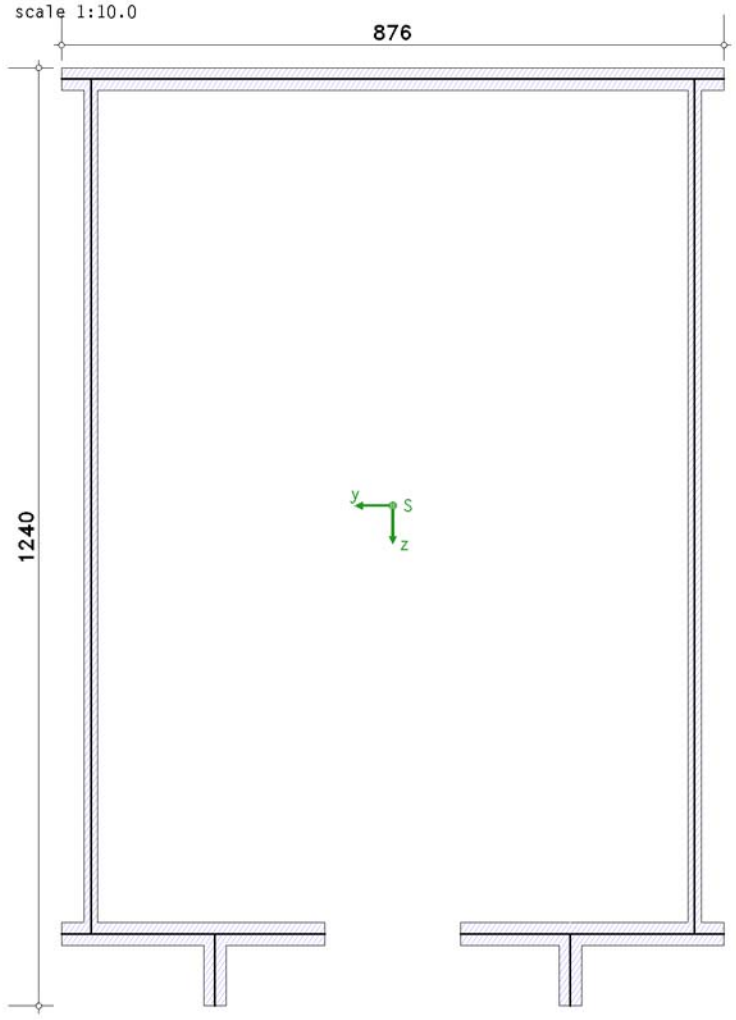
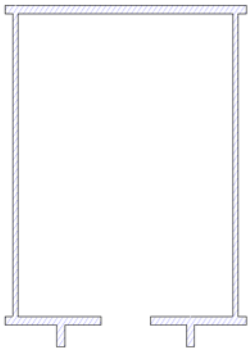
POS. 19: KINDMANN/KRÜGER 2.8.7

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

1. input report



steel
steel grade S235
material safety factor
resistance of cross-sections γ_{M0} = 1.00
geometry
dimensions of cross-section: y_{min} = -438.0 mm, y_{max} = 438.0 mm, z_{min} = -15.0 mm, z_{max} = 1225.0 mm
width,height of cross-section: b = 876.0 mm, h = 1240.0 mm
centroid, rotation angle of main axis: e_y = 0.0 mm, e_z = 564.2 mm, α = 0.00 °
distance shear center to centroid: y_{SM} = 0.0 mm, z_{SM} = -1315.3 mm



cross-sectional area	A	= 915.60 cm²
bending moment of inertia	I_η	= 2089880.66 cm⁴
bending moment of inertia	I_ζ	= 991739.57 cm⁴
section modulus	W_η+	= 31625.61 cm³
section modulus	W_η-	= 36083.39 cm³
section modulus	W_ζ+	= 22642.46 cm³
section modulus	W_ζ-	= 22642.46 cm³
torsional moment of inertia	I_T	= 2025.14 cm⁴
warping moment of inertia	I_ω	= 7298084297.93 cm⁶
section of cross-section	i_M	= 143.75 cm
section of cross-section	r_η	= 0.00 cm
section of cross-section	r_ζ	= 264.92 cm
section of cross-section	r_ω	= 0.00

resistance
elastic verification, calculation as thin-walled cross-section

valid normal, shear-, equivalent stress: $\sigma_{x,Rd}$ = 235.0 N/mm², τ_{Rd} = 135.7 N/mm², $\sigma_{v,Rd}$ = 235.0 N/mm²
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
warping forces (T_ω, B) work at shear center
Lk 1: Feldmitte
$M_{y,Ed}$ = 662.30 kNm, $M_{z,Ed}$ = -14.40 kNm, B_{Ed} = 499.00 kNm²
Lk 2: Auflager
$V_{z,Ed}$ = 68.00 kN, $T_{t,Ed}$ = 3.68 kNm, $T_{\omega,Ed}$ = 61.45 kNm
Lk 3: Tw
$T_{\omega,Ed}$ = 61.45 kNm

notes
buckling is not investigated.

2. Lk 1: Feldmitte

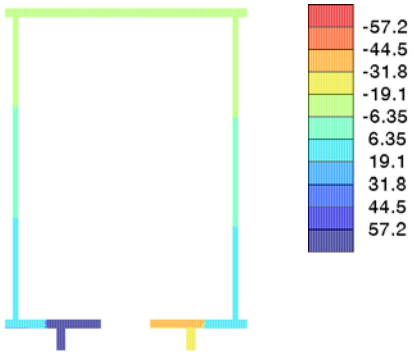
2.1. verification of cross-section

internal forces and moments: M_y = 662.30 kNm, M_z = -14.40 kNm, B = 499.00 kNm²

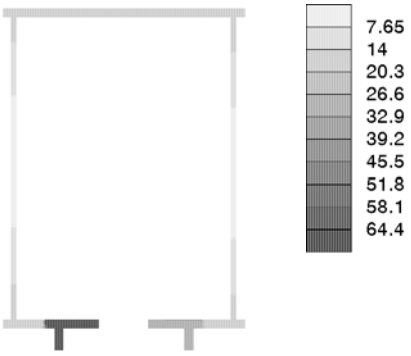
2.1.1. elastic verification

elastic verification for M_y = 662.30 kNm, M_z = -14.40 kNm, B = 499.00 kNm²
elastic stresses: max |σx| = 68.62 N/mm², max τ = 0.00 N/mm², max σv = 68.62 N/mm²
max σx bei y = 90.0 mm, z = 580.8 mm: σx = 68.62 N/mm², τ = 0.00 N/mm², σv = 68.62 N/mm²
min σx bei y = 438.0 mm, z = -579.2 mm: σx = -40.21 N/mm², τ = 0.00 N/mm², σv = 40.21 N/mm²
max σv bei y = 90.0 mm, z = 580.8 mm: σx = 68.62 N/mm², τ = 0.00 N/mm², σv = 68.62 N/mm²
valid equivalent stress: $\sigma_{v,Rd}$ = 235.0 N/mm²
verification: σv = 68.62 N/mm² < $\sigma_{v,Rd}$ = 235.00 N/mm² ⇒ U_σ = 0.292 < 1 **ok**

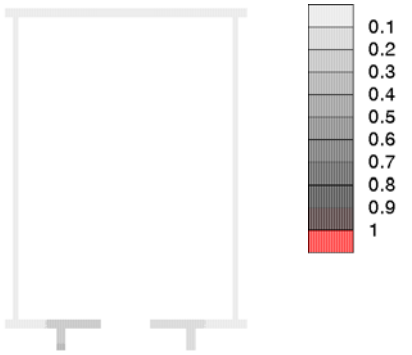
normal stresses σx [N/mm²]
min σx = -33.1, max σx = 71.5



equivalent stresses σv [N/mm²]
max σv = 71.5



utilization U_σ
max U_σ = 0.304



stresses, utilizations

y mm	z mm	σx N/mm²	σv N/mm²	U_σ
-719.5	1130.0	-33.08	33.08	0.141
-188.0	1240.0	71.45	71.45	0.304
-203.0	1240.0	71.44	71.44	0.304

y,z: node coordinates; σx,σv: stresses; U_σ: stress utilization

3. Lk 2: Auflager

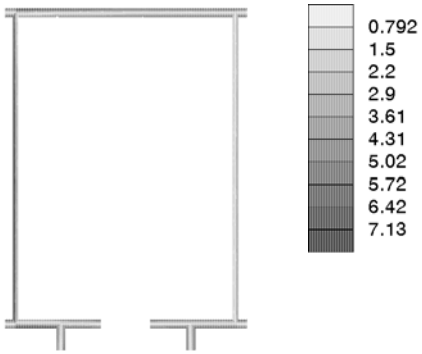
3.1. verification of cross-section

internal forces and moments: V_z = 68.00 kN, T_t = 3.68 kNm, T_ω = 61.45 kNm

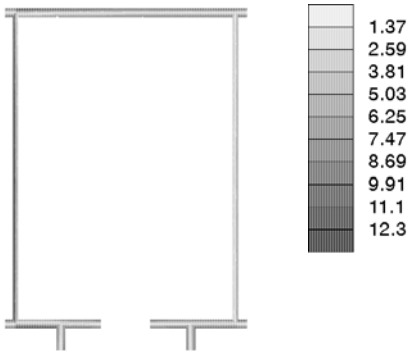
3.1.1. elastic verification

elastic verification for V_z = 68.00 kN, T_t = 3.68 kNm, T_ω = 61.45 kNm
elastic stresses: max $|\sigma_x|$ = 0.00 N/mm², max τ = 7.92 N/mm², max σ_v = 13.71 N/mm²
max τ bei y = 408.0 mm, z = 110.8 mm: σ_x = 0.00 N/mm², τ = 7.92 N/mm², σ_v = 13.71 N/mm²
max σ_v bei y = 408.0 mm, z = 110.8 mm: σ_x = 0.00 N/mm², τ = 7.92 N/mm², σ_v = 13.71 N/mm²
valid equivalent stress: $\sigma_{v,Rd}$ = 235.0 N/mm²
verification: σ_v = 13.71 N/mm² < $\sigma_{v,Rd}$ = 235.00 N/mm² ⇒ U_σ = 0.058 < 1 ok

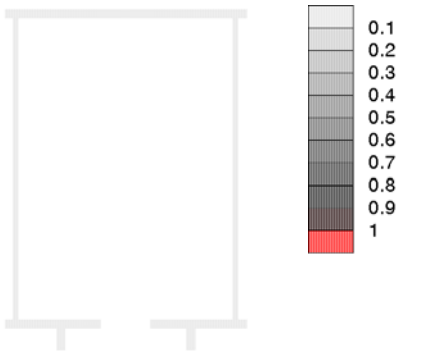
shear stresses τ [N/mm²]
max τ = 7.9



equivalent stresses σ_v [N/mm²]
max σ_v = 13.7



utilization U_σ
max U_σ = 0.058



stresses, utilizations

y	z	τ	σ_v	U_σ
mm	mm	N/mm²	N/mm²	
-30.0	635.0	7.92	13.72	0.058

y,z: node coordinates; τ,σ_v: stresses; U_σ: stress utilization

4. Lk 3: Tw

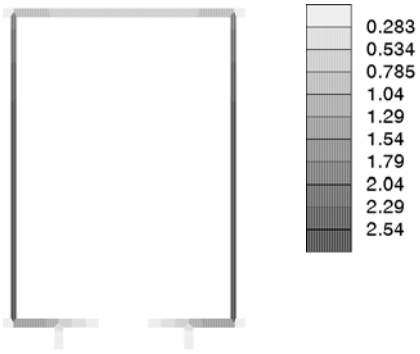
4.1. verification of cross-section

internal forces and moments: T_ω = 61.45 kNm

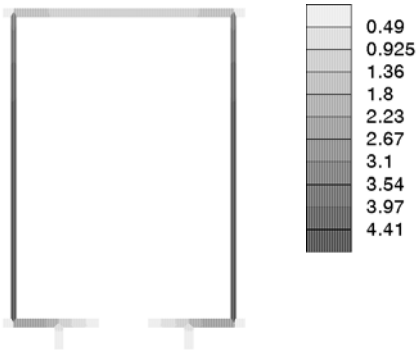
4.1.1. elastic verification

elastic verification for T_ω = 61.45 kNm
elastic stresses: max $|\sigma_x|$ = 0.00 N/mm², max τ = 2.84 N/mm², max σ_v = 4.93 N/mm²
max τ bei y = -399.0 mm, z = 226.8 mm: σ_x = 0.00 N/mm², τ = 2.84 N/mm², σ_v = 4.93 N/mm²
max σ_v bei y = -399.0 mm, z = 226.8 mm: σ_x = 0.00 N/mm², τ = -2.84 N/mm², σ_v = 4.93 N/mm²
valid equivalent stress: $\sigma_{v,Rd}$ = 235.0 N/mm²
verification: σ_v = 4.93 N/mm² < $\sigma_{v,Rd}$ = 235.00 N/mm² ⇒ U_σ = 0.021 < 1 ok

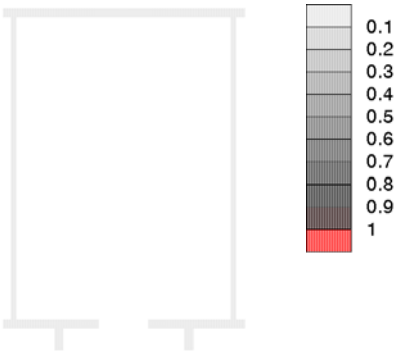
shear stresses τ [N/mm²]
max τ = 2.8



equivalent stresses σ_V [N/mm²]
max σ_V = 4.9



utilization U_σ
max U_σ = 0.021



stresses, utilizations

y	z	τ	σ_V	U_σ
mm	mm	N/mm²	N/mm²	
-30.0	690.0	2.83	4.90	0.021
-48.0	690.0	2.83	4.90	0.021
-39.0	693.0	2.83	4.90	0.021

y,z: node coordinates; τ,σ_V: stresses; U_σ: stress utilization

5. final result

maximum utilization [Lk 1]: resistance max U = 0.292 < 1 ok

verification succeeded