POS. 2: BEAM SPLICE M. 4 BOLTS

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

Standardized IH-Joints

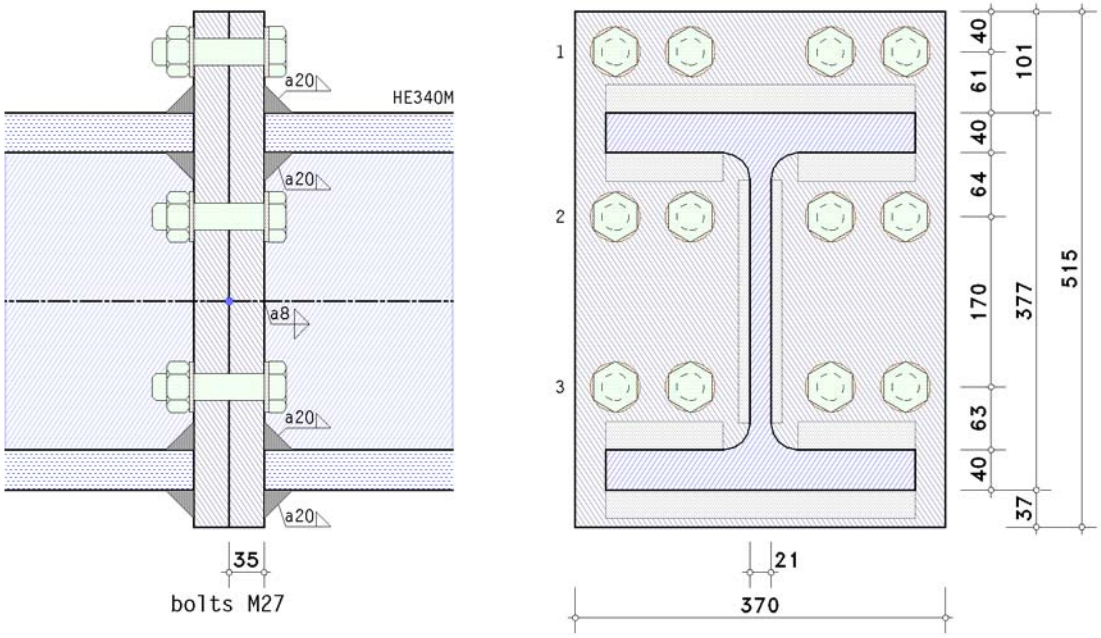
IH-joint due to EC 3-1-8 (12.10), NA: Deutschland

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.
verification method is 'elastic-plastic'. bolts are preloaded.

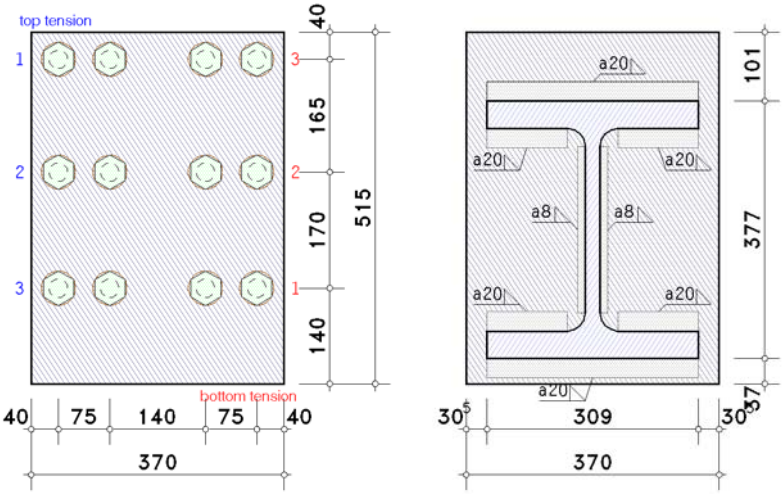
beam splice, steel grade S 355, bolt class of bolts 10.9

787: beam section HEM340, connection type IH4.1, bolt size M27
end-plate: t_p = 35 mm, b_p = 370 mm, h_p = 515 mm, e_1 = 40 mm, $p_{1,1}$ = 165 mm, $p_{1,2}$ = 170 mm, e_{1n} = 140 mm
u_1 = 101 mm, u_{1n} = 37 mm, w = 140 mm, p_2 = 75 mm, e_2 = 40 mm
fillet welds: a_w = 8 mm, a_f = 20 mm

Rigid beam splice



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: $M_{pl,N,Q}$ = 1690.35 kNm

connection design capacity

moment resistance

distance between bolt-row(s) in tension and centre of compression:
h_1 = 418.0 mm, h_2 = 253.0 mm, h_3 = 83.0 mm

design resistance per bolt-row
row 1: $F_{tr,Rd}$ = 1188.0 kN
row 2: $F_{tr,Rd}$ = 1031.6 kN
row 3: $F_{tr,Rd}$ = 1029.2 kN
potential failure by basic component 5

moment resistance
$M_{j,Rd} = \Sigma(F_{tr,Rd} \cdot h_r)$ = 843.0 kNm

shear/design bearing resistance

design resistance per bolt-row
row 1: $F_{vr,Rd}$ = 393.7 kN
row 2: $F_{vr,Rd}$ = 486.6 kN
row 3: $F_{vr,Rd}$ = 487.9 kN

shear/design bearing resistance
$V_{j,Rd} = \Sigma F_{vr,Rd}$ = 1368.2 kN

shear resistance

zul $V_{pl,Rd} = 0.5 \cdot A_v \cdot (f_y / 3^{1/3}) / \gamma_{M0}$ = 1010.7 kN (requirement, s. 'Typisierte Anschlüsse')

total

$M_{j,Rd}$ = 843.0 kNm $V_{j,Rd}$ = 1368.2 kN $V_{pl,Rd}$ = 1010.7 kN

rotational stiffness

stiffness coefficients
equivalent stiffness coefficient for 3 bolt-rows:
k_5 = 126.34 mm, k_{10} = 7.38 mm $\Rightarrow$ $k_{eff,1} = 1 / \Sigma(1/k_{i,1})$ = 11.966 mm
k_5 = 118.12 mm, k_{10} = 7.38 mm $\Rightarrow$ $k_{eff,2} = 1 / \Sigma(1/k_{i,2})$ = 11.810 mm
k_5 = 7.65 mm, k_{10} = 7.38 mm $\Rightarrow$ $k_{eff,3} = 1 / \Sigma(1/k_{i,3})$ = 2.519 mm
$k_{eq} = \Sigma(k_{eff,r} \cdot h_r) / z_{eq}$ = 23.470 mm, $z_{eq} = \Sigma(k_{eff,r} \cdot h_r^2) / \Sigma(k_{eff,r} \cdot h_r)$ = 349.3 mm
rotational stiffness
initial rotational stiffness: $S_{j,ini} = (E \cdot z^2) / \Sigma(1/k_i)$ = 601439.0 kNm/rad, $z = z_{eq}$ = 349.3 mm, $\Sigma(1/k_i)$ = 0.043 mm^{-1}

resistance of cross section

plastic design resistance moment: $M_{pl,N,Q}$ = 1690.35 kNm

connection design capacity

moment resistance

distance between bolt-row(s) in tension and centre of compression:
h_1 = 254.0 mm, h_2 = 84.0 mm

design resistance per bolt-row
row 1: $F_{tr,Rd}$ = 1029.2 kN
row 2: $F_{tr,Rd}$ = 1031.6 kN
potential failure by basic component 5

moment resistance
$M_{j,Rd} = \Sigma(F_{tr,Rd} \cdot h_r)$ = 348.1 kNm

shear/design bearing resistance

design resistance per bolt-row
row 1: $F_{vr,Rd}$ = 487.9 kN
row 2: $F_{vr,Rd}$ = 486.6 kN
row 3: $F_{vr,Rd}$ = 1099.3 kN

shear/design bearing resistance
$V_{j,Rd} = \Sigma F_{vr,Rd}$ = 2073.8 kN

shear resistance

zul $V_{pl,Rd} = 0.5 \cdot A_v \cdot (f_y/3^{1/3}) / \gamma_{M0}$ = 1010.7 kN (requirement, s. 'Typisierte Anschlüsse')

total

$M_{j,Rd}$ = 348.1 kNm $V_{j,Rd}$ = 2073.8 kN $V_{pl,Rd}$ = 1010.7 kN

rotational stiffness

stiffness coefficients
equivalent stiffness coefficient for 2 bolt-rows:
k_5 = 117.59 mm, k_{10} = 7.38 mm $\Rightarrow$ $k_{eff,1} = 1 / \Sigma(1/k_{i,1})$ = 11.799 mm
k_5 = 7.68 mm, k_{10} = 7.38 mm $\Rightarrow$ $k_{eff,2} = 1 / \Sigma(1/k_{i,2})$ = 2.526 mm
$k_{eq} = \Sigma(k_{eff,r} \cdot h_r) / z_{eq}$ = 13.220 mm, $z_{eq} = \Sigma(k_{eff,r} \cdot h_r^2) / \Sigma(k_{eff,r} \cdot h_r)$ = 242.8 mm
rotational stiffness
initial rotational stiffness: $S_{j,ini} = (E \cdot z^2) / \Sigma(1/k_i)$ = 163605.4 kNm/rad, $z = z_{eq}$ = 242.8 mm, $\Sigma(1/k_i)$ = 0.076 mm^{-1}

Final result

initial stiffness:	$S_{j,ini}$	= 601.4 MNm/rad
moment resistance (M+):	$M_{j1,Rd}$	= 843.0 kNm
moment resistance (M-):	$M_{j2,Rd}$	= 348.1 kNm
shear force resistance:	$V_{j,Rd}$	= 1010.7 kNm
moment resistance of beam section:	$M_{c,Rd}$	= 1690.4 kNm