POS. 1: BEAM-COLUMN M. PROJECTION

4H-EC3IH version: 7/2014-1k

Standardized IH-Joints

IH-joint due to EC 3-1-8 (12.10), NA: Deutschland

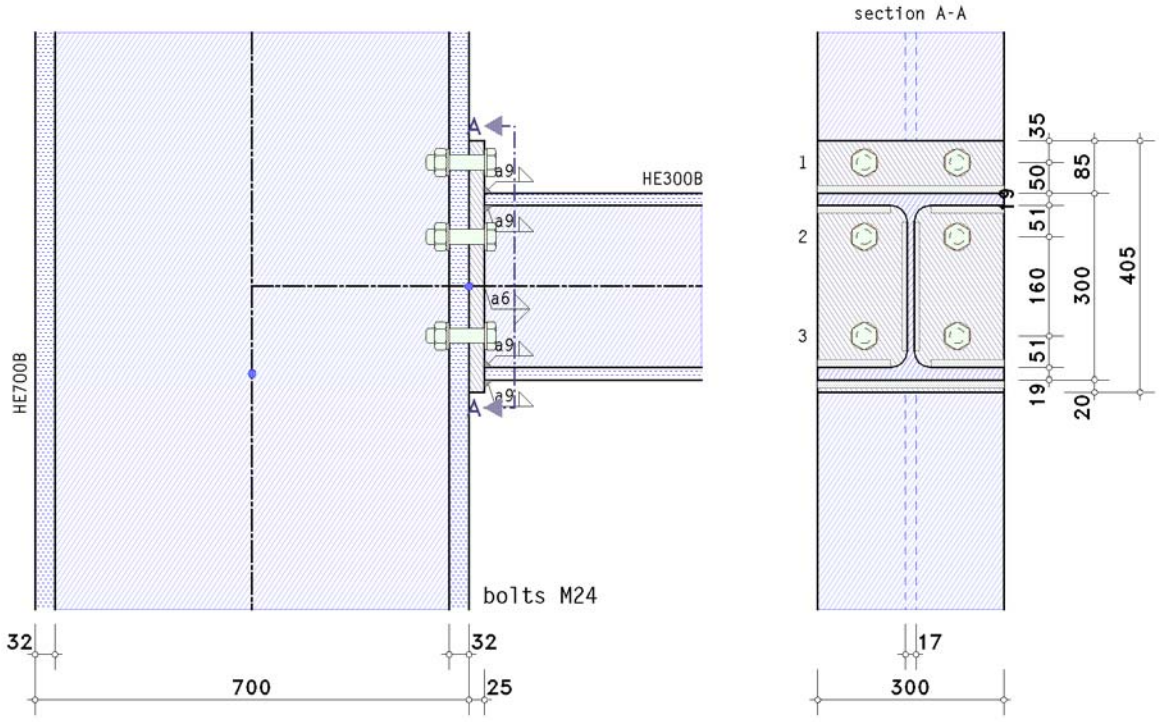
connection type and dimensions of beam, of bolts, of end-plate, of welds
and material are taken of the following literature:
'Typisierte Anschlüsse im Stahlhochbau nach DIN EN 1993-1-8, Stahlbau Verlags- und Service GmbH, Ausgabe 2013'
the current number and associated parameters are recorded.
the column has no reference to the literature.
verification method is 'elastic-plastic'. bolts are preloaded.

beam-column connection, steel grade S 235, bolt class of bolts 10.9

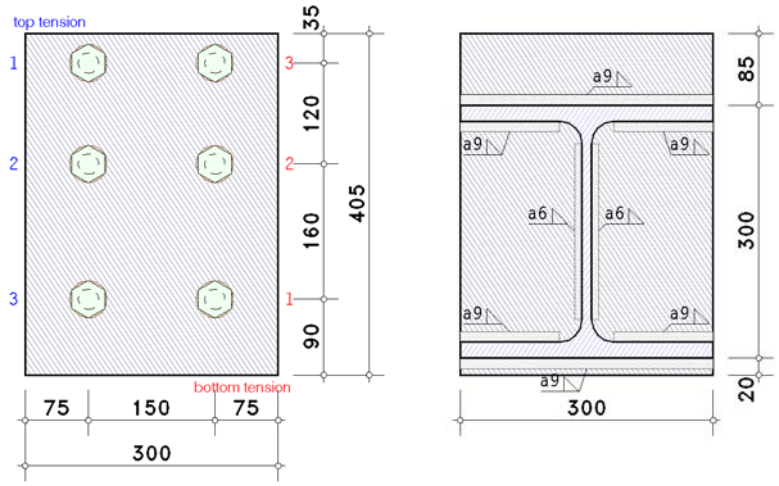
607: beam section HEB300, connection type IH3.1, bolt size M24
end-plate: t_p = 25 mm, b_p = 300 mm, h_p = 405 mm, e_1 = 35 mm, $p_{1,1}$ = 120 mm, $p_{1,2}$ = 160 mm, e_{1n} = 90 mm
u_1 = 85 mm, u_{1n} = 20 mm, w = 150 mm, p_2 = 0 mm, e_2 = 75 mm
fillet welds: a_w = 6 mm, a_f = 9 mm

column: section HE700B

Rigid beam connection



details



Component method

notes
high strength bolts have to be controlled prestressed, bolt category D (tension), A (shear).
welds are not regarded by calculation the T-stub design resistance.

Lk 1: pos. internal moment

resistance of cross section

plastic design resistance moment: $M_{pl,N,Q}$ = 427.43 kNm

connection design capacity

moment resistance

distance between bolt-row(s) in tension and centre of compression:
h_1 = 340.5 mm, h_2 = 220.5 mm, h_3 = 60.5 mm

design resistance per bolt-row
row 1: $F_{tr,Rd}$ = 385.0 kN
row 2: $F_{tr,Rd}$ = 499.6 kN
row 3: $F_{tr,Rd}$ = 137.1 kN
potential failure by basic component 2, 5, 10

moment resistance
$M_{j,Rd} = \Sigma(F_{tr,Rd} \cdot h_r)$ = 249.6 kNm

shear/design bearing resistance

design resistance per bolt-row
row 1: $F_{vr,Rd}$ = 199.3 kN
row 2: $F_{vr,Rd}$ = 129.4 kN
row 3: $F_{vr,Rd}$ = 350.6 kN

shear/design bearing resistance
$V_{j,Rd} = \Sigma F_{vr,Rd}$ = 679.4 kN

shear resistance

$V_{wp,Rd}/\beta$ = 1674.1 kN
zul $V_{pl,Rd} = 0.5 \cdot A_v \cdot (f_y/3^{1/3}) / \gamma_{M0}$ = 321.7 kN (requirement, s. 'Typisierte Anschlüsse')

total

$M_{j,Rd}$ = 249.6 kNm $V_{j,Rd}$ = 679.4 kN $V_{wp,Rd}/\beta$ = 1674.1 kN $V_{pl,Rd}$ = 321.7 kN

rotational stiffness

stiffness coefficients
$k_1 = 0.38 \cdot A_{vc} / (\beta \cdot z) = 19.14$ mm
$k_2 = 0.7 \cdot b_{eff,c,wc} \cdot t_{wc} / d_c = 7.60$ mm
equivalent stiffness coefficient for 3 bolt-rows:
$k_3 = 5.59$ mm, $k_4 = 89.06$ mm, $k_5 = 33.41$ mm, $k_{10} = 6.85$ mm $\Rightarrow$ $k_{eff,1} = 1 / \Sigma(1/k_{i,1}) = 2.731$ mm
$k_3 = 5.59$ mm, $k_4 = 89.06$ mm, $k_5 = 22.47$ mm, $k_{10} = 6.85$ mm $\Rightarrow$ $k_{eff,2} = 1 / \Sigma(1/k_{i,2}) = 2.627$ mm
$k_3 = 5.59$ mm, $k_4 = 89.06$ mm, $k_5 = 22.47$ mm, $k_{10} = 6.85$ mm $\Rightarrow$ $k_{eff,3} = 1 / \Sigma(1/k_{i,3}) = 2.627$ mm
$k_{eq} = \Sigma(k_{eff,r} \cdot h_r) / z_{eq} = 6.129$ mm, $z_{eq} = \Sigma(k_{eff,r} \cdot h_r^2) / \Sigma(k_{eff,r} \cdot h_r) = 272.2$ mm
rotational stiffness
initial rotational stiffness: $S_{j,ini} = (E \cdot z^2) / \Sigma(1/k_i) = 44830.5$ kNm/rad, $z = z_{eq} = 272.2$ mm, $\Sigma(1/k_i) = 0.347$ mm^{-1}

Lk 2: neg. internal moment

resistance of cross section

plastic design resistance moment: $M_{pl,N,Q} = 427.43$ kNm

connection design capacity

moment resistance

distance between bolt-row(s) in tension and centre of compression:
$h_1 = 220.5$ mm, $h_2 = 60.5$ mm

design resistance per bolt-row
row 1: $F_{tr,Rd} = 499.6$ kN
row 2: $F_{tr,Rd} = 137.1$ kN
potential failure by basic component 5, 10

moment resistance
$M_{j,Rd} = \Sigma(F_{tr,Rd} \cdot h_r) = 118.5$ kNm

shear/design bearing resistance

design resistance per bolt-row
row 1: $F_{vr,Rd} = 115.5$ kN
row 2: $F_{vr,Rd} = 313.0$ kN
row 3: $F_{vr,Rd} = 387.7$ kN

shear/design bearing resistance
$V_{j,Rd} = \Sigma F_{vr,Rd} = 816.2$ kN

shear resistance

$V_{wp,Rd}/\beta = 1674.1$ kN
zul $V_{pl,Rd} = 0.5 \cdot A_v \cdot (f_y / 3^{1/3}) / \gamma_{M0} = 321.7$ kN (requirement, s. 'Typisierte Anschlüsse')

total

$M_{j,Rd} = 118.5$ kNm $V_{j,Rd} = 816.2$ kN $V_{wp,Rd}/\beta = 1674.1$ kN $V_{pl,Rd} = 321.7$ kN

rotational stiffness

stiffness coefficients
$k_1 = 0.38 \cdot A_{vc} / (\beta \cdot z) = 28.00$ mm
$k_2 = 0.7 \cdot b_{eff,c,wc} \cdot t_{wc} / d_c = 7.96$ mm
equivalent stiffness coefficient for 2 bolt-rows:
$k_3 = 5.59$ mm, $k_4 = 89.06$ mm, $k_5 = 22.47$ mm, $k_{10} = 6.85$ mm $\Rightarrow$ $k_{eff,1} = 1 / \Sigma(1/k_{i,1}) = 2.627$ mm
$k_3 = 5.59$ mm, $k_4 = 89.06$ mm, $k_5 = 22.47$ mm, $k_{10} = 6.85$ mm $\Rightarrow$ $k_{eff,2} = 1 / \Sigma(1/k_{i,2}) = 2.627$ mm
$k_{eq} = \Sigma(k_{eff,r} \cdot h_r) / z_{eq} = 3.967$ mm, $z_{eq} = \Sigma(k_{eff,r} \cdot h_r^2) / \Sigma(k_{eff,r} \cdot h_r) = 186.1$ mm
rotational stiffness
initial rotational stiffness: $S_{j,ini} = (E \cdot z^2) / \Sigma(1/k_i) = 17585.1$ kNm/rad, $z = z_{eq} = 186.1$ mm, $\Sigma(1/k_i) = 0.413$ mm^{-1}

Final result

initial stiffness:	$S_{j,ini}$	= 44.8 MNm/rad
moment resistance (M+):	$M_{j1,Rd}$	= 249.6 kNm
moment resistance (M-):	$M_{j2,Rd}$	= 118.5 kNm
shear force resistance:	$V_{j,Rd}$	= 321.7 kNm
moment resistance of beam section:	$M_{c,Rd}$	= 427.4 kNm