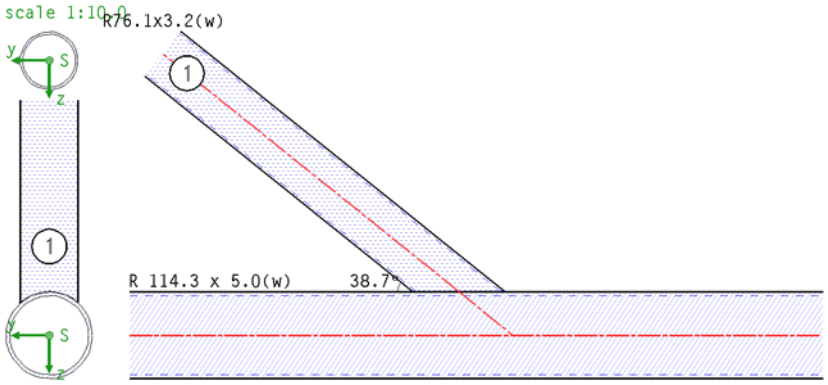
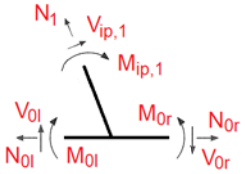
POS. 2: SK'02, 4.1, KNOTEN 1, Y

verification of a welded hollow section joint EC 3-1-8 (12.10), NA: Deutschland 4H-EC3HK version: 5/2014-3z

1. input report



steel
steel grade S235
material safety factor
resistance of cross-sections γ_{M0} = 1.00
resistance of bolts, welds, plates in bearing γ_{M2} = 1.25
resistance of hollow section joints γ_{M5} = 1.00
geometry
T/Y joint
chord: section R 114.3 x 5.0(w)
brace 1: connection angle Θ = 38.70°, section R 76.1 x 3.2(w)
welds
fillet weld, weld thickness a = 3.2 mm
verifications
verification of hollow section joint (chord and brace)
verification of welds with the directional method
plastic verification of joining sections
internal forces and moments
Lk 1: $N_{0l,Ed}$ = 97.00 kN, $N_{1,Ed}$ = -124.30 kN



note
equilibrium is not checked.

check of data
brace 1: a = 3.2 mm > req a = $\beta_w \cdot 2^{1/2} \cdot f_y/f_u \cdot \gamma_{M2}/\gamma_{M0} \cdot t$ = 0.923·t_1 = 2.95 mm ok (s. EC 3-1-8, 4.9(6))
brace 1: hollow section: plate thickness t_1 = 5.0 mm > 2.5 mm ok
brace 1: hollow section: plate thickness t_2 = 3.2 mm > 2.5 mm ok
brace 1: NA-DE: plate thickness $t_{max} \geq$ 3 mm: weld thickness a = 3.2 mm > $a_{min} = t_{max}^{1/2}$ - 0.5 = 1.74 mm ok
brace 1: weld thickness a = 3.2 mm > a_{min} = 3 mm ok
coefficient $\beta = d_1/d_0$ = 0.666

2. Lk 1

2.1. verification of a welded hollow section joint

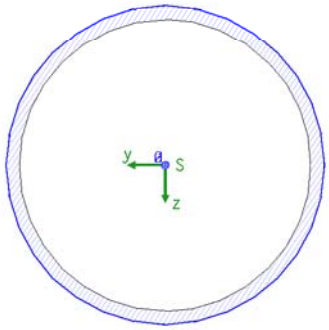
design values: $N_{1,Ed}$ = -124.30 kN
range of validity (table 7.1, T/Y joint)
chord: 10 < d_0/t_0 = 22.860 < 50 ok
brace 1: 0.2 < d_1/d_0 = 0.666 < 1 ok
brace 1: section class 1 < 2 ok
resistance (table 7.2, T/Y joint)
coefficient $\gamma = d_0/(2 \cdot t_0)$ = 11.430
chord-preload force $N_p = N_{0,Ed} - \Sigma(N_{i,Ed} \cdot \cos(\Theta_i))$ = 97.0 kN ⇒ coefficient k_p = 1
brace 1:
chord face failure
resistance: $N_{1,Rd} = (\gamma^{0.2} \cdot k_p \cdot f_{y0} \cdot t_0^2)/\sin(\Theta_1) \cdot (2.8+14.2 \cdot \beta^2) / \gamma_{M5}$ = 139.11 kN
utilisation: $U_1 = N_{1,Ed}/N_{1,Rd}$ = 0.894 < 1 ok
punching shear failure for d_1 = 76.1 mm ≤ $d_0 - 2 \cdot t_0$ = 104.3 mm
resistance: $N_{1,Rd} = f_{y0}/3^{1/2} \cdot t_0 \cdot \pi \cdot d_1 \cdot (1+\sin(\Theta_1))/(2 \cdot \sin^2(\Theta_1)) / \gamma_{M5}$ = 337.13 kN
utilisation: $U_1 = N_{1,Ed}/N_{1,Rd}$ = 0.369 < 1 ok

total: U_{Lk1} = 0.894 < 1 ok

2.2. weld verification

brace 1:
to simplify, the weld of a non-sloped or cut-out brace is verified

calculation section:



weld 1: a_w = 3.2 mm l_w = 239.1 mm

design values refering to centroid of the section:
N_{Ed} = -124.30 kN
cross-sectional properties refering to centroid of the line cross-section:
ΣA_w = 7.65 cm², $A_{w,y}$ = 3.83 cm², $A_{w,z}$ = 3.83 cm², Σl_w = 23.9 cm
$I_{w,y}$ = 55.38 cm⁴, $I_{w,z}$ = 55.38 cm⁴, Δy_w = 0.0 mm, Δz_w = 0.0 mm
verification of line section:

pt. 0:	$\sigma_{w,x}$ = -162.48 N/mm²	$\tau_{w,t}$ = 0.00 N/mm²	⇒ U_w = 0.591 < 1	ok
pt. 1:	$\sigma_{w,x}$ = -162.48 N/mm²	$\tau_{w,t}$ = 0.00 N/mm²	⇒ U_w = 0.591 < 1	ok
pt. 2:	$\sigma_{w,x}$ = -162.48 N/mm²	$\tau_{w,t}$ = 0.00 N/mm²	⇒ U_w = 0.591 < 1	ok
pt. 3:	$\sigma_{w,x}$ = -162.48 N/mm²	$\tau_{w,t}$ = 0.00 N/mm²	⇒ U_w = 0.591 < 1	ok

Result:
pt. 0: $\sigma_{w,x}$ = -162.48 N/mm² $\tau_{w,t}$ = 0.00 N/mm²
Max: $\sigma_{1,w,Ed}$ = 17.94 kN/cm² < $f_{1w,d}$ = 36.00 kN/cm²,
$\sigma_{2,w,Ed}$ = 15.33 kN/cm² < $f_{2w,d}$ = 25.92 kN/cm² ⇒ U_w = 0.591 < 1 ok

2.3. verification of cross-section

chord:
plastic verification for N = 97.00 kN
plastic values: $N_{pl,Rd} = A \cdot f_y/\gamma_{M0}$ = 403.47 kN

verification: $|N_{Ed}|/N_{pl,Rd}$ = 0.240 < 1 ok

brace 1:
plastic verification for N = -124.30 kN
plastic values: $N_{pl,Rd} = A \cdot f_y/\gamma_{M0}$ = 172.22 kN

verification: $|N_{Ed}|/N_{pl,Rd}$ = 0.722 < 1 ok

2.4. check of the hinge rotation (EC 3-1-8, 4.9(6))

brace 1: U_w = 0.591 < U = 0.894 ok

3. final result

maximum utilisation: resistance max U = 0.894 < 1 ok

verification succeeded

4. Regulations

DIN EN 1990, Eurocode 0: Grundlagen der Tragwerksplanung;
Deutsche Fassung EN 1990:2002 + A1:2005 + A1:2005/AC:2010, Ausgabe Dezember 2010
DIN EN 1990/NA, Nationaler Anhang zur DIN EN 1990, Ausgabe Dezember 2010

DIN EN 1993-1-1, Eurocode 3: Bemessung und Konstruktion von Stahlbauten -
Teil 1-1: Allgemeine Bemessungsregeln und Regeln für den Hochbau;
Deutsche Fassung EN 1993-1-1:2005 + AC:2009, Ausgabe Dezember 2010
DIN EN 1993-1-1/A1, Ergänzungen zur DIN EN 1993-1-1, Ausgabe Juli 2014
DIN EN 1993-1-1/NA, Nationaler Anhang zur DIN EN 1993-1-1, Ausgabe Dezember 2018

DIN EN 1993-1-8, Eurocode 3: Bemessung und Konstruktion von Stahlbauten -
Teil 1-8: Bemessung von Anschlüssen;
Deutsche Fassung EN 1993-1-8:2005 + AC:2009, Ausgabe Dezember 2010