standardized IM-joint

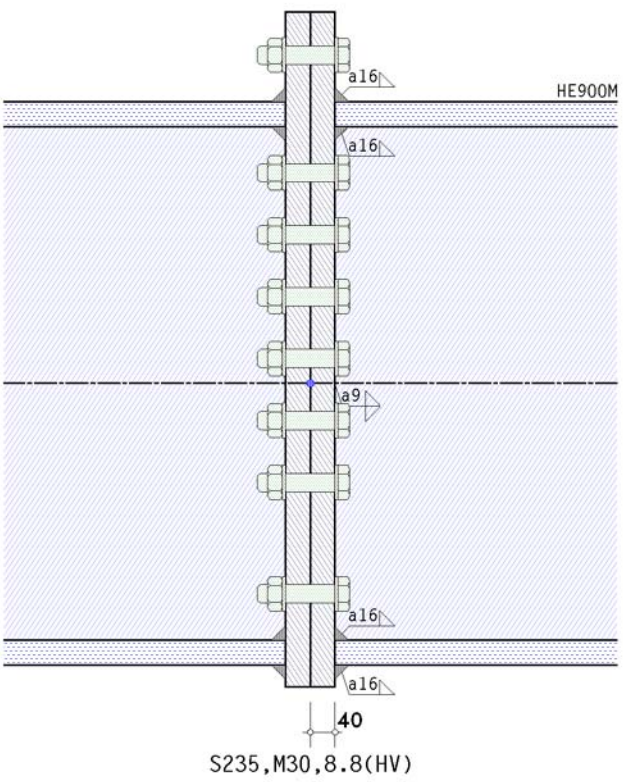
moment resistant joints IM acc. to EC 3-1-8 (12.10), NA: Deutschland

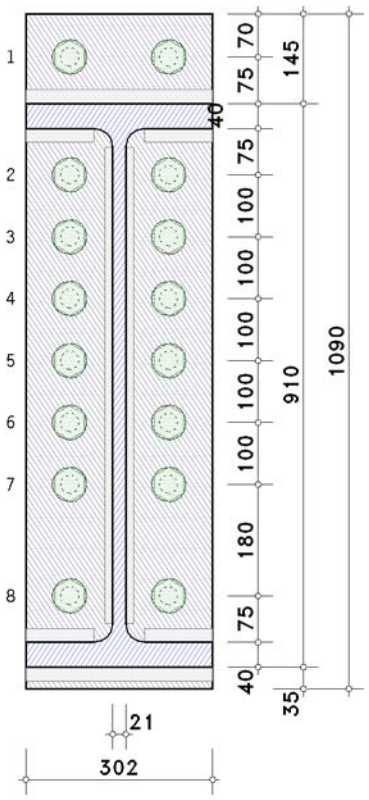
dimensions of beam, bolts, end-plate and welds, material
and arrangement of bolts are taken of the following literature:
'Typisierte Anschlüsse im Stahlhochbau nach DIN EN 1993-1-8, Ergänzungsband 2018,
Stahlbau Verlags- und Service GmbH, Ausgabe 2018'
the current number and associated parameters are recorded.
MN-interaction follows Cerfontaine (in Jaspart/Weynand: Design of Joints in Steel Structures).
maximum resistance of normal forces are calculated without components of compression/shear and linearization.

beam splice, steel grade S235, bolt class of bolts 8.8

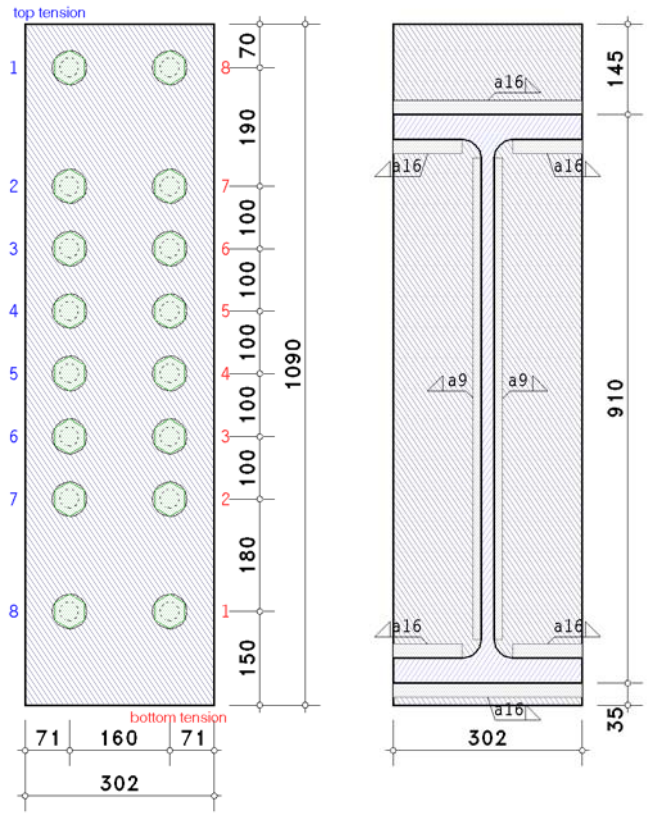
31802: beam section HEM900, bolt size M30, connection with 2 bolts per row
end-plate: t_p = 40 mm, b_p = 302 mm, h_p = 1090 mm, e_1 = 70 mm, $p_{1,1}$ = 190 mm, $p_{1,2}$ = 100 mm
$p_{1,3}$ = 100 mm, $p_{1,4}$ = 100 mm, $p_{1,5}$ = 100 mm, $p_{1,6}$ = 100 mm, $p_{1,7}$ = 180 mm, u_1 = 145 mm
w = 160 mm
fillet welds: a_f = 16 mm, a_w = 9 mm

Rigid beam splice





details



Component method

notes
connection is verified due to EC 3-1-8 regardless of preloading.
however, connections may be constructed with prestressed high strength bolts.
the welds are not regarded by calculation the T-stub resistance.
simplified calculation of shear force resistance takes all bolt-rows into account.

Lk 1: internal moment (top tension) + shear force

resistance of cross-section

plastic resistance moment: $M_{pl,N,Q}$ = 3403.58 kNm

connection capacity

moment resistance

distance of tension-bolt-rows from centre of compression:
h_1 = 965.0 mm, h_2 = 775.0 mm, h_3 = 675.0 mm, h_4 = 575.0 mm, h_5 = 475.0 mm, h_6 = 375.0 mm, h_7 = 275.0 mm
h_8 = 95.0 mm

resistance per bolt-row
row 1: $F_{tr,Rd}$ = 580.2 kN
row 2: $F_{tr,Rd}$ = 646.3 kN
row 3: $F_{tr,Rd}$ = 562.9 kN
row 4: $F_{tr,Rd}$ = 479.5 kN
row 5: $F_{tr,Rd}$ = 396.1 kN
row 6: $F_{tr,Rd}$ = 312.7 kN
row 7: $F_{tr,Rd}$ = 229.3 kN
row 8: $F_{tr,Rd}$ = 79.2 kN
$\Sigma F_{tr,Rd}$ = 3286.2 kN

resistance of flanges
$F_{c,Rd}$ = 3901.0 kN

moment resistance
$M_{j,Rd} = \Sigma(F_{tr,Rd} \cdot h_r)$ = 2092.4 kNm
tension resistance
$N_{j,t,Rd} = \Sigma F_{tr,Rd}^{*}$ = 4580.1 kN
compression resistance

$N_{j,c,Rd} = F_{c,Rd} = 3901.0$ kN

shear/bearing resistance

resistance per bolt-row
row 1: $F_{vr,Rd} = 155.1$ kN
row 2: $F_{vr,Rd} = 155.1$ kN
row 3: $F_{vr,Rd} = 155.1$ kN
row 4: $F_{vr,Rd} = 155.1$ kN
row 5: $F_{vr,Rd} = 155.1$ kN
row 6: $F_{vr,Rd} = 155.1$ kN
row 7: $F_{vr,Rd} = 155.1$ kN
row 8: $F_{vr,Rd} = 155.1$ kN
$\Sigma F_{vr,Rd} = 1240.8$ kN

shear/bearing resistance
$V_{j,Rd} = \Sigma F_{vr,Rd} = 1240.8$ kN

shear resistance

shear resistance of end plate
plate: $V_{ep,Rd} = 4178.86$ kN
resistance of a weld (req.1): $f_{1w,d} = f_u / (\beta_w \cdot \gamma_{M2}) = 360.0$ N/mm²
welds: $F_{w,Rd} = 2880.75$ kN
shear resistance of end plate: $V_{ep,Rd} = F_{w,Rd} = 2880.75$ kN

plastic shear resistance
$V_{pl,Rd} = 0.5 \cdot A_v \cdot (f_y / 3^{1/2}) / \gamma_{M0} = 1454.6$ kN (requirement, s. 'Typisierte Anschlüsse')

total

$M_{j,Rd} = 2092.4$ kNm $N_{j,t,Rd} = 4580.1$ kN $N_{j,c,Rd} = 3901.0$ kN $V_{j,Rd} = 1240.8$ kN $V_{pl,Rd} = 1454.6$ kN $V_{ep,Rd} = 2880.7$ kN

rotational stiffness

stiffness coefficients
equivalent stiffness coefficient for 8 tension-bolt-rows:
1: $k_5 = 47.22$ mm, $k_{10} = 8.06$ mm $\Rightarrow$ $k_{eff,1} = 1 / \Sigma(1/k_{i,1}) = 6.009$ mm
2: $k_5 = 68.22$ mm, $k_{10} = 8.06$ mm $\Rightarrow$ $k_{eff,2} = 1 / \Sigma(1/k_{i,2}) = 6.520$ mm
3: $k_5 = 27.60$ mm, $k_{10} = 8.06$ mm $\Rightarrow$ $k_{eff,3} = 1 / \Sigma(1/k_{i,3}) = 5.088$ mm
4: $k_5 = 27.60$ mm, $k_{10} = 8.06$ mm $\Rightarrow$ $k_{eff,4} = 1 / \Sigma(1/k_{i,4}) = 5.088$ mm
5: $k_5 = 27.60$ mm, $k_{10} = 8.06$ mm $\Rightarrow$ $k_{eff,5} = 1 / \Sigma(1/k_{i,5}) = 5.088$ mm
6: $k_5 = 27.60$ mm, $k_{10} = 8.06$ mm $\Rightarrow$ $k_{eff,6} = 1 / \Sigma(1/k_{i,6}) = 5.088$ mm
7: $k_5 = 58.79$ mm, $k_{10} = 8.06$ mm $\Rightarrow$ $k_{eff,7} = 1 / \Sigma(1/k_{i,7}) = 6.326$ mm
8: $k_5 = 99.41$ mm, $k_{10} = 8.06$ mm $\Rightarrow$ $k_{eff,8} = 1 / \Sigma(1/k_{i,8}) = 6.936$ mm
$k_{eq} = \Sigma(k_{eff,r} \cdot h_r) / z_{eq} = 35.995$ mm, $z_{eq} = \Sigma(k_{eff,r} \cdot h_r^2) / \Sigma(k_{eff,r} \cdot h_r) = 665.0$ mm
rotational stiffness
initial rotational stiffness: $S_{j,ini} = (E \cdot z^2) / \Sigma(1/k_i) = 3342697.8$ kNm/rad, $z = z_{eq} = 665.0$ mm, $\Sigma(1/k_i) = 0.028$ mm^{-1}
$|M_{j,Ed}| = 1.00$ kNm $\leq$ 2/3 $M_{j,Rd} = 1394.9$ kNm $\Rightarrow$ $\mu = 1$
rotational stiffness: $S_{j,Rd} = S_{j,ini} / \mu = 3342697.8$ kNm/rad
rotation: $\varphi_{j,Ed} = M_{j,Ed} / S_{j,Rd} = 0.000°$

Lk 2: internal moment (bottom tension) + shear force

resistance of cross-section

plastic resistance moment: $M_{pl,N,Q} = 3403.58$ kNm

connection capacity

moment resistance

distance of tension-bolt-rows from centre of compression:
$h_1 = 775.0$ mm, $h_2 = 595.0$ mm, $h_3 = 495.0$ mm, $h_4 = 395.0$ mm, $h_5 = 295.0$ mm, $h_6 = 195.0$ mm, $h_7 = 95.0$ mm

resistance per bolt-row
row 1: $F_{tr,Rd} = 646.3$ kN
row 2: $F_{tr,Rd} = 496.2$ kN
row 3: $F_{tr,Rd} = 412.8$ kN
row 4: $F_{tr,Rd} = 329.4$ kN
row 5: $F_{tr,Rd} = 246.0$ kN
row 6: $F_{tr,Rd} = 162.6$ kN
row 7: $F_{tr,Rd} = 79.2$ kN
$\Sigma F_{tr,Rd} = 2372.4$ kN

resistance of flanges
$F_{c,Rd}$ = 3901.0 kN

moment resistance
$M_{j,Rd} = \Sigma(F_{tr,Rd} \cdot h_r)$ = 1242.3 kNm
tension resistance
$N_{j,t,Rd} = \Sigma F_{tr,Rd}^{*}$ = 3836.8 kN
compression resistance
$N_{j,c,Rd} = F_{c,Rd}$ = 3901.0 kN

shear/bearing resistance

resistance per bolt-row
row 1: $F_{vr,Rd}$ = 155.1 kN
row 2: $F_{vr,Rd}$ = 155.1 kN
row 3: $F_{vr,Rd}$ = 155.1 kN
row 4: $F_{vr,Rd}$ = 155.1 kN
row 5: $F_{vr,Rd}$ = 155.1 kN
row 6: $F_{vr,Rd}$ = 155.1 kN
row 7: $F_{vr,Rd}$ = 155.1 kN
row 8: $F_{vr,Rd}$ = 155.1 kN
$\Sigma F_{vr,Rd}$ = 1240.8 kN

shear/bearing resistance
$V_{j,Rd} = \Sigma F_{vr,Rd}$ = 1240.8 kN

shear resistance

shear resistance of end plate
plate: $V_{ep,Rd}$ = 4178.86 kN
resistance of a weld (req.1): $f_{1w,d} = f_u / (\beta_w \cdot \gamma_{M2})$ = 360.0 N/mm²
welds: $F_{w,Rd}$ = 2880.75 kN
shear resistance of end plate: $V_{ep,Rd} = F_{w,Rd}$ = 2880.75 kN

plastic shear resistance
$V_{pl,Rd} = 0.5 \cdot A_v \cdot (f_y / 3^{1/2}) / \gamma_{M0}$ = 1454.6 kN (requirement, s. 'Typisierte Anschlüsse')

total

$M_{j,Rd}$ = 1242.3 kNm $N_{j,t,Rd}$ = 3836.8 kN $N_{j,c,Rd}$ = 3901.0 kN $V_{j,Rd}$ = 1240.8 kN $V_{pl,Rd}$ = 1454.6 kN $V_{ep,Rd}$ = 2880.7 kN

rotational stiffness

stiffness coefficients
equivalent stiffness coefficient for 7 tension-bolt-rows:
1: k_5 = 99.41 mm, k_{10} = 8.06 mm $\Rightarrow$ $k_{eff,1} = 1 / \Sigma(1/k_{i,1})$ = 6.936 mm
2: k_5 = 27.60 mm, k_{10} = 8.06 mm $\Rightarrow$ $k_{eff,2} = 1 / \Sigma(1/k_{i,2})$ = 5.088 mm
3: k_5 = 27.60 mm, k_{10} = 8.06 mm $\Rightarrow$ $k_{eff,3} = 1 / \Sigma(1/k_{i,3})$ = 5.088 mm
4: k_5 = 27.60 mm, k_{10} = 8.06 mm $\Rightarrow$ $k_{eff,4} = 1 / \Sigma(1/k_{i,4})$ = 5.088 mm
5: k_5 = 27.60 mm, k_{10} = 8.06 mm $\Rightarrow$ $k_{eff,5} = 1 / \Sigma(1/k_{i,5})$ = 5.088 mm
6: k_5 = 27.60 mm, k_{10} = 8.06 mm $\Rightarrow$ $k_{eff,6} = 1 / \Sigma(1/k_{i,6})$ = 5.088 mm
7: k_5 = 68.22 mm, k_{10} = 8.06 mm $\Rightarrow$ $k_{eff,7} = 1 / \Sigma(1/k_{i,7})$ = 6.520 mm
$k_{eq} = \Sigma(k_{eff,r} \cdot h_r) / z_{eq}$ = 29.578 mm, $z_{eq} = \Sigma(k_{eff,r} \cdot h_r^2) / \Sigma(k_{eff,r} \cdot h_r)$ = 542.4 mm
rotational stiffness
initial rotational stiffness: $S_{j,ini} = (E \cdot z^2) / \Sigma(1/k_i)$ = 1827702.7 kNm/rad, $z = z_{eq}$ = 542.4 mm, $\Sigma(1/k_i)$ = 0.034 mm^{-1}
$|M_{j,Ed}|$ = 1.00 kNm $\leq$ 2/3 $M_{j,Rd}$ = 828.2 kNm $\Rightarrow$ μ = 1
rotational stiffness: $S_{j,Rd} = S_{j,ini} / \mu$ = 1827702.7 kNm/rad
rotation: $\varphi_{j,Ed} = M_{j,Ed} / S_{j,Rd}$ = 0.000°

Lk 3: tension force + internal moment (top tension) + shear force

resistance of cross-section

plastic resistance moment: $M_{pl,N,Q}$ = 3403.58 kNm

connection capacity

bending/tension resistance

distance of tension-bolt-rows from centre of compression:
h_1 = 965.0 mm, h_2 = 775.0 mm, h_3 = 675.0 mm, h_4 = 575.0 mm, h_5 = 475.0 mm, h_6 = 375.0 mm, h_7 = 275.0 mm
h_8 = 95.0 mm

resistance per bolt-row
row 1: $F_{tr,Rd}$ = 0.0 kN

row 2: $F_{tr,Rd}$ = 646.3 kN
row 3: $F_{tr,Rd}$ = 562.9 kN
row 4: $F_{tr,Rd}$ = 479.5 kN
row 5: $F_{tr,Rd}$ = 396.1 kN
row 6: $F_{tr,Rd}$ = 312.7 kN
row 7: $F_{tr,Rd}$ = 229.3 kN
row 8: $F_{tr,Rd}$ = 79.2 kN
$\Sigma F_{tr,Rd}$ = 2706.0 kN

moment resistance
$M_{j,Rd} = \Sigma(F_{tr,Rd} \cdot h_r)$ = 1532.5 kNm
tension resistance
$N_{j,t,Rd} = \Sigma F_{tr,Rd}^{*}$ = 3999.8 kN

shear/bearing resistance

resistance per bolt-row
row 1: $F_{vr,Rd}$ = 155.1 kN
row 2: $F_{vr,Rd}$ = 155.1 kN
row 3: $F_{vr,Rd}$ = 155.1 kN
row 4: $F_{vr,Rd}$ = 155.1 kN
row 5: $F_{vr,Rd}$ = 155.1 kN
row 6: $F_{vr,Rd}$ = 155.1 kN
row 7: $F_{vr,Rd}$ = 155.1 kN
row 8: $F_{vr,Rd}$ = 155.1 kN
$\Sigma F_{vr,Rd}$ = 1240.8 kN

shear/bearing resistance
$V_{j,Rd} = \Sigma F_{vr,Rd}$ = 1240.8 kN

shear resistance

shear resistance of end plate
plate: $V_{ep,Rd}$ = 4178.86 kN
resistance of a weld (req.1): $f_{1w,d} = f_u / (\beta_w \cdot \gamma_{M2})$ = 360.0 N/mm²
welds: $F_{w,Rd}$ = 2880.75 kN
shear resistance of end plate: $V_{ep,Rd} = F_{w,Rd}$ = 2880.75 kN

plastic shear resistance
$V_{pl,Rd} = 0.5 \cdot A_v \cdot (f_y / 3^{1/2}) / \gamma_{M0}$ = 1454.6 kN (requirement, s. 'Typisierte Anschlüsse')

total

$M_{j,Rd}$ = 1532.5 kNm $N_{j,t,Rd}$ = 3999.8 kN $V_{j,Rd}$ = 1240.8 kN $V_{pl,Rd}$ = 1454.6 kN $V_{ep,Rd}$ = 2880.7 kN

rotational stiffness

rotational stiffness only für bending connections !!

Lk 4: tension force + internal moment (bottom tension) + shear force

resistance of cross-section

plastic resistance moment: $M_{pl,N,Q}$ = 3403.58 kNm

connection capacity

bending/tension resistance

distance of tension-bolt-rows from centre of compression:
h_1 = 775.0 mm, h_2 = 595.0 mm, h_3 = 495.0 mm, h_4 = 395.0 mm, h_5 = 295.0 mm, h_6 = 195.0 mm, h_7 = 95.0 mm
h_8 = -95.0 mm

resistance per bolt-row
row 1: $F_{tr,Rd}$ = 646.3 kN
row 2: $F_{tr,Rd}$ = 496.2 kN
row 3: $F_{tr,Rd}$ = 412.8 kN
row 4: $F_{tr,Rd}$ = 329.4 kN
row 5: $F_{tr,Rd}$ = 246.0 kN
row 6: $F_{tr,Rd}$ = 162.6 kN
row 7: $F_{tr,Rd}$ = 79.2 kN
row 8: $F_{tr,Rd}$ = 0.0 kN
$\Sigma F_{tr,Rd}$ = 2372.4 kN

moment resistance

$M_{j,Rd} = \Sigma(F_{tr,Rd} \cdot h_r) = 1242.3$ kNm for $h_r \geq 0$
tension resistance
$N_{j,t,Rd} = \Sigma F_{tr,Rd}^{*} = 3836.8$ kN

shear/bearing resistance

resistance per bolt-row
row 1: $F_{vr,Rd} = 155.1$ kN
row 2: $F_{vr,Rd} = 155.1$ kN
row 3: $F_{vr,Rd} = 155.1$ kN
row 4: $F_{vr,Rd} = 155.1$ kN
row 5: $F_{vr,Rd} = 155.1$ kN
row 6: $F_{vr,Rd} = 155.1$ kN
row 7: $F_{vr,Rd} = 155.1$ kN
row 8: $F_{vr,Rd} = 155.1$ kN
$\Sigma F_{vr,Rd} = 1240.8$ kN

shear/bearing resistance
$V_{j,Rd} = \Sigma F_{vr,Rd} = 1240.8$ kN

shear resistance

shear resistance of end plate
plate: $V_{ep,Rd} = 4178.86$ kN
resistance of a weld (req.1): $f_{1w,d} = f_u / (\beta_w \cdot \gamma_{M2}) = 360.0$ N/mm²
welds: $F_{w,Rd} = 2880.75$ kN
shear resistance of end plate: $V_{ep,Rd} = F_{w,Rd} = 2880.75$ kN

plastic shear resistance
$V_{pl,Rd} = 0.5 \cdot A_v \cdot (f_y / 3^{1/2}) / \gamma_{M0} = 1454.6$ kN (requirement, s. 'Typisierte Anschlüsse')

total

$M_{j,Rd} = 1242.3$ kNm $N_{j,t,Rd} = 3836.8$ kN $V_{j,Rd} = 1240.8$ kN $V_{pl,Rd} = 1454.6$ kN $V_{ep,Rd} = 2880.7$ kN

rotational stiffness

rotational stiffness only für bending connections !!

Lk 5: compression force + internal moment (top tension)

resistance of cross-section

plastic resistance moment: $M_{pl,N,Q} = 3403.58$ kNm

connection capacity

bending/comporession resistance

distance of tension-bolt-rows from centre of compression:
$h_1 = 965.0$ mm, $h_2 = 775.0$ mm, $h_3 = 675.0$ mm, $h_4 = 575.0$ mm, $h_5 = 475.0$ mm, $h_6 = 375.0$ mm, $h_7 = 275.0$ mm
$h_8 = 95.0$ mm

resistance per bolt-row
row 1: $F_{tr,Rd} = 580.2$ kN
row 2: $F_{tr,Rd} = 646.3$ kN
row 3: $F_{tr,Rd} = 562.9$ kN
row 4: $F_{tr,Rd} = 479.5$ kN
row 5: $F_{tr,Rd} = 396.1$ kN
row 6: $F_{tr,Rd} = 312.7$ kN
row 7: $F_{tr,Rd} = 229.3$ kN
row 8: $F_{tr,Rd} = 79.2$ kN
$\Sigma F_{tr,Rd} = 3286.2$ kN

resistance of flanges
$\Sigma F_{c,Rd} = 3901.0+3901.0 = 7802.0$ kN

moment resistance
$M_{j,Rd} = \Sigma(F_{tr,Rd} \cdot h_r) = 2092.4$ kNm
compression resistance
$N_{j,c,Rd} = \Sigma F_{c,Rd} = 7802.0$ kN

shear/bearing resistance

resistance per bolt-row
row 1: $F_{vr,Rd} = 155.1$ kN

row 2: $F_{vr,Rd}$ = 155.1 kN
row 3: $F_{vr,Rd}$ = 155.1 kN
row 4: $F_{vr,Rd}$ = 155.1 kN
row 5: $F_{vr,Rd}$ = 155.1 kN
row 6: $F_{vr,Rd}$ = 155.1 kN
row 7: $F_{vr,Rd}$ = 155.1 kN
row 8: $F_{vr,Rd}$ = 155.1 kN
$\Sigma F_{vr,Rd}$ = 1240.8 kN

shear/bearing resistance
$V_{j,Rd} = \Sigma F_{vr,Rd}$ = 1240.8 kN

shear resistance

shear resistance of end plate
plate: $V_{ep,Rd}$ = 4178.86 kN
resistance of a weld (req.1): $f_{1w,d} = f_u / (\beta_w \cdot \gamma_{M2})$ = 360.0 N/mm²
welds: $F_{w,Rd}$ = 2880.75 kN
shear resistance of end plate: $V_{ep,Rd} = F_{w,Rd}$ = 2880.75 kN

plastic shear resistance
$V_{pl,Rd} = 0.5 \cdot A_v \cdot (f_y/3^{1/2}) / \gamma_{M0}$ = 1454.6 kN (requirement, s. 'Typisierte Anschlüsse')

total

$M_{j,Rd}$ = 2092.4 kNm $N_{j,c,Rd}$ = 7802.0 kN $V_{j,Rd}$ = 1240.8 kN $V_{pl,Rd}$ = 1454.6 kN $V_{ep,Rd}$ = 2880.7 kN

rotational stiffness

rotational stiffness only für bending connections !!

Lk 6: compression force + internal moment (bottom tension)

resistance of cross-section

plastic resistance moment: $M_{pl,N,Q}$ = 3403.58 kNm

connection capacity

bending/comporession resistance

distance of tension-bolt-rows from centre of compression:
h_1 = 775.0 mm, h_2 = 595.0 mm, h_3 = 495.0 mm, h_4 = 395.0 mm, h_5 = 295.0 mm, h_6 = 195.0 mm, h_7 = 95.0 mm

resistance per bolt-row
row 1: $F_{tr,Rd}$ = 646.3 kN
row 2: $F_{tr,Rd}$ = 496.2 kN
row 3: $F_{tr,Rd}$ = 412.8 kN
row 4: $F_{tr,Rd}$ = 329.4 kN
row 5: $F_{tr,Rd}$ = 246.0 kN
row 6: $F_{tr,Rd}$ = 162.6 kN
row 7: $F_{tr,Rd}$ = 79.2 kN
$\Sigma F_{tr,Rd}$ = 2372.4 kN

resistance of flanges
$\Sigma F_{c,Rd}$ = 3901.0+3901.0 = 7802.0 kN

moment resistance
$M_{j,Rd} = \Sigma(F_{tr,Rd} \cdot h_r)$ = 1242.3 kNm
compression resistance
$N_{j,c,Rd} = \Sigma F_{c,Rd}$ = 7802.0 kN

shear/bearing resistance

resistance per bolt-row
row 1: $F_{vr,Rd}$ = 155.1 kN
row 2: $F_{vr,Rd}$ = 155.1 kN
row 3: $F_{vr,Rd}$ = 155.1 kN
row 4: $F_{vr,Rd}$ = 155.1 kN
row 5: $F_{vr,Rd}$ = 155.1 kN
row 6: $F_{vr,Rd}$ = 155.1 kN
row 7: $F_{vr,Rd}$ = 155.1 kN
row 8: $F_{vr,Rd}$ = 155.1 kN
$\Sigma F_{vr,Rd}$ = 1240.8 kN

shear/bearing resistance
$V_{j,Rd} = \Sigma F_{vr,Rd} = 1240.8$ kN

shear resistance

shear resistance of end plate
plate: $V_{ep,Rd} = 4178.86$ kN
resistance of a weld (req.1): $f_{1w,d} = f_u / (\beta_w \cdot \gamma_{M2}) = 360.0$ N/mm²
welds: $F_{w,Rd} = 2880.75$ kN
shear resistance of end plate: $V_{ep,Rd} = F_{w,Rd} = 2880.75$ kN

plastic shear resistance
$V_{pl,Rd} = 0.5 \cdot A_v \cdot (f_y / 3^{1/2}) / \gamma_{M0} = 1454.6$ kN (requirement, s. 'Typisierte Anschlüsse')

total

$M_{j,Rd} = 1242.3$ kNm $N_{j,c,Rd} = 7802.0$ kN $V_{j,Rd} = 1240.8$ kN $V_{pl,Rd} = 1454.6$ kN $V_{ep,Rd} = 2880.7$ kN

rotational stiffness

rotational stiffness only für bending connections !!

Final Result

initial stiffness:	$S_{j,ini}$	= 3342.7 MNm/rad
moment resistance (M+):	$M_{j1,Rd}$	= 2092.4 kNm
moment resistance (M-):	$M_{j2,Rd}$	= 1242.3 kNm
tension resistance:	$N_{jt,Rd}$	= 3836.8 kNm
compression resistance:	$N_{jc,Rd}$	= 7802.0 kNm
shear force resistance:	$V_{j,Rd}$	= 1240.8 kNm
moment resistance of beam section:	$M_{c,Rd}$	= 3403.6 kNm