2$, $\Delta\sigma_{z,Rd,f} = 87.0\ N/mm^2$

verification of notch stresses
pt. 19: y = -6.8 mm, z = 51.0 mm
$\Delta\sigma_{x,f} = 26.9\ N/mm^2 < \Delta\sigma_{x,Rd,f} = 69.6\ N/mm^2 \Rightarrow U_{\Delta\sigma x} = 0.387$ ok.
$\Delta\tau_f = 54.4\ N/mm^2 < \Delta\tau_{Rd,f} = 87.0\ N/mm^2 \Rightarrow U_{\Delta\tau} = 0.626$ ok.
$\Delta\sigma_{z,f} = 39.9\ N/mm^2 < \Delta\sigma_{z,Rd,f} = 87.0\ N/mm^2 \Rightarrow U_{\Delta\sigma z} = 0.458$ ok.
interaction $U_i = U_{\Delta\sigma x}^3 + U_{\Delta\sigma z}^3 + U_{\Delta\tau}^5 = 0.250 < 1$ ok.

Final Result

fatigue design [pt. 19]: max U = 0.626 < 1 ok.

verification succeeded