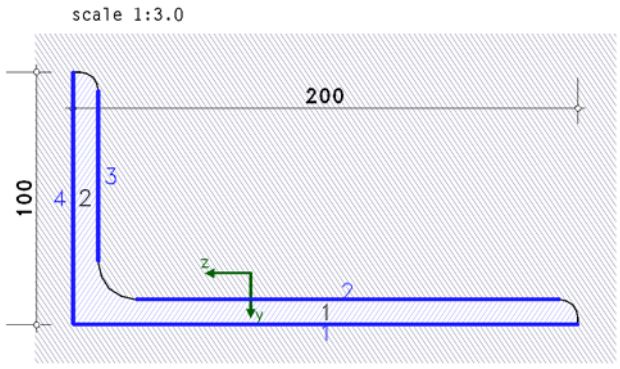
POS. 9: L-SECTION, EC3, AUSFÜHRLICH

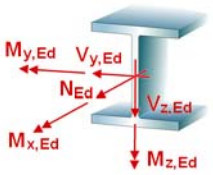
4H-EC3SA version: 10/2014-1m

Welded connection

EC 3-1-8 (12.10), NA: Deutschland



material
steel grade S 235
geometry
section L200X100X10
plate: thickness t_p = 35.0 mm
welds as fillet weld (full-size):
a_{w1} = 6.0 mm, l_{w1} = 200.0 mm a_{w2} = 6.0 mm, l_{w2} = 167.5 mm a_{w3} = 6.0 mm, l_{w3} = 67.5 mm
a_{w4} = 6.0 mm, l_{w4} = 100.0 mm
design resistance
elastic cross-sectional check
weld verification with the simplified method
resolution of shear force is made by the stiffness of the single weld.
internal forces and moments (sign definition of statics)
Lk 1: N_{Ed} = 1.90 kN $V_{z,Ed}$ = -2.87 kN $M_{z,Ed}$ = 4.26 kNm



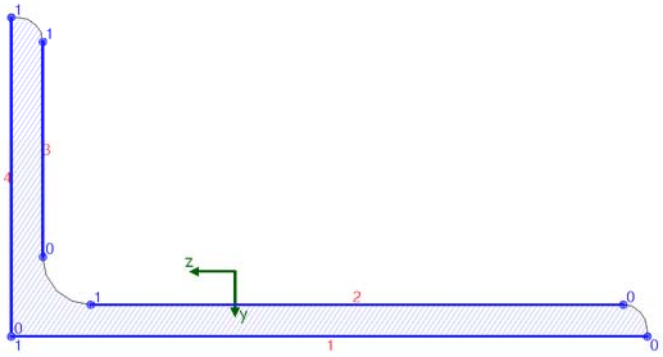
Lk 1:

cross-sectional check

design values:	N_{Ed} = 1.90 kN, $M_{y,Ed}$ = 1.10 kNm, $V_{z,Ed}$ = -2.77 kN, $M_{z,Ed}$ = 4.12 kNm, $V_{y,Ed}$ = -0.74 kN
at major axis system	
elastic stresses:	max σ_x = 199.0 N/mm², min σ_x = -105.8 N/mm², max τ = 2.0 N/mm², max σ_v = 199.0 N/mm²
valid stresses:	σ_{Rd} = 235.0 N/mm², τ_{Rd} = 135.7 N/mm²
utilizations:	design resistance U_σ = 0.847 < 1 **ok.**, c/t-ratio $U_{c/t}$ = 0.180 < 1 **ok.**

verification of welds

calculation section:



weld 1:	a_w = 6.0 mm	l_w = 200.0 mm
weld 2:	a_w = 6.0 mm	l_w = 167.5 mm
weld 3:	a_w = 6.0 mm	l_w = 67.5 mm
weld 4:	a_w = 6.0 mm	l_w = 100.0 mm

design values:

N_{Ed} = 1.90 kN, $V_{z,Ed}$ = -2.87 kN, $M_{z,Ed}$ = 4.26 kNm

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

ΣA_w = 32.10 cm², Σl_w = 53.5 cm

$I_{w,y}$ = 1331.65 cm⁴, $I_{w,z}$ = 238.90 cm⁴, $I_{w,yz}$ = -331.01 cm⁴, Δy_w = 0.6 mm, Δz_w = -2.3 mm

member forces distributed to the individual welds:

weld 1:	N_w = -42.05 kN	$M_{y,w}$ = -2.70 kNm	$M_{z,w}$ = 0.01 kNm	$V_{z,w}$ = -1.81 kN
weld 2:	N_w = -1.94 kN	$M_{y,w}$ = -1.59 kNm	$M_{z,w}$ = 0.01 kNm	$V_{z,w}$ = -1.06 kN
weld 3:	N_w = 25.88 kN	$M_{z,w}$ = 0.42 kNm		
weld 4:	N_w = 20.01 kN	$M_{y,w}$ = -0.00 kNm	$M_{z,w}$ = 1.36 kNm	

stresses in the edge points of the individual welds:

weld 1,	pt. 0:	$\sigma_{w,x}$ = 32.57 N/mm²	$\tau_{w,z}$ = -1.51 N/mm²
	pt. 1:	$\sigma_{w,x}$ = -102.65 N/mm²	$\tau_{w,z}$ = -1.51 N/mm²
weld 2,	pt. 0:	$\sigma_{w,x}$ = 54.70 N/mm²	$\tau_{w,z}$ = -1.06 N/mm²
	pt. 1:	$\sigma_{w,x}$ = -58.55 N/mm²	$\tau_{w,z}$ = -1.06 N/mm²
weld 3,	pt. 0:	$\sigma_{w,x}$ = -27.89 N/mm²	$\tau_{w,z}$ = -0.00 N/mm²
	pt. 1:	$\sigma_{w,x}$ = 155.71 N/mm²	$\tau_{w,z}$ = -0.00 N/mm²
weld 4,	pt. 0:	$\sigma_{w,x}$ = -102.65 N/mm²	$\tau_{w,z}$ = -0.00 N/mm²
	pt. 1:	$\sigma_{w,x}$ = 169.34 N/mm²	$\tau_{w,z}$ = -0.00 N/mm²

verifications in the edge points of the individual welds:

verification of weld 1, pt. 0:

stresses on the design area of the weld (α = 45°):

$\sigma_{w,Ed} = (\sigma_{w,x}^2 + \tau_{w,z}^2)^{1/2}$ = 32.6 N/mm²

resultant weld force: $F_{w,Ed} = \sigma_{w,Ed} \cdot a$ = 1.96 kN/cm

design resistance of the weld: $F_{w,Rd} = f_{vw,d} \cdot a$ = 12.47 kN/cm, a = 6.0 mm, $f_{vw,d}$ = 207.85 N/mm²

$F_{w,Ed}$ = 1.96 kN/cm < $F_{w,Rd}$ = 12.47 kN/cm ⇒ utilization U = 0.157 < 1 **ok.**

verification of weld 1, pt. 1:

stresses on the design area of the weld (α = 45°):

$\sigma_{w,Ed} = (\sigma_{w,x}^2 + \tau_{w,z}^2)^{1/2}$ = 102.7 N/mm²

resultant weld force: $F_{w,Ed} = \sigma_{w,Ed} \cdot a$ = 6.16 kN/cm

design resistance of the weld: $F_{w,Rd} = f_{vw,d} \cdot a$ = 12.47 kN/cm, a = 6.0 mm, $f_{vw,d}$ = 207.85 N/mm²

$F_{w,Ed}$ = 6.16 kN/cm < $F_{w,Rd}$ = 12.47 kN/cm ⇒ utilization U = 0.494 < 1 **ok.**

verification of weld 2, pt. 0:

stresses on the design area of the weld (α = 45°):

$\sigma_{w,Ed} = (\sigma_{w,x}^2 + \tau_{w,z}^2)^{1/2}$ = 54.7 N/mm²

resultant weld force: $F_{w,Ed} = \sigma_{w,Ed} \cdot a$ = 3.28 kN/cm

design resistance of the weld: $F_{w,Rd} = f_{vw,d} \cdot a$ = 12.47 kN/cm, a = 6.0 mm, $f_{vw,d}$ = 207.85 N/mm²

$F_{w,Ed}$ = 3.28 kN/cm < $F_{w,Rd}$ = 12.47 kN/cm ⇒ utilization U = 0.263 < 1 **ok.**

verification of weld 2, pt. 1:

stresses on the design area of the weld (α = 45°):

$\sigma_{w,Ed} = (\sigma_{w,x}^2 + \tau_{w,z}^2)^{1/2}$ = 58.6 N/mm²

resultant weld force: $F_{w,Ed} = \sigma_{w,Ed} \cdot a$ = 3.51 kN/cm

design resistance of the weld: $F_{w,Rd} = f_{vw,d} \cdot a$ = 12.47 kN/cm, a = 6.0 mm, $f_{vw,d}$ = 207.85 N/mm²

$F_{w,Ed}$ = 3.51 kN/cm < $F_{w,Rd}$ = 12.47 kN/cm ⇒ utilization U = 0.282 < 1 **ok.**

verification of weld 3, pt. 0:

stresses on the design area of the weld (α = 45°):

$\sigma_{w,Ed} = (\sigma_{w,x}^2 + \tau_{w,z}^2)^{1/2}$ = 27.9 N/mm²

resultant weld force: $F_{w,Ed} = \sigma_{w,Ed} \cdot a$ = 1.67 kN/cm

design resistance of the weld: $F_{w,Rd} = f_{vw,d} \cdot a$ = 12.47 kN/cm, a = 6.0 mm, $f_{vw,d}$ = 207.85 N/mm²

$F_{w,Ed}$ = 1.67 kN/cm < $F_{w,Rd}$ = 12.47 kN/cm ⇒ utilization U = 0.134 < 1 **ok.**

verification of weld 3, pt. 1:

stresses on the design area of the weld (α = 45°):

$\sigma_{w,Ed} = (\sigma_{w,x}^2 + \tau_{w,z}^2)^{1/2}$ = 155.7 N/mm²

resultant weld force: $F_{w,Ed} = \sigma_{w,Ed} \cdot a$ = 9.34 kN/cm

design resistance of the weld: $F_{w,Rd} = f_{vw,d} \cdot a$ = 12.47 kN/cm, a = 6.0 mm, $f_{vw,d}$ = 207.85 N/mm²

$F_{w,Ed}$ = 9.34 kN/cm < $F_{w,Rd}$ = 12.47 kN/cm ⇒ utilization U = 0.749 < 1 **ok.**

verification of weld 4, pt. 0:

stresses on the design area of the weld (α = 45°):

$\sigma_{w,Ed} = (\sigma_{w,x}^2 + \tau_{w,z}^2)^{1/2}$ = 102.7 N/mm²

resultant weld force: $F_{w,Ed} = \sigma_{w,Ed} \cdot a$ = 6.16 kN/cm

design resistance of the weld: $F_{w,Rd} = f_{vw,d} \cdot a$ = 12.47 kN/cm, a = 6.0 mm, $f_{vw,d}$ = 207.85 N/mm²

$F_{w,Ed}$ = 6.16 kN/cm < $F_{w,Rd}$ = 12.47 kN/cm ⇒ utilization U = 0.494 < 1 **ok.**

verification of weld 4, pt. 1:

stresses on the design area of the weld (α = 45°):

$\sigma_{w,Ed} = (\sigma_{w,x}^2 + \tau_{w,z}^2)^{1/2}$ = 169.3 N/mm²

resultant weld force: $F_{w,Ed} = \sigma_{w,Ed} \cdot a$ = 10.16 kN/cm

design resistance of the weld: $F_{w,Rd} = f_{vw,d} \cdot a$ = 12.47 kN/cm, a = 6.0 mm, $f_{vw,d}$ = 207.85 N/mm²

$F_{w,Ed}$ = 10.16 kN/cm < $F_{w,Rd}$ = 12.47 kN/cm ⇒ utilization U = 0.815 < 1 **ok.**

Result:

weld 4, pt. 1: $\sigma_{w,x}$ = 169.34 N/mm² $\tau_{w,z}$ = 0.00 N/mm²

$F_{w,Ed}$ = 10.16 kN/cm < $F_{w,Rd}$ = 12.47 kN/cm ⇒ U_w = 0.815 < 1 **ok.**

Final result

maximum utilization: design resistance max U = 0.847 < 1 **ok.**

c/t-ratio max U = 0.180 < 1 **ok.**

verification succeeded