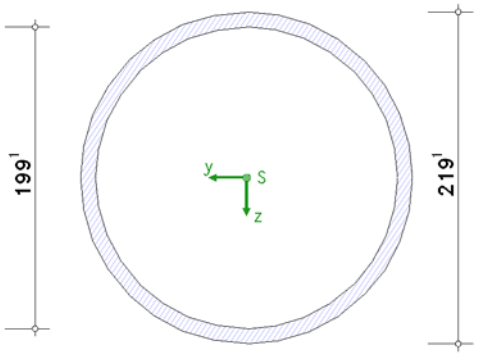
POS. 27: KINDMANN/KRÜGER 2.9.7

verification of cross-section EC 3-1-8 (12.10), NA: Deutschland

1. input report

scale 1:5.0



steel
steel grade S235
material safety factor
resistance of cross-sections $\gamma_{M0} = 1.00$
geometry
section R 219.1 x 10.0(w)
resistance
plastic verification acc. to EC 3-1-1, 6.2
internal forces and moments refering to local axes of cross-section
σ-generating forces (N, M) work at centroid, τ-generating forces (V, T_t) work at shear center
Lk 1: $V_{z,Ed} = 150.00$ kN, $V_{y,Ed} = 60.00$ kN, $T_{t,Ed} = 14.00$ kNm
Lk 2: $N_{Ed} = 240.00$ kN, $M_{y,Ed} = 85.00$ kNm, $V_{z,Ed} = 150.00$ kN, $M_{z,Ed} = 25.00$ kNm, $V_{y,Ed} = 60.00$ kN
$T_{t,Ed} = 14.00$ kNm

notes
buckling is not investigated.

2. Lk 1

2.1. verification of cross-section

internal forces and moments: $V_z = 150.00$ kN, $V_y = 60.00$ kN, $T_t = 14.00$ kNm

2.1.1. plastic verification

circular hollow section: $V = (V_y^2+V_z^2)^{1/2} = 161.55$ kN
plastic verification for $V = 161.55$ kN, $T_t = 14.00$ kNm
plastic values: $V_{pl,Rd} = A_v \cdot f_y/(3^{1/2} \cdot \gamma_{M0}) = 567.40$ kN

torsion
$\tau_{t,Ed} = |T_{t,Ed}|/W_t = 20.38$ N/mm², $W_t = 686.80$ cm³
verification: $\tau_{t,Ed}/\tau_{Rd} = 0.150 < 1$ ok

shear force and torsion
deduction: $\tau_{t,Ed} = |T_{t,Ed}|/W_t = 20.38$ N/mm², $W_t = 686.80$ cm³
$f_T = 1 - \tau_{t,Ed}/\tau_{Rd} = 0.850 \Rightarrow V_{pl,T,Rd} = V_{pl,Rd} \cdot f_T = 482.15$ kNm

shear force
verification: $V_{Ed}/V_{pl,T,z,Rd} = 0.335 < 1$ ok

3. Lk 2

3.1. verification of cross-section

internal forces and moments: $N = 240.00$ kN, $M_y = 85.00$ kNm, $V_z = 150.00$ kN, $M_z = 25.00$ kNm, $V_y = 60.00$ kN, $T_t = 14.00$ kN

3.1.1. plastic verification

circular hollow section: $V = (V_y^2+V_z^2)^{1/2} = 161.55$ kN, $M = (M_y^2+M_z^2)^{1/2} = 88.60$ kNm
plastic verification for $N = 240.00$ kN, $M = 88.60$ kNm, $V = 161.55$ kN, $T_t = 14.00$ kNm
plastic values: $N_{pl,Rd} = A \cdot f_y/\gamma_{M0} = 1543.73$ kN, $M_{pl,Rd} = W_{pl} \cdot f_y/\gamma_{M0} = 100.83$ kNm
$V_{pl,Rd} = A_v \cdot f_y/(3^{1/2} \cdot \gamma_{M0}) = 567.40$ kN

torsion
$\tau_{t,Ed} = |T_{t,Ed}|/W_t = 20.38$ N/mm², $W_t = 686.80$ cm³

shear force and torsion
deduction: $\tau_{t,Ed} = |T_{t,Ed}|/W_t = 20.38$ N/mm², $W_t = 686.80$ cm³
$f_T = 1 - \tau_{t,Ed}/\tau_{Rd} = 0.850 \Rightarrow V_{pl,T,Rd} = V_{pl,Rd} \cdot f_T = 482.15$ kNm

shear force
reduction factor: $\rho = (2 \cdot V_{Ed}/V_{pl,T,Rd} - 1)^2 = 0.109$

axial force and shear force/torsion
$N_{pl,Rd} = A \cdot (1-\rho) \cdot f_y/\gamma_{M0} = 1375.76$ kN

bending and shear force/torsion
$M_{pl,V,Rd} = W_{pl} \cdot (1-\rho) \cdot f_y/\gamma_{M0} = 89.86$ kNm

bending
verification: $|M_{y,Ed}|/M_{pl,V,y,Rd} = 0.986 < 1$ ok

4. final result

maximum utilization [Lk 2]: resistance max U = 0.986 < 1 ok

verification succeeded