detailed problems acc. to Eurocode 3

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

steel grade

steel grade S 235

cross-section

beam: section HE300B

transverse stiffeners: section ½ IPE270

recess at transverse stiffener $c_{st,q}$ = 27.0 mm

weld thickness $a_{st,q}$ = 5.0 mm

parameters

damage equivalent stress factors λ_σ = 0.315, λ_τ = 0.500

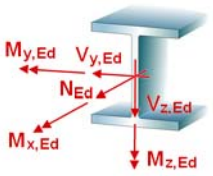
notch class / valid notch stresses:

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.
17	-130.3	19.0	80.0	0.0	0.0	due to transv.stiff.	8.4(7)

loading

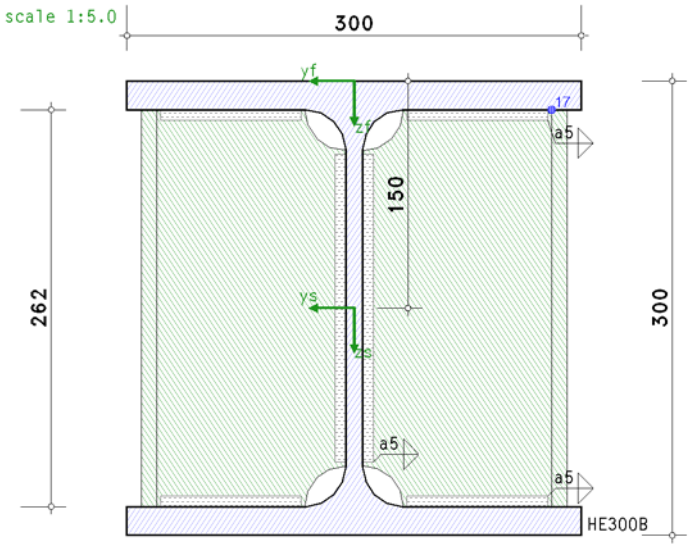
Lk 1: $M_{y,Ed}$ = -85.2 kNm

Lk 2: $M_{y,Ed}$ = 0.0 kNm



material safety factor

design concept: damage tolerance, damage consequence: high ⇒ fatigue strength γ_{Mf} = 1.15



Fatigue Design

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

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. 17: y_f = -130.3 mm, z_f = 19.0 mm Lk 1: σ_x = 44.4 N/mm²

2: σ_x = 0.0 N/mm²

$\Delta\sigma_{x,Ed}$ = 44.4 N/mm²

equivalent constand amplitude stress range

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

pt. 17: y_f = -130.3 mm, z_f = 19.0 mm $\Delta\sigma_{x,f}$ = 14.0 N/mm²

valid notch stresses

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

pt. 17: y_f = -130.3 mm, z_f = 19.0 mm $\Delta\sigma_{x,Rd,f}$ = 69.6 N/mm²

verification of notch stresses

pt. 17: y = -130.3 mm, z = 19.0 mm $\Delta\sigma_{x,f} = 14.0$ N/mm² < $\Delta\sigma_{x,Rd,f} = 69.6$ N/mm² ⇒ $U_{\Delta\sigma x} = 0.201$ ok.

Final Result

fatigue design [pt. 17]: max U = 0.201 < 1 ok.

verification succeeded