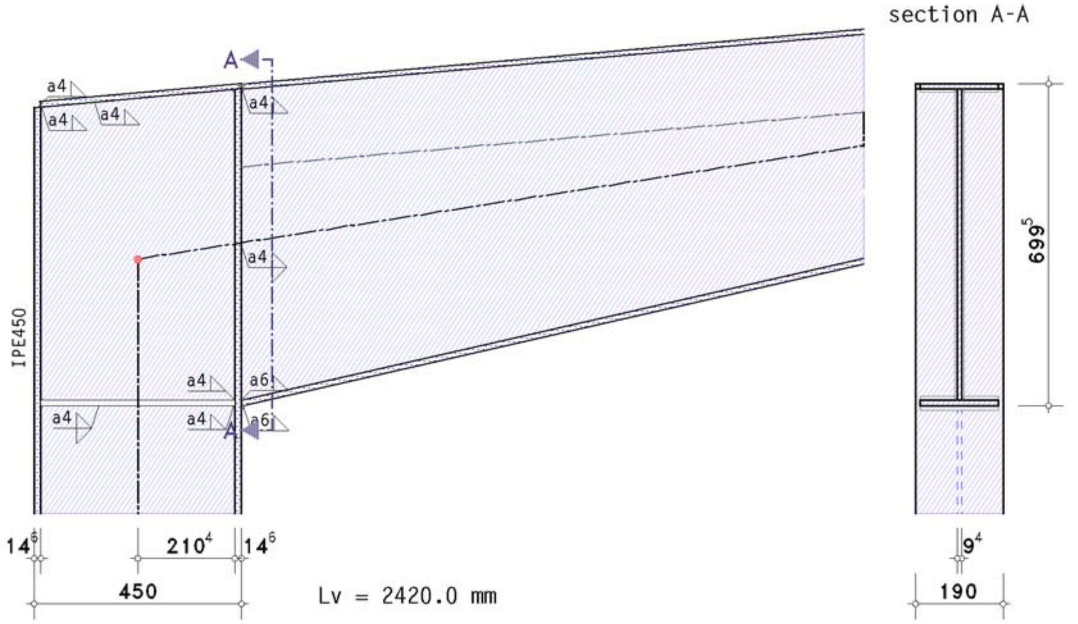
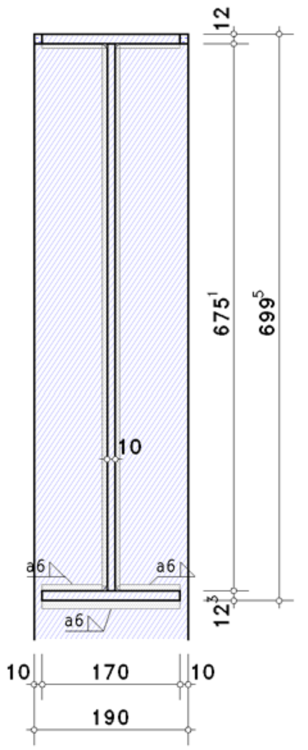
4H-EC3RE version: 5/2014-1x

frame corner

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



details



steel grade

steel grade S 235

column parameters

section IPE450

reinforcement of the section with transverse stiffeners (web stiffeners, d_{st} = 686.0 mm):

thickness t_{st} = 12.0 mm

welds $a_{st,f}$ = 4.0 mm, $a_{st,w}$ = 4.0 mm

beam parameters

parameter (I-section):

overall depth h = 360.0 mm, web thickness t_w = 10.0 mm

flange width b_f = 170.0 mm, flange thickness t_f = 12.0 mm

welded section, weld thickness a = 4.0 mm
section angle of inclination about the horizontal axis α_b = 5.00° ⇒ section depth at the joint loc. $h_b = h/\cos(\alpha_b)$ = 361.4 mm
haunch angle of inclination about the horizontal axis α_v = 12.80° ⇒ haunch angle about the beam axis $\Delta\alpha_v$ = 7.80°
haunch length L_v = 2420.0 mm, haunch depth at the connection point $h_v = L_v \cdot (\tan(\alpha_v) - \tan(\alpha_b))$ = 338.1 mm
total beam depth at the connection point $h_{ges} = h_b + h_v$ = 699.5 mm

verification parameters

welded connection:
tension plate: thickness t_z = 12.0 mm, width b_z = 190.0 mm
welds $a_{z,f}$ = 4.0 mm, $a_{z,w}$ = 4.0 mm
welds at the connection point:
beam flange top: fillet weld, weld thickness a = 4.0 mm, angle φ = 85°
beam web: fillet weld, weld thickness a = 4.0 mm
beam flange bottom: fillet weld, weld thickness a = 6.0 mm, angle φ = 103°

internal forces and moments in the intersection point of system axes (sign convention of statics)

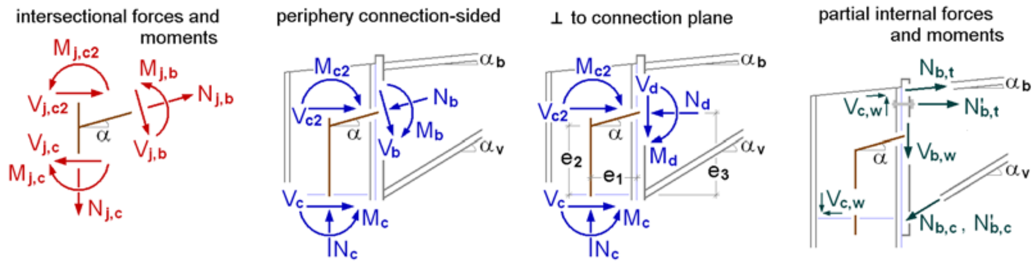
Lk 1: $N_{j,b1,Ed}$ = -58.20 kN $M_{j,b1,Ed}$ = -301.00 kNm $V_{j,b1,Ed}$ = 78.80 kN

partial safety factors for material

resistance of cross sections γ_{M0} = 1.00
resistance of members in stability failure γ_{M1} = 1.10
resistance of bolts, welds, plates in bearing γ_{M2} = 1.25

Lk 1:

design values



sign definition of statics: a positive axial force means tension, a positive bending moment produces tension at the bottom
⇒ transformation acc. to EC3: a positive axial force means compression, a positive bending moment produces tension at the top

angle of inclination: α_b = 5.0°, α_v = 12.8° ⇒ $\alpha = (\alpha_b+\alpha_v)/2$ = 8.9°
distance: $e_1 = z_{cu}$ = 225.0 mm, $e_3 = z_{bu} - t_{bfu}/2$ = 342.3 mm

internal forces and moments in the periphery refering to the system axes (-> EC 3-1-8)

$N_{b,Ed} = -N_{j,b,Ed}$ = 58.20 kN
$M_{b,Ed} = -M_{j,b,Ed} - V_{j,b,Ed} \cdot e_1/\cos(\alpha)$ = 283.05 kNm
$V_{b,Ed} = V_{j,b,Ed}$ = 78.80 kN
periphery column (bottom):
$N_{c,Ed} = N_{b,Ed} \cdot \sin(\alpha) + V_{b,Ed} \cdot \cos(\alpha)$ = 86.86 kN
$M_{c,Ed} = M_{b,Ed} - V_{c,Ed} \cdot e_3 + N_{c,Ed} \cdot e_1$ = 287.09 kNm
$V_{c,Ed} = N_{b,Ed} \cdot \cos(\alpha) - V_{b,Ed} \cdot \sin(\alpha)$ = 45.31 kN

internal forces and moments perpendicular to the connection plane

$N_d = N_{b,Ed} \cdot \cos(\alpha) - V_{b,Ed} \cdot \sin(\alpha)$ = 45.31 kN
$M_d = M_{b,Ed}$ = 283.05 kNm
$V_d = N_{b,Ed} \cdot \sin(\alpha) + V_{b,Ed} \cdot \cos(\alpha)$ = 86.86 kN

partial internal forces and moments

$N_{b,t} = (-N_d \cdot z_{bu}/z_b + M'_d/z_b) / \cos(\alpha_b)$ = 390.76 kN, z_b = 687.3 mm, z_{bu} = 342.3 mm
$N_{b,c} = (N_d \cdot z_{bo}/z_b + M'_d/z_b) / \cos(\alpha_v)$ = 445.66 kN, z_b = 687.3 mm, z_{bo} = 345.0 mm

verifications

verification of the shear area

column web as an ideal shear area

requirements concerning stiffeners: verification of web stiffeners required !!
requirements concerning shear area: verification of buckling resistance required !!
internal forces and moments at shear area (sign definition of statics):
$N_3 = -N_c$ = -86.86 kN, $M_3 = -M_c$ = -287.09 kNm, $V_3 = -V_c$ = -45.31 kN
$N_4 = -N_d$ = -45.31 kN, $M_4 = -(M_d + V_d \cdot t_{fc}/2)$ = -283.69 kNm, $V_4 = V_d$ = 86.86 kN
dimensions of the joint area: l_b = 435.4 mm, l_t = 437.1 mm, l_l = 648.6 mm, l_r = 686.6 mm
joint forces at shear area:
F_{b4} = -435.80 kN, F_{t4} = 390.49 kN, F_{r3} = -702.79 kN, F_{l3} = 615.94 kN, V_{b3} = -45.31 kN
internal forces and moments of the edge stiffeners:

N_b = -435.80 kN, N_t = 391.99 kN, N_l = 615.94 kN, N_r = -668.63 kN
forces in the shear area:
T_b = -390.49 kN, T_t = -391.99 kN, T_l = -615.94 kN, T_r = -581.77 kN
dimensions of the shear area (at periphery of stiffeners):
h_b = 420.8 mm, h_t = 422.4 mm, h_l = 637.2 mm, h_r = 674.0 mm
stresses within the shear area:
τ_b = 98.7 N/mm², τ_t = 98.7 N/mm², τ_l = 102.8 N/mm², τ_r = 91.8 N/mm²
verification of the shear area:
max τ_{Ed} = 102.8 N/mm² $<$ τ_{Rd} = 135.7 N/mm² $\Rightarrow$ U = 0.758 $<$ 1 ok.
stresses in edge stiffeners:
σ_b = 191.1 N/mm², σ_t = 171.9 N/mm², σ_l = 222.0 N/mm², σ_r = 253.4 N/mm²
verification of the edge stiffeners:
max σ_{Ed} = 253.4 N/mm² $>$ σ_{Rd} = 235.0 N/mm² $\Rightarrow$ U = 1.078 $>$ 1 not ok. !!

verification result

maximum utilization: max U = 1.078 $>$ 1 not ok. !!
fault at calculation of the shear area

Final result

maximum utilization: max U = 1.078 $>$ 1 not ok. !!

design resistance not ensured !!

verification could not be executed, see Lk 1 !!