

5. Lc 1 (decisive)

5.1. verification of cross-section

calculation acc. to EC 3-1-1, 8.2 not possible for this section !!

verification with TSV:

plastic verification for $N = 0.21 \text{ kN}$, $M_y = -3.72 \text{ kNm}$, $V_z = 3.16 \text{ kN}$, $M_z = -0.60 \text{ kNm}$

$V_y = -7.05 \text{ kN}$

internal forces and moments reg. yz-direction in kN, m: $M_y = -3.72$, $M_z = -0.60$, $V_y = -7.05$, $V_z = 3.16$

partial internal forces and moments of lines of cross-section in kN, m:

1: $N = 30.32$, $M_y = -0.00$, $M_z = -0.00$, $V_y = -4.03$, $V_z = 0.04$, $T = 0.00$

2: $N = 20.90$, $M_y = 0.00$, $M_z = -0.27$, $V_y = -3.02$, $V_z = -0.03$, $T = 0.00$

3: $N = -51.00$, $M_y = -0.48$, $M_z = -0.00$, $V_y = 0.00$, $V_z = 3.15$, $T = 0.00$

utilizations of lines of cross-section

1: $U_\sigma = 0.125$, $U_\tau = 0.029$, $U = 0.129$

2: $U_\sigma = 0.125$, $U_\tau = 0.022$, $U = 0.126$

3: $U_\sigma = 0.129$, $U_\tau = 0.012$, $U = 0.129$

max. load factor (plastic): $f_{pl} = 7.747$

no equilibrium of warping at limit state: $\Delta B = 0.000 \text{ kNm}^2$

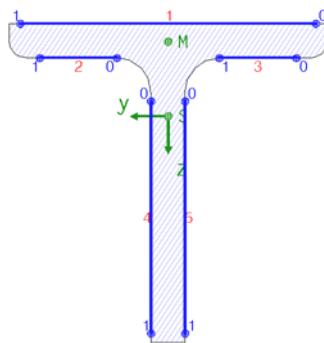
utilization (without equilibrium of warping): $U_{pl} = 0.129$

verification: $U_{pl} = 0.129 < 1$ ok

c/t-verification: utilization $U_{c/t} = 0.700 < 1$ ok (reg. section class 2)

5.2. verification of welds

calculation section:



weld 1:	$a_w = 5.0 \text{ mm}$	$l_w = 130.0 \text{ mm}$
weld 2:	$a_w = 3.0 \text{ mm}$	$l_w = 34.0 \text{ mm}$
weld 3:	$a_w = 3.0 \text{ mm}$	$l_w = 34.0 \text{ mm}$
weld 4:	$a_w = 4.0 \text{ mm}$	$l_w = 102.0 \text{ mm}$
weld 5:	$a_w = 4.0 \text{ mm}$	$l_w = 102.0 \text{ mm}$

design values referring to centroid of the section:

$N_{Ed} = 0.21 \text{ kN}$, $M_{y,Ed} = -3.72 \text{ kNm}$, $V_{z,Ed} = 3.16 \text{ kN}$, $M_{z,Ed} = -0.60 \text{ kNm}$, $V_{y,Ed} = -7.05 \text{ kN}$

cross-sectional properties referring to centroid of the line cross-section:

$\Sigma A_w = 16.70 \text{ cm}^2$, $A_{w,y} = 8.54 \text{ cm}^2$, $A_{w,z} = 8.16 \text{ cm}^2$, $\Sigma l_w = 40.2 \text{ cm}$

$I_{w,y} = 350.85 \text{ cm}^4$, $I_{w,z} = 129.93 \text{ cm}^4$, $\Delta y_w = 0.0 \text{ mm}$, $\Delta z_w = 2.9 \text{ mm}$

distribution of internal forces and moments:

weld 1: $N_w = 29.97 \text{ kN}$, $M_{z,w} = -0.42 \text{ kNm}$

weld 2: $N_w = 4.94 \text{ kN}$, $M_{z,w} = -0.00 \text{ kNm}$

weld 3: $N_w = 1.22 \text{ kN}$, $M_{z,w} = -0.00 \text{ kNm}$

weld 4: $N_w = -16.55 \text{ kN}$, $M_{y,w} = -0.38 \text{ kNm}$

weld 5: $N_w = -19.37 \text{ kN}$, $M_{y,w} = -0.38 \text{ kNm}$

from conventional distribution of shear force: $V_{y,w} = -7.05 \text{ kN}$, $V_{z,w} = 3.16 \text{ kN}$

verifications in weld edges:

30% decrease of stress by pressure contact

weld 1,	pt. 0:	$\sigma_{w,x} = 16.09 \text{ N/mm}^2$	$\tau_{w,y} = -8.26 \text{ N/mm}^2$	$\Rightarrow U_w = 0.075 < 1$ ok
	pt. 1:	$\sigma_{w,x} = 76.12 \text{ N/mm}^2$	$\tau_{w,y} = -8.26 \text{ N/mm}^2$	$\Rightarrow U_w = 0.302 < 1$ ok
weld 2,	pt. 0:	$\sigma_{w,x} = 40.59 \text{ N/mm}^2$	$\tau_{w,y} = -8.26 \text{ N/mm}^2$	$\Rightarrow U_w = 0.164 < 1$ ok
	pt. 1:	$\sigma_{w,x} = 56.29 \text{ N/mm}^2$	$\tau_{w,y} = -8.26 \text{ N/mm}^2$	$\Rightarrow U_w = 0.225 < 1$ ok
weld 3,	pt. 0:	$\sigma_{w,x} = 4.11 \text{ N/mm}^2$	$\tau_{w,y} = -8.26 \text{ N/mm}^2$	$\Rightarrow U_w = 0.043 < 1$ ok
	pt. 1:	$\sigma_{w,x} = 19.81 \text{ N/mm}^2$	$\tau_{w,y} = -8.26 \text{ N/mm}^2$	$\Rightarrow U_w = 0.087 < 1$ ok
weld 4,	pt. 0:	$\sigma_{w,x} = 13.52 \text{ N/mm}^2$	$\tau_{w,z} = 3.87 \text{ N/mm}^2$	$\Rightarrow U_w = 0.056 < 1$ ok
	pt. 1:	$\sigma_{w,x} = -66.24 \text{ N/mm}^2$	$\tau_{w,z} = 3.87 \text{ N/mm}^2$	$\Rightarrow U_w = 0.261 < 1$ ok
weld 5,	pt. 0:	$\sigma_{w,x} = 6.59 \text{ N/mm}^2$	$\tau_{w,z} = 3.87 \text{ N/mm}^2$	$\Rightarrow U_w = 0.032 < 1$ ok
	pt. 1:	$\sigma_{w,x} = -71.09 \text{ N/mm}^2$	$\tau_{w,z} = 3.87 \text{ N/mm}^2$	$\Rightarrow U_w = 0.280 < 1$ ok

Result:

weld 1, pt. 1: $\sigma_{w,x} = 76.12 \text{ N/mm}^2$, $\tau_{w,y} = -8.26 \text{ N/mm}^2$

Max: $\sigma_{1,w,Ed} = 108.60 \text{ N/mm}^2 < f_{1w,d} = 360.00 \text{ N/mm}^2$,

$\sigma_{2,w,Ed} = 53.83 \text{ N/mm}^2 < f_{2w,d} = 259.20 \text{ N/mm}^2 \Rightarrow U_w = 0.302 < 1$ ok