POS. 10: TYPED IG-CONNECTION

standard IG-connection

hinged IG-connection acc. to EC 3-1-8 (12.10), NA: Deutschland

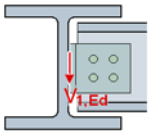
the connection type, dimensions of beam, bolts, end-plate resp. angle
and material are taken of the following literature:
'Typisierte Anschlüsse im Stahlhochbau nach DIN EN 1993-1-8, Stahlbau Verlags- und Service GmbH, Ausgabe 2013'
the current number and associated parameters are recorded.
verification method is 'elastic-elastic'. bolts are not preloaded.

code IG, steel grade S 235, bolt class of bolts 4.6

160: beam section IPE400, connection type 1, bolt size M24, 3 bolt-rows
angle: L200x100x12, h_{wi} = 260 mm
$e_{z,mg}$ = 50 mm, $p_{z,mg}$ = 80 mm, $e_{x,mg}$ = 50 mm, $e_{z,sb}$ = 50 mm, $p_{z,sb}$ = 80 mm, $e_{x,sb}$ = 50 mm

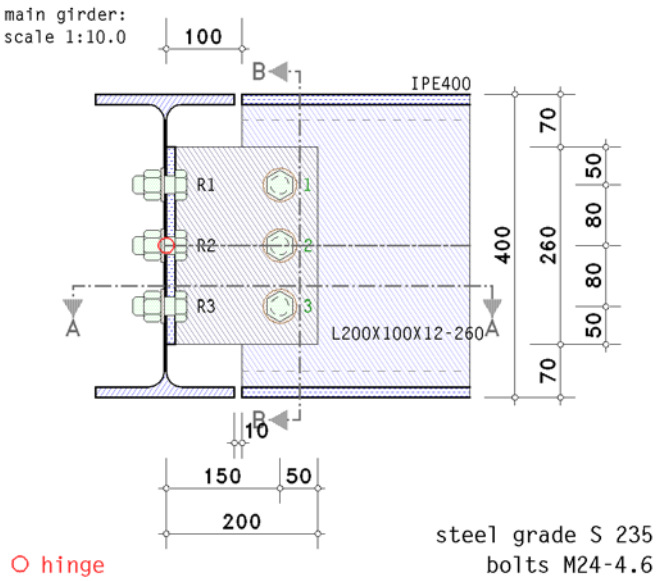
$V_{j,Ed}$: internal forces and moments at hinge

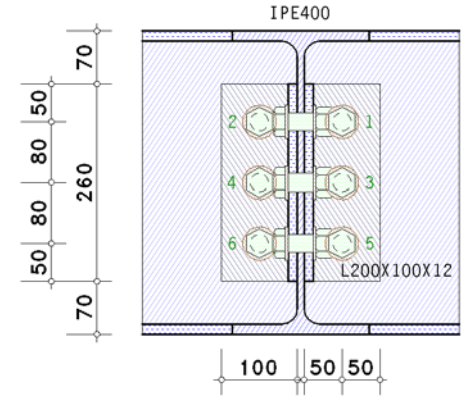
Lk	$V_{j,Ed}$ kN		Lk	$V_{j,Ed}$ kN		Lk	$V_{j,Ed}$ kN	
1	27.22	min N	5	-6.85	min Vζ	9	-22.74	min Vη
2	89.08	max N	6	63.25	min σl	10	-79.40	min Vζ
3	26.19	min Vη	7	-68.00	min N	11	-4.22	max Vζ
4	89.70	max Vη	8	-23.21	max N			

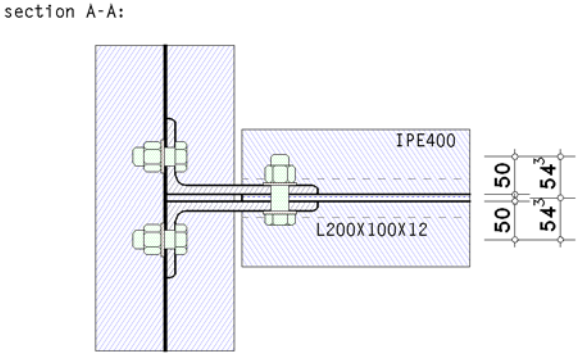


Simple Joint of Beams

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







partial safety factors for material
resistance of cross sections γ_{M0} = 1.00
resistance of bolts, welds, plates in bearing γ_{M2} = 1.25
resistance with tension loads γ_{Mu} = 1.10

Final Result

maximum utilization [Lk 4]: design resistance max U = 0.847 < 1 ok.

verification succeeded

Decisive load case combination

notes
design resistance of the main girder is not verified.
distances between bolts are not checked.

Lk 4: max Vη

design values

transformation of member forces to the reference point (intersection point of beam axis')

$M_{1,Ed}$ = $V_{j1,Ed} \cdot e_1$ = -0.13 kNm, e_1 = -1.5 mm
$V_{1,Ed}$ = $V_{j1,Ed}$ = 89.70 kN

design resistance of the connection

angle leg at main girder:

shear force resistance
bolts in shear:
design shear resistance per shear plane: $F_{v,Rd} = \alpha_v \cdot f_{ub} \cdot A / \gamma_{M2}$ = 86.86 kN, α_v = 0.60
design shear resistance total: $V_{Rd,1}$ = 334.3 kN

angle leg 2 with bearing resistance:
design bearing resistance total: $V_{Rd,2}$ = 581.8 kN

angle leg 2 with shear (gross section):
shear resistance $V_{Rd} = (A_v \cdot f_y) / (3^{1/2} \cdot \gamma_{M0})$ = 423.31 kN
shear resistance total: $V_{Rd,3} = 2 \cdot V_{Rd} / 1.27$ = 666.6 kN

angle leg 2 with shear (net section):
shear resistance $V_{Rd} = (A_{v,net} \cdot f_u) / (3^{1/2} \cdot \gamma_{M2})$ = 363.15 kN
shear resistance total: $V_{Rd,4} = 2 \cdot V_{Rd}$ = 726.3 kN

shear resistance: min $V_{Rd,a2}$ = $V_{Rd,1}$ = 334.3 kN

angle leg at supported beam:

shear force resistance
bolts in shear:
design shear resistance per shear plane: $F_{v,Rd} = \alpha_v \cdot f_{ub} \cdot A / \gamma_{M2}$ = 86.86 kN, α_v = 0.60
design shear resistance total: $V_{Rd,1}$ = 174.6 kN

angle leg 1 with bearing resistance:
design bearing resistance total: $V_{Rd,2}$ = 795.9 kN

angle leg 1 with shear (gross section):
shear resistance $V_{Rd} = (A_v \cdot f_y) / (3^{1/2} \cdot \gamma_{M0})$ = 423.31 kN
shear resistance total: $V_{Rd,3} = 2 \cdot V_{Rd} / 1.27$ = 666.6 kN

angle leg 1 with shear (net section):
shear resistance $V_{Rd} = (A_{v,net} \cdot f_u) / (3^{1/2} \cdot \gamma_{M2})$ = 363.15 kN
shear resistance total: $V_{Rd,4} = 2 \cdot V_{Rd}$ = 726.3 kN

angle leg 1 in tension and shear (shear block):
shear resistance $V_{eff,Rd} = (0.5 \cdot A_{nt} \cdot f_u) / \gamma_{M2} + (A_{nv} \cdot f_y / 3^{1/2}) / \gamma_{M0}$ = 300.01 kN

shear resistance total: $V_{Rd,5} = 2 \cdot V_{eff,Rd} = 600.0$ kN

angle leg 1 in bending and shear:
$b_F = 260.0$ mm $< 2.73 \cdot z = 409.5$ mm:
shear resistance total: $V_{Rd,6} = 2 \cdot V_{Rd} = 423.6$ kN

angle leg 1 with buckling:
$z_F = 150.0$ mm $> t_F/0.15 = 80.0$ mm:
buckling of anglechenkel 1s ist gesondert zu untersuchen !!
beam web (sb) with bearing resistance:
design bearing resistance total: $V_{Rd,8} = 106.0$ kN

beam web (sb) with shear (gross section):
shear resistance $V_{Rd} = (A_v \cdot f_y) / (3^{1/2} \cdot \gamma_{M0}) = 579.27$ kN
shear resistance total: $V_{Rd,9} = 579.3$ kN

beam web (sb) with shear (net section):
shear resistance $V_{Rd} = (A_{v,net} \cdot f_u) / (3^{1/2} \cdot \gamma_{M2}) = 598.37$ kN
shear resistance total: $V_{Rd,10} = 598.4$ kN

beam web (sb) in tension and shear (shear block):
shear resistance $V_{eff,Rd} = (0.5 \cdot A_{nt} \cdot f_u) / \gamma_{M2} + (A_{nv} \cdot f_y / 3^{1/2}) / \gamma_{M0} = 296.69$ kN
shear resistance total: $V_{Rd,11} = 296.7$ kN

shear resistance: min $V_{Rd,a1} = V_{Rd,8} = 106.0$ kN

design resistance: min $V_{Rd} = 106.0$ kN

required plate thickness of main girder web:

beam web (mg) with bearing resistance:
design bearing resistance: $V_{Rd} = 195.1$ kN
erf t_u = min $V_{Rd} \cdot t / V_{Rd} = 1.63$ mm

verification of the connection

$V_{Ed} = 89.7$ kN: V_{Ed} / min $V_{Rd} = 0.847 < 1$ ok.

verification result

maximum utilization: max $U = 0.847 < 1$ ok.

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/NA, Nationaler Anhang zur DIN EN 1993-1-1, Ausgabe Dezember 2010

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
DIN EN 1993-1-8/NA, Nationaler Anhang zur DIN EN 1993-1-8, Ausgabe Dezember 2010

ECCS Document No. 126: European Recommendations for the Design of Simple Joints in Steel Structures.
ECCS TC10 - Structural Connections, 2009. J.P. Jaspart, J.F. Demonceau, S. Renkin, M.L. Guillaume

Klaus Weynand, Ralf Oerder: Typisierte Anschlüsse im Stahlhochbau nach DIN EN 1993-1-8,
IS - Gelenkige Stirnplattenanschlüsse, IW - Gelenkige Winkelanschlüsse
IG - Gelenkige Winkelanschlüsse mit großem Spalt, IK - Ausklinkungen,
Stahlbau Verlags- und Service GmbH, Ausgabe 2013