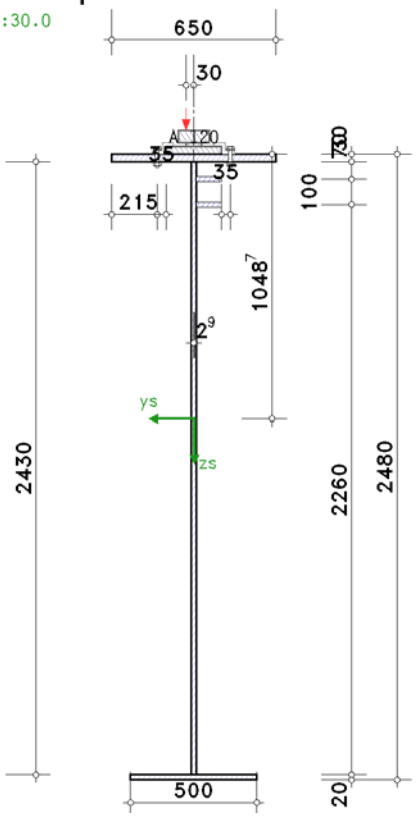
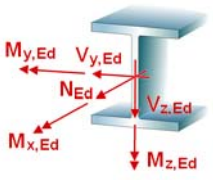
detailed problems acc. to Eurocode 3, EC 3-6 (12.10), NA: Deutschland

1. input report

scale 1:30.0



steel grade
steel grade S235
cross-section
beam: parameter (I-section):
overall depth h = 2480.0 mm, web thickness t_w = 20.0 mm
flange width top b_{fo} = 650.0 mm, flange thickness top t_{fo} = 30.0 mm
flange width bottom b_{fu} = 500.0 mm, flange thickness bottom t_{fu} = 20.0 mm
longitudinal stiffeners (right): number n_{st} = 2
section parameters (flat steel):
height h = 100.0 mm, thickness t = 20.0 mm
distance of the first stiffener to the upper edge of beam $d_{st,0}$ = 100.0 mm
constant distance of stiffeners d_{st} = 100.0 mm
distance of transverse stiffeners a = 200.0 cm
crane gantry
A-crane rail 120, floating with clamps joined with the girder
clamp connection with bolts: bolt class 8.8, bolt size M16
large wrench size (high strength bolt), preloaded (for info: preloading $F_{p,C}^* = 0.7 \cdot f_{yb} \cdot A_s$ = 70.3 kN)
shear plane passes through the unthreaded portion of the bolt
crane rail: head width b_k = 120.0 mm, bottom width b_r = 220.0 mm, height h = 105.0 mm, 25% wear
height, cross-sectional area, moments of inertia of fretted rail h_r = 93.1 mm, A_r = 113.60 cm², I_{yr} = 973.00 cm⁴, I_{tr} = 954.00 cm⁴
loading
internal forces and moments refering to unstiffened cross-secion:
internal forces and moments at limit state of serviceability (SLS):
transverse loading on upper edge of cross-section:
vertical wheel pressure $F_{z,Ed,SLS}$ = 560.00 kN, eccentricity e_y = 30.0 mm



partial safety factors for material
serviceability $\gamma_{M,ser}$ = 1.00

2. verification der local loading due to crane gantry

cross-sectional properties
$A = 821.00\ cm^2$, $z_s = 1048.7\ mm$, $I_y = 7006754.11\ cm^4$, $y_s = 2.9\ mm$, $I_z = 91354.76\ cm^4$

effective loading length from crane gantry
effective width $b_{eff} = b_r+h_r+t_{fo} = 343.1\ mm \le b_{fo}$
effective moment of inertia of beam flange $I_{f,eff} = b_{eff}\cdot t_{fo}^3/12 = 77.20\ cm^4$
moment of inertia of crane rail $I_r = 973.00\ cm^4$
effective length $l_{eff} = 3.25\cdot((I_r+I_{f,eff})/t_w)^{1/3} = 262.2\ mm$

length of local loading
refering to outer edge of flange $s_s = l_{eff} - 2\cdot t_f = 202.2\ mm$ / auf den webanschnitt $s_w = l_{eff} = 262.2\ mm$

2.1. elastic behaviour (SLS)

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

bending stress of web
$M_{T,Ed} = F_{z,Ed}\cdot e_y = 16.80\ kNm \Rightarrow \sigma_T = (6\cdot M_{T,Ed})/(a\cdot t_w^2)\cdot\eta\cdot\tanh(\eta) = 98.3\ N/mm^2$
with $F_{z,Ed} = 560.0\ kN$, $\eta = ((0.75\cdot a\cdot t_w^3)/I_t\cdot \sinh^2(\pi\cdot h_w/a)/(\sinh(2\cdot\pi\cdot h_w/a)-2\cdot\pi\cdot h_w/a))^{0.5} = 1.016$, $I_t = 585.00\ cm^4$

wheel pressure at top edge of the web
local normal stress $\sigma_{oz,Ed} = -F_{z,Ed}/(t_w\cdot s_w) = -106.8\ N/mm^2$, $F_{z,Ed} = 560.0\ kN$, $s_w = 262.2\ mm$
$|\sigma_{oz,Ed}|+|\sigma_{T,Ed}| = 205.1\ N/mm^2 < \sigma_{Rd} = 235.0\ N/mm^2 \Rightarrow U = 0.873 < 1$ ok
associated local shear stress $\tau_{oxz,Ed} = 0.2\cdot\sigma_{oz,Ed} = -21.4\ N/mm^2$
$|\tau_{oxz,Ed}| = 21.4\ N/mm^2 < \tau_{Rd} = 135.7\ N/mm^2 \Rightarrow U = 0.157 < 1$ ok

3. final result

maximum utilization: max U = 0.873 < 1 ok

verification succeeded