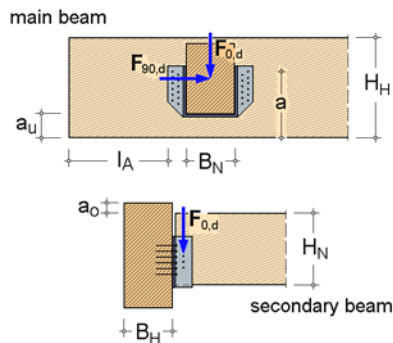


POSITION 2: BS-SIMPSON SHORT-TERM

4H-HOLZ joist hanger connection

(4H-HLZ72 Version: 1/2012-1a) (principle sketch)



calculation bases:

DIN EN 1995-1-1:2010-12 (EC5) /NA:2010-12,
BAZ Z-9.1-225 und ETA-04/0013

sizes of main and secondary beam (single-sided)

$H_H = 320 \text{ mm}$ $B_H = 240 \text{ mm}$ $a_0 = 50 \text{ mm}$
 $H_N = 220 \text{ mm}$ $B_N = 120 \text{ mm}$ $a_u = 50 \text{ mm}$
 $w = 189 \text{ mm}$ $a = 190 \text{ mm}$ $l_A \geq H_H$

service class 2

species/timber grade

main beam: coniferous timber, timber grade C24

secondary beam: coniferous timber, timber grade C24

internal forces and factors

$F_{0,d}$ force perpendicular to the base plate
 $F_{90,d}$ force parallel to the base plate
 $N_{,d}$ normal force in secondary beam

combinations of internal forces (design values)

LK-Nr.	KLED	$F_{0,d}$	$F_{90,d}$	$N_{,d}$	k_{mod}
1	permanent	4.50 kN	0.50 kN	---	0.60
2	long-term	1.00 kN	0.00 kN	---	0.70
3	medium-term	1.00 kN	0.00 kN	---	0.80
4	short-term	-1.00 kN	0.00 kN	---	0.90
5	instantan.	1.00 kN	0.00 kN	---	1.10

connection method joist hanger with outer plates

make BS-Simpson / short 120x157.5, basic form 440

joist hanger size width $b = 120.0 \text{ mm}$ height $h = 157.5 \text{ mm}$ steel plate thickness $t = 2.0 \text{ mm}$

nails CNA ribbed nails 4,0x35

$d_n = 4.0 \text{ mm}$ $l_n = 35.0 \text{ mm}$ $d_k = 8.0 \text{ mm}$ $l_g = 25.0 \text{ mm}$ $M_{yk} = 6.6 \text{ Nm}$

verifications

combination of internal forces 1 (design values)

LK-Nr.	KLED	$F_{0,d}$	$F_{90,d}$	$N_{,d}$	k_{mod}
1	permanent	4.50 kN	0.50 kN	---	0.60

nail anchorage capacities (withdrawal)

main beam $f_{1,k} = 6.125 \text{ N/mm}^2$ $R_{ax,k} = 0.613 \text{ kN}$ $R_{ax,d} = 0.283 \text{ kN}$

secondary beam $f_{1,k} = 6.125 \text{ N/mm}^2$ $R_{ax,k} = 0.613 \text{ kN}$ $R_{ax,d} = 0.283 \text{ kN}$

nail anchorage capacities (shear)

main beam $f_{h,k} = 18.935 \text{ N/mm}^2$ $R_{1a,k} = 1.156 \text{ kN}$ $R_{1a,d} = 0.631 \text{ kN}$

secondary beam $f_{h,k} = 18.935 \text{ N/mm}^2$ $R_{1a,k} = 1.156 \text{ kN}$ $R_{1a,d} = 0.631 \text{ kN}$

joist hanger load-carrying capacities (full nailing)

number of nails $n_H = 26$ $n_N = 14$

form factors $k_{H1} = 40.40$ $k_{H2} = 36.70$

material safety factors $\gamma_{M,timber} = 1.30$ $\gamma_{M,steel} = 1.10$ $\gamma_{M,calc} = 1.00$

transversely load-carrying capacity ($R_{2,d}$) (1)

$e_N = 110.00 \text{ mm}$ $R = 67.50 \text{ mm}$

$F_{2,d} = 0.50 \text{ kN}$ $R_{2,d} = 3.06 \text{ kN}$ $F_{2,d}/R_{2,d} = 0.16 \leq 1.00$ verification successful

load-carrying capacity for load towards base plate ($R_{1,d}$) (2)

$F_{1,d} = 4.50 \text{ kN}$ $R_{1,d} = 9.37 \text{ kN}$ $F_{1,d}/R_{1,d} = 0.48 \leq 1.00$ verification successful

load-carrying capacity for load away from base plate ($R_{1a,d}$) (3)

$F_{1a,d} = 0.00 \text{ kN}$ $R_{1a,d} = 8.77 \text{ kN}$ $F_{1a,d}/R_{1a,d} = 0.00 \leq 1.00$ verification successful

verification of interaction (4 + 5)

$(F_{1,d}/R_{1,d})^2 + (F_{2,d}/R_{2,d})^2 = 0.26 \leq 1.00$ verification successful

$(F_{1a,d}/R_{1a,d})^2 + (F_{2,d}/R_{2,d})^2$ verification not required

verification of splitting capacity (6)

For $a/H_H = 0.594 \leq 0.7$ verif. of splitting capacity is required. Acc. to DIN 1052:2008-12, par. 11.1.5 the following requirement should be satisfied: $F_{90,d}/R_{90,d} \leq 1.0$

$F_{90,d}$ design value of the force component perpendicular to grain

$R_{90,d}$ design splitting capacity of the beams

$R_{90,d} = k_s \cdot k_r \cdot (6.5 + 18 \cdot a^2/H_H^2) \cdot (t_{ef} \cdot H_H) \cdot 0.8 \cdot f_{t,90,d}$



verifications

$a = 190.0 \text{ mm}$ $H_H = 320.0 \text{ mm}$ $a/H_H = 0.594$ $a_r = 189.0 \text{ mm}$ $t_{ef} = 33.0 \text{ mm}$
 $h_1 = 130.0 \text{ mm}$ $k_s = 1.527$ $k_r = 1.893$ $l_{Ag} = 189.0 \text{ mm}$ $k_g = 0.648$
 $f_{t,90,k} = 0.400 \text{ N/mm}^2$ $f_{t,90,d} = 0.240 \text{ N/mm}^2$ $F_{90,d} = 4.50 \text{ kN}$ $R_{90,d} = 7.35 \text{ kN}$
 $F_{90,d} / R_{90,d} = 4.50 / 7.35 = 0.61 \leq 1.0$ verification successful

LK1: all verifications successful.

combination of internal forces 2 (design values)

LK-Nr.	KLED	$F_{0,d}$	$F_{90,d}$	$N_{,d}$	k_{mod}
2	long-term	1.00 kN	0.00 kN	---	0.70

joist hanger load-carrying capacities (full nailing)

number of nails $n_H = 26$ $n_N = 14$
form factors $k_{H1} = 40.40$ $k_{H2} = 36.70$
material safety factors $\gamma_{M,timber} = 1.30$ $\gamma_{M,steel} = 1.10$ $\gamma_{M,calc} = 1.00$

transversely load-carrying capacity ($R_{2,d}$) (1)

$e_N = 110.00 \text{ mm}$ $R = 67.50 \text{ mm}$
 $F_{2,d} = 0.00 \text{ kN}$ $R_{2,d} = 3.57 \text{ kN}$ $F_{2,d} / R_{2,d} = 0.00 \leq 1.00$ verification successful

load-carrying capacity for load towards base plate ($R_{1,d}$) (2)

$F_{1,d} = 1.00 \text{ kN}$ $R_{1,d} = 10.93 \text{ kN}$ $F_{1,d} / R_{1,d} = 0.09 \leq 1.00$ verification successful

load-carrying capacity for load away from base plate ($R_{1a,d}$) (3)

$F_{1a,d} = 0.00 \text{ kN}$ $R_{1a,d} = 10.23 \text{ kN}$ $F_{1a,d} / R_{1a,d} = 0.00 \leq 1.00$ verification successful

verification of interaction (4 + 5)

$(F_{1,d} / R_{1,d})^2 + (F_{2,d} / R_{2,d})^2$ verification not required
 $(F_{1a,d} / R_{1a,d})^2 + (F_{2,d} / R_{2,d})^2$ verification not required

verification of splitting capacity (6)

For $a/H_H = 0.594 \leq 0.7$ verif. of splitting capacity is required. Acc. to DIN 1052:2008-12, par. 11.1.5 the following requirement should be satisfied: $F_{90,d} / R_{90,d} \leq 1.0$

$F_{90,d}$ design value of the force component perpendicular to grain

$R_{90,d}$ design splitting capacity of the beams

$R_{90,d} = k_s \cdot k_r \cdot (6.5 + 18 \cdot a^2 / H_H^2) \cdot (t_{ef} \cdot H_H)^{0.8} \cdot f_{t,90,d}$

$a = 190.0 \text{ mm}$ $H_H = 320.0 \text{ mm}$ $a/H_H = 0.594$ $a_r = 189.0 \text{ mm}$ $t_{ef} = 33.0 \text{ mm}$
 $h_1 = 130.0 \text{ mm}$ $k_s = 1.527$ $k_r = 1.893$ $l_{Ag} = 189.0 \text{ mm}$ $k_g = 0.648$
 $f_{t,90,k} = 0.400 \text{ N/mm}^2$ $f_{t,90,d} = 0.280 \text{ N/mm}^2$ $F_{90,d} = 1.00 \text{ kN}$ $R_{90,d} = 8.58 \text{ kN}$
 $F_{90,d} / R_{90,d} = 1.00 / 8.58 = 0.12 \leq 1.0$ verification successful

LK2: all verifications successful.

combination of internal forces 3 (design values)

LK-Nr.	KLED	$F_{0,d}$	$F_{90,d}$	$N_{,d}$	k_{mod}
3	medium-term	1.00 kN	0.00 kN	---	0.80

joist hanger load-carrying capacities (full nailing)

number of nails $n_H = 26$ $n_N = 14$
form factors $k_{H1} = 40.40$ $k_{H2} = 36.70$
material safety factors $\gamma_{M,timber} = 1.30$ $\gamma_{M,steel} = 1.10$ $\gamma_{M,calc} = 1.00$

transversely load-carrying capacity ($R_{2,d}$) (1)

$e_N = 110.00 \text{ mm}$ $R = 67.50 \text{ mm}$
 $F_{2,d} = 0.00 \text{ kN}$ $R_{2,d} = 4.08 \text{ kN}$ $F_{2,d} / R_{2,d} = 0.00 \leq 1.00$ verification successful

load-carrying capacity for load towards base plate ($R_{1,d}$) (2)

$F_{1,d} = 1.00 \text{ kN}$ $R_{1,d} = 12.50 \text{ kN}$ $F_{1,d} / R_{1,d} = 0.08 \leq 1.00$ verification successful

load-carrying capacity for load away from base plate ($R_{1a,d}$) (3)

$F_{1a,d} = 0.00 \text{ kN}$ $R_{1a,d} = 11.69 \text{ kN}$ $F_{1a,d} / R_{1a,d} = 0.00 \leq 1.00$ verification successful

verification of interaction (4 + 5)

$(F_{1,d} / R_{1,d})^2 + (F_{2,d} / R_{2,d})^2$ verification not required
 $(F_{1a,d} / R_{1a,d})^2 + (F_{2,d} / R_{2,d})^2$ verification not required

verification of splitting capacity (6)

For $a/H_H = 0.594 \leq 0.7$ verif. of splitting capacity is required. Acc. to DIN 1052:2008-12, par. 11.1.5 the following requirement should be satisfied: $F_{90,d} / R_{90,d} \leq 1.0$

$F_{90,d}$ design value of the force component perpendicular to grain

$R_{90,d}$ design splitting capacity of the beams

$R_{90,d} = k_s \cdot k_r \cdot (6.5 + 18 \cdot a^2 / H_H^2) \cdot (t_{ef} \cdot H_H)^{0.8} \cdot f_{t,90,d}$

verifications

$a = 190.0 \text{ mm}$ $H_H = 320.0 \text{ mm}$ $a/H_H = 0.594$ $a_r = 189.0 \text{ mm}$ $t_{ef} = 33.0 \text{ mm}$
 $h_1 = 130.0 \text{ mm}$ $k_s = 1.527$ $k_r = 1.893$ $l_{Ag} = 189.0 \text{ mm}$ $k_g = 0.648$
 $f_{t,90,k} = 0.400 \text{ N/mm}^2$ $f_{t,90,d} = 0.320 \text{ N/mm}^2$ $F_{90,d} = 1.00 \text{ kN}$ $R_{90,d} = 9.80 \text{ kN}$
 $F_{90,d} / R_{90,d} = 1.00 / 9.80 = 0.10 \leq 1.0$ verification successful

LK3: all verifications successful.

combination of internal forces 4 (design values)

LK-Nr.	KLED	$F_{0,d}$	$F_{90,d}$	$N_{,d}$	k_{mod}
4	short-term	-1.00 kN	0.00 kN	---	0.90

joist hanger load-carrying capacities (full nailing)

number of nails $n_H = 26$ $n_N = 14$
form factors $k_{H1} = 40.40$ $k_{H2} = 36.70$
material safety factors $\gamma_{M,timber} = 1.30$ $\gamma_{M,steel} = 1.10$ $\gamma_{M,calc} = 1.00$

transversely load-carrying capacity ($R_{2,d}$) (1)

$e_N = 110.00 \text{ mm}$ $R = 67.50 \text{ mm}$
 $F_{2,d} = 0.00 \text{ kN}$ $R_{2,d} = 4.59 \text{ kN}$ $F_{2,d} / R_{2,d} = 0.00 \leq 1.00$ verification successful

load-carrying capacity for load towards base plate ($R_{1,d}$) (2)

$F_{1,d} = 0.00 \text{ kN}$ $R_{1,d} = 14.06 \text{ kN}$ $F_{1,d} / R_{1,d} = 0.00 \leq 1.00$ verification successful

load-carrying capacity for load away from base plate ($R_{1a,d}$) (3)

$F_{1a,d} = -1.00 \text{ kN}$ $R_{1a,d} = 13.15 \text{ kN}$ $F_{1a,d} / R_{1a,d} = 0.08 \leq 1.00$ verification successful

verification of interaction (4 + 5)

$(F_{1,d} / R_{1,d})^2 + (F_{2,d} / R_{2,d})^2$ verification not required
 $(F_{1a,d} / R_{1a,d})^2 + (F_{2,d} / R_{2,d})^2$ verification not required

verification of splitting capacity (6)

For $a/H_H = 0.594 \leq 0.7$ verif. of splitting capacity is required. Acc. to DIN 1052:2008-12, par. 11.1.5 the following requirement should be satisfied: $F_{90,d} / R_{90,d} \leq 1.0$

$F_{90,d}$ design value of the force component perpendicular to grain

$R_{90,d}$ design splitting capacity of the beams

$R_{90,d} = k_s \cdot k_r \cdot (6.5 + 18 \cdot a^2 / H_H^2) \cdot (t_{ef} \cdot H_H)^{0.8} \cdot f_{t,90,d}$

$a = 190.0 \text{ mm}$ $H_H = 320.0 \text{ mm}$ $a/H_H = 0.594$ $a_r = 189.0 \text{ mm}$ $t_{ef} = 33.0 \text{ mm}$
 $h_1 = 130.0 \text{ mm}$ $k_s = 1.527$ $k_r = 1.893$ $l_{Ag} = 189.0 \text{ mm}$ $k_g = 0.648$
 $f_{t,90,k} = 0.400 \text{ N/mm}^2$ $f_{t,90,d} = 0.360 \text{ N/mm}^2$ $F_{90,d} = 0.00 \text{ kN}$ $R_{90,d} = 11.03 \text{ kN}$
 $F_{90,d} / R_{90,d} = 0.00 / 11.03 = 0.00 \leq 1.0$ verification successful

LK4: all verifications successful.

combination of internal forces 5 (design values)

LK-Nr.	KLED	$F_{0,d}$	$F_{90,d}$	$N_{,d}$	k_{mod}
5	instantan.	1.00 kN	0.00 kN	---	1.10

joist hanger load-carrying capacities (full nailing)

number of nails $n_H = 26$ $n_N = 14$
form factors $k_{H1} = 40.40$ $k_{H2} = 36.70$
material safety factors $\gamma_{M,timber} = 1.30$ $\gamma_{M,steel} = 1.10$ $\gamma_{M,calc} = 1.00$

transversely load-carrying capacity ($R_{2,d}$) (1)

$e_N = 110.00 \text{ mm}$ $R = 67.50 \text{ mm}$
 $F_{2,d} = 0.00 \text{ kN}$ $R_{2,d} = 5.61 \text{ kN}$ $F_{2,d} / R_{2,d} = 0.00 \leq 1.00$ verification successful

load-carrying capacity for load towards base plate ($R_{1,d}$) (2)

$F_{1,d} = 1.00 \text{ kN}$ $R_{1,d} = 17.18 \text{ kN}$ $F_{1,d} / R_{1,d} = 0.06 \leq 1.00$ verification successful

load-carrying capacity for load away from base plate ($R_{1a,d}$) (3)

$F_{1a,d} = 0.00 \text{ kN}$ $R_{1a,d} = 16.07 \text{ kN}$ $F_{1a,d} / R_{1a,d} = 0.00 \leq 1.00$ verification successful

verification of interaction (4 + 5)

$(F_{1,d} / R_{1,d})^2 + (F_{2,d} / R_{2,d})^2$ verification not required
 $(F_{1a,d} / R_{1a,d})^2 + (F_{2,d} / R_{2,d})^2$ verification not required

verification of splitting capacity (6)

For $a/H_H = 0.594 \leq 0.7$ verif. of splitting capacity is required. Acc. to DIN 1052:2008-12, par. 11.1.5 the following requirement should be satisfied: $F_{90,d} / R_{90,d} \leq 1.0$

$F_{90,d}$ design value of the force component perpendicular to grain

$R_{90,d}$ design splitting capacity of the beams

$R_{90,d} = k_s \cdot k_r \cdot (6.5 + 18 \cdot a^2 / H_H^2) \cdot (t_{ef} \cdot H_H)^{0.8} \cdot f_{t,90,d}$

verifications

$a = 190.0 \text{ mm}$ $H_H = 320.0 \text{ mm}$ $a/H_H = 0.594$ $a_r = 189.0 \text{ mm}$ $t_{ef} = 33.0 \text{ mm}$
 $h_1 = 130.0 \text{ mm}$ $k_s = 1.527$ $k_r = 1.893$ $l_{Ag} = 189.0 \text{ mm}$ $k_g = 0.648$
 $f_{t,90,k} = 0.400 \text{ N/mm}^2$ $f_{t,90,d} = 0.440 \text{ N/mm}^2$ $F_{90,d} = 1.00 \text{ kN}$ $R_{90,d} = 13.48 \text{ kN}$
 $F_{90,d} / R_{90,d} = 1.00 / 13.48 = 0.07 \leq 1.0$ verification successful

LK5: all verifications successful.

summary

maximum utilization max U = 0.61
decisive load combination 1, verification 6