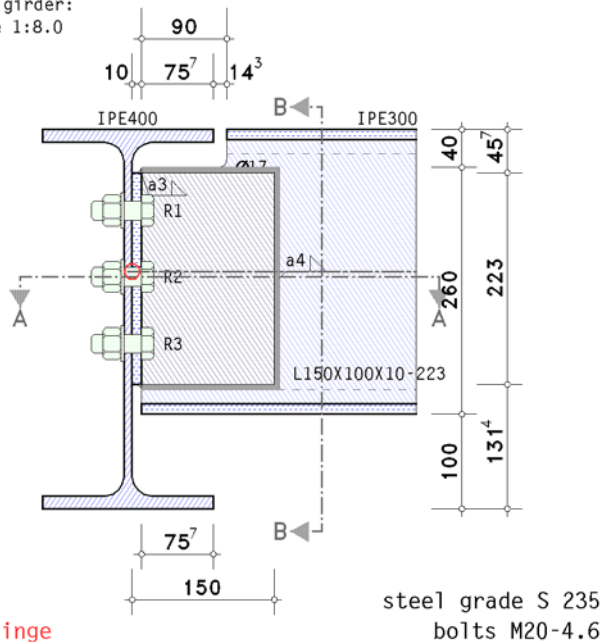


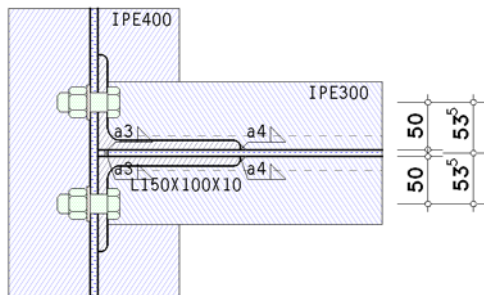
Simple Joint of Beams

DIN 18800 (11.08)

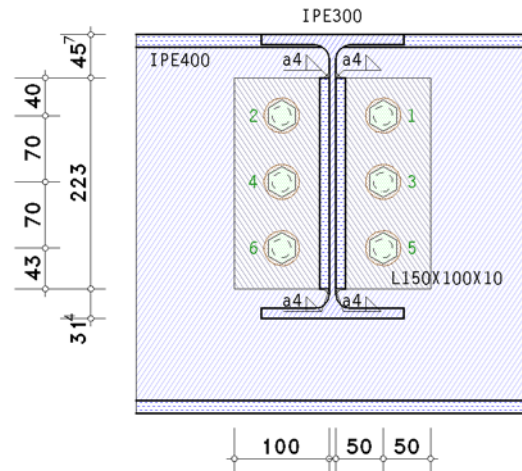
main girder:
scale 1:8.0



○ hinge
section A-A:



section B-B:



beam connection with two bolted/welded angles

steel grade

steel grade S 235

bolts

bolt: bolt class 4.6, bolt size M20

shear plane passes through the unthreaded portion of the bolt

geometry

main girder

section IPE400

supported beam

section IPE300

joint configuration

2 x angle: section L150X100X10

width of angles $b_a = 223.0$ mm

plate lengths: $h_o = 0.0$ mm, $\ddot{u}_o = 45.7$ mm ($h_u = 100.0$ mm, $\ddot{u}_u = 31.4$ mm), $s = 10.0$ mm

notch: $a_o = 90.0$ mm, $e_o = 40.0$ mm

rounded notch (root radius $r_a = 8.5$ mm)

distances between bolts at main girder: $e_{z,0} = 40.0$ mm, $p_{z,1-2} = 70.0$ mm, $p_{z,2-3} = 70.0$ mm, $e_{x,0} = 50.0$ mm

thickness weld: $a_w = 4.0$ mm (at angle leg), $a_{w,s} = 3.0$ mm (end weld)

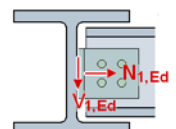
internal forces and moments

Lk 1: $V_{1,Ed} = 200.00$ kN

Lk 2: $V_{1,Ed} = 160.00$ kN

partial safety factors for material

resistance of cross sections $\gamma_{M0} = 1.00$



resistance of bolts, welds, plates in bearing $\gamma_{M2} = 1.25$

Simple Joint of Beams

assumption: hinge is in the periphery to main girder web

notes

distances between bolts are not checked.

though notches exist the cross-sectional check is not verified

Lk 1:

right cross girder

notch: (section 1 - 1) type IK 3

$$h_1 = 260.0 \text{ mm} \quad t_s = 7.1 \text{ mm} \quad A = 33.8 \text{ cm}^2 \quad S_y = 629.3 \text{ cm}^3 \quad S_{y1} = 109.4 \text{ cm}^3 \quad I = 2340.8 \text{ cm}^4$$

$$z_o = 186.5 \text{ mm} \quad z_u = 73.5 \text{ cm} \quad \sigma_o = 17.53 \text{ kN/cm}^2 \quad \max \tau = 14.85 \text{ kN/cm}^2$$

$$\sigma_1 = 5.90 \text{ kN/cm}^2 \quad \tau_1 = 13.17 \text{ kN/cm}^2 \quad \sigma_v = 23.56 \text{ kN/cm}^2$$

$$V_{r,d} = 200.0 \text{ kN} \quad V_{R,d} = 169.6 \text{ kN} \quad \Rightarrow \text{difference load } \Delta V = 30.4 \text{ kN}$$

ΔV and the moment due to eccentricity $\Delta M = \Delta V \cdot (s+a) = 3.0 \text{ kNm}$ have to be taken up by the angle stiffening

connection cross girder QT at angle L150X100X10

$$\text{length of angle } h_w = 223 \text{ mm} \quad t_w = 10 \text{ mm} \quad A_w = 22.3 \text{ cm}^2 \quad \sigma_{R,d} = 21.82 \text{ kN/cm}^2 \quad \tau_{R,d} = 12.60 \text{ kN/cm}^2$$

section 1 - 1: verification of bending stress is decisive

$$V_{w,d} = \Delta V = 30.4 \text{ kN} \quad V_{R,d} = 361.6 \text{ kN} \Rightarrow \text{utilization} = V_{w,d} / V_{R,d} = 0.08$$

welds $\sigma_{w,R,d} = 20.73 \text{ kN/cm}^2$

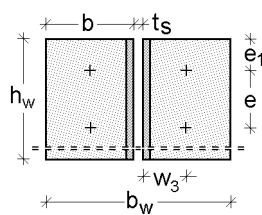
$$\text{end weld: } V_{as} = 169.6 \text{ kN} \quad l_w = h_w = 223.0 \text{ mm} \Rightarrow \text{erf } a_{w3} = 1.8 \text{ mm} \quad \text{gew. } a_{w3} = 3.0 \text{ mm}$$

connection of $V = 30.4 \text{ kN}$ by vertical and $M = V \cdot l_M = 4.6 \text{ kNm}$ by horizontal fillet welds

$$\text{fillet weld 2: } l_{w2} = h_w = 223.0 \text{ mm} \quad \text{erf } a_{w2} = 0.3 \text{ mm} \Rightarrow \text{gew. } a_{w2} = 3.0 \text{ mm} \Rightarrow \sigma_w = 2.27 \text{ kN/cm}^2$$

$$\text{fillet weld 1: } l_{w1} = 50.0 \text{ mm} \quad \text{erf } a_{w1} = 1.0 \text{ mm} \Rightarrow \text{gew. } a_{w1} = 3.0 \text{ mm} \Rightarrow \sigma_w = 6.82 \text{ kN/cm}^2$$

connection angle L150X100X10 at main girder HT



number of bolts: 3 bolts angle, $w_3 = 50 \text{ mm}$

$$h_w = 223 \text{ mm} \quad b = 100.0 \text{ mm} \quad b_w = 207.1 \text{ mm} \quad e_1 = 40 \text{ mm} \quad e = 70 \text{ mm} \quad t_s = 7 \text{ mm}$$

$$\text{contact force} = 36.54 \text{ kN} \Rightarrow \text{erf. contact surface} = 1.52 \text{ cm}^2$$

the load capacity each bolt is:

$$V_{a,R,d} = 68.5 \text{ kN} \quad V_{1w,R,d} = 130.9 \text{ kN} \quad V_{1H,R,d} = 112.6 \text{ kN} \Rightarrow V_{R,d} = 68.5 \text{ kN}$$

$\Rightarrow$ verification shear is decisive

$$\text{with } S_{ah,d} = 4.9 \text{ kN} \text{ and } S_{av,d} = 35.7 \text{ kN} \quad S_d = 36.0 \text{ kN}$$

$$\Rightarrow S_d = 36.0 \text{ kN} < V_{R,d} = 68.5 \text{ kN} \Rightarrow \text{utilization } S_d / S_{R,d} = 0.525 < 1$$

all verifications are verified!

verification result

maximum utilization: $\max U = 0.534 < 1$ **ok.**

Lk 2:

right cross girder

notch: (section 1 - 1) type IK 3

$$h_1 = 260.0 \text{ mm} \quad t_s = 7.1 \text{ mm} \quad A = 33.8 \text{ cm}^2 \quad S_y = 629.3 \text{ cm}^3 \quad S_{y1} = 109.4 \text{ cm}^3 \quad I = 2340.8 \text{ cm}^4$$

$$z_o = 186.5 \text{ mm} \quad z_u = 73.5 \text{ cm} \quad \sigma_o = 14.02 \text{ kN/cm}^2 \quad \max \tau = 11.88 \text{ kN/cm}^2$$

$$\sigma_1 = 4.72 \text{ kN/cm}^2 \quad \tau_1 = 10.53 \text{ kN/cm}^2 \quad \sigma_v = 18.85 \text{ kN/cm}^2$$

$$V_{r,d} = 160.0 \text{ kN} \quad V_{R,d} = 169.6 \text{ kN} \quad \Rightarrow \text{difference load } \Delta V = 0.0 \text{ kN}$$

connection cross girder QT at angle L150X100X10

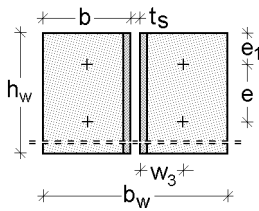
$$\text{length of angle } h_w = 223 \text{ mm} \quad t_w = 10 \text{ mm} \quad A_w = 22.3 \text{ cm}^2 \quad \sigma_{R,d} = 21.82 \text{ kN/cm}^2 \quad \tau_{R,d} = 12.60 \text{ kN/cm}^2$$

welds $\sigma_{w,R,d} = 20.73 \text{ kN/cm}^2$

$$\text{end weld: } V_{as} = 160.0 \text{ kN} \quad l_w = h_w = 223.0 \text{ mm} \Rightarrow \text{erf } a_{w3} = 1.7 \text{ mm} \quad \text{gew. } a_{w3} = 3.0 \text{ mm}$$

fillet welds 1 and 2: structural connection with $a_w = 3 \text{ mm}$

connection angle L150X100X10 at main girder HT



number of bolts: 3 bolts angle, $w_3 = 50 \text{ mm}$

$h_w = 223 \text{ mm}$ $b = 100.0 \text{ mm}$ $b_w = 207.1 \text{ mm}$ $e_1 = 40 \text{ mm}$ $e = 70 \text{ mm}$ $t_s = 7 \text{ mm}$

contact force = 29.23 kN $\Rightarrow$ erf. contact surface = 1.22 cm²

the load capacity each bolt is:

$V_{a,R,d} = 68.5 \text{ kN}$ $V_{1W,R,d} = 130.9 \text{ kN}$ $V_{1H,R,d} = 112.6 \text{ kN} \Rightarrow V_{R,d} = 68.5 \text{ kN}$

$\Rightarrow$ verification shear is decisive

with $S_{ah,d} = 3.9 \text{ kN}$ and $S_{av,d} = 28.5 \text{ kN}$ $S_d = 28.8 \text{ kN}$

$\Rightarrow S_d = 28.8 \text{ kN} < V_{R,d} = 68.5 \text{ kN} \Rightarrow$ utilization $S_d/S_{R,d} = 0.420 < 1$

all verifications are verified!

verification result

maximum utilization: max $U = 0.943 < 1$ **ok.**

Final Result

maximum utilization [Lk 2]: design resistance max $U = 0.943 < 1$ **ok.**

verification succeeded

Regulations

DIN 18800-1: Stahlbauten - Teil 1: Bemessung und Konstruktion, Ausgabe November 2008