POS. 5: TYPED IS-CONNECTION

standard IS-connection

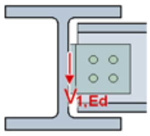
hinged IS-connection acc. to EC 3-1-8 (12.10), NA: Deutschland

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 IS, steel grade S 235, bolt class of bolts 4.6

123: beam section IPE400, bolt size M20, 3 bolt-rows
end-plate: t_p = 10 mm, h_p = 220 mm, b_p = 180 mm, w = 100 mm, e_z = 40 mm, p_z = 70 mm, e_x = 40 mm

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

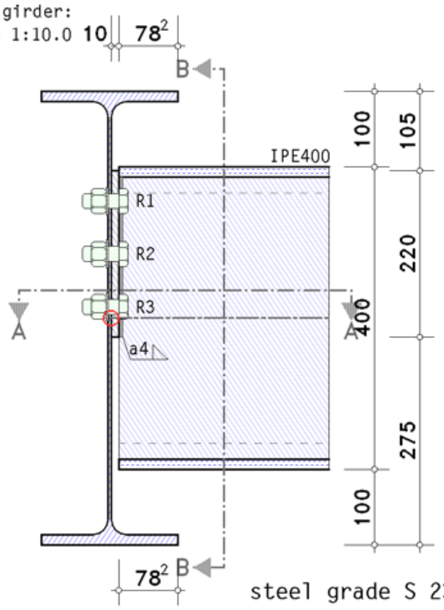


Lk	$V_{j,Ed}$		Lk	$V_{j,Ed}$		Lk	$V_{j,Ed}$	
--	kN		--	kN		--	kN	
1	-68.00	min N	5	-4.22	max Vζ	9	-7.76	max Vη
2	-23.21	max N	6	-95.92	min N	10	-116.87	min Vζ
3	-22.74	min Vη	7	-33.27	max N	11	-111.22	min T
4	-79.40	min Vζ	8	-87.48	min Vη	12	-42.68	max T

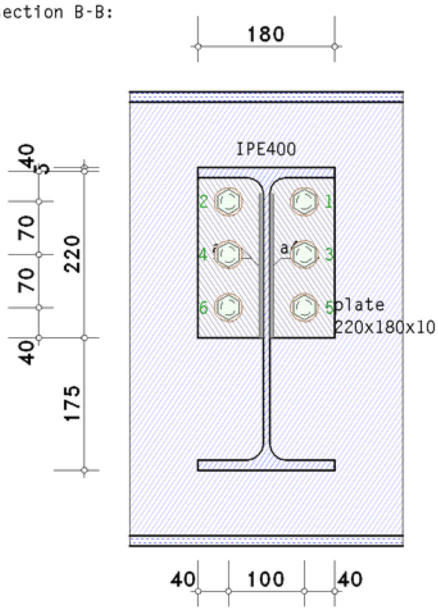
Simple Joint of Beams

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

main girder:
scale 1:10.0



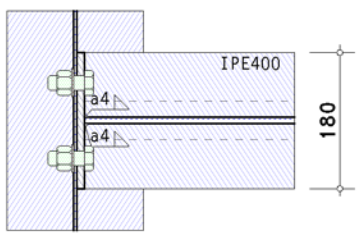
section B-B:



steel grade S 235
bolts M20-4.6

○ hinge

section A-A:



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 10]: design resistance max $U = 0.455 < 1$ ok.

verification succeeded

Decisive load case combination

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

erf $a_w = \beta_w/2^{1/2} \cdot f_y/f_u \cdot \gamma_{M2}/\gamma_{M0} \cdot t_w = 3.97$ mm

design resistance of the connection

shear force resistance
bolts in shear:
design shear resistance per shear plane: $F_{v,Rd} = \alpha_v \cdot f_{ub} \cdot A / \gamma_{M2} = 60.32$ kN, $\alpha_v = 0.60$
design shear resistance total: $V_{Rd,1} = 0.8 \cdot 6 \cdot F_{v,Rd} = 289.5$ kN

end-plate with bearing resistance:
bearing resistance: $F_{b,Rd} = (k_1 \cdot \alpha_b \cdot f_u \cdot d \cdot t) / \gamma_{M2} = 87.27$ kN, $k_1 = 2.50$, $\alpha_b = 0.61$
design bearing resistance total: $V_{Rd,2} = 6 \cdot F_{b,Rd} = 523.6$ kN

end-plate with shear (gross section):
shear resistance $V_{Rd} = (A_v \cdot f_y) / (3^{1/2} \cdot \gamma_{M0}) = 298.49$ kN
shear resistance total: $V_{Rd,3} = 2 \cdot V_{Rd}/1.27 = 470.1$ kN

end-plate with shear (net section):
shear resistance $V_{Rd} = (A_{v,net} \cdot f_u) / (3^{1/2} \cdot \gamma_{M2}) = 256.07$ kN
shear resistance total: $V_{Rd,4} = 2 \cdot V_{Rd} = 512.1$ kN

end-plate in tension and shear (shear block):
$l_p = 220.0$ mm $> 1.36 \cdot p_{22} = 136.0$ mm and $n_z = 3 > 1$:
shear resistance $V_{eff,Rd} = (0.5 \cdot A_{nt} \cdot f_u) / \gamma_{M2} + (A_{nv} \cdot f_y/3^{1/2}) / \gamma_{M0} = 253.12$ kN
shear resistance total: $V_{Rd,5} = 2 \cdot V_{eff,Rd} = 506.2$ kN

end-plate in bending and shear:
$l_p = 220.0$ mm $> 1.36 \cdot p_{22} = 136.0$ mm:
shear resistance total: $V_{Rd,6} = \infty$

beam web (sb) with shear (next to the weld):
shear resistance $V_{Rd} = (A_v \cdot f_y) / (3^{1/2} \cdot \gamma_{M0}) = 256.70$ kN
shear resistance total: $V_{Rd,7} = 256.7$ kN

shear resistance: min $V_{Rd,p} = V_{Rd,7} =$ 256.7 kN

required plate thickness from beam web (mg) with bearing resistance:
bearing resistance: $F_{b,Rd} = (k_1 \cdot \alpha_b \cdot f_u \cdot d \cdot t) / \gamma_{M2} = 42.78$ kN, $k_1 = 2.50$, $\alpha_b = 0.81$
erf $t_w = \min V_{Rd,p} \cdot t/(6 \cdot F_{b,Rd}) = 3.67$ mm

Lk 10: min Vζ

design values

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

$M_{1,Ed}$ = $V_{j1,Ed} \cdot e_1$ = 0.21 kNm, e_1 = -1.8 mm
$V_{1,Ed}$ = $V_{j1,Ed}$ = -116.87 kN

verification of the connection

V_{Ed} = 116.9 kN: V_{Ed} / min V_{Rd} = 0.455 < 1 ok.

verification result

maximum utilization: max U = 0.455 < 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