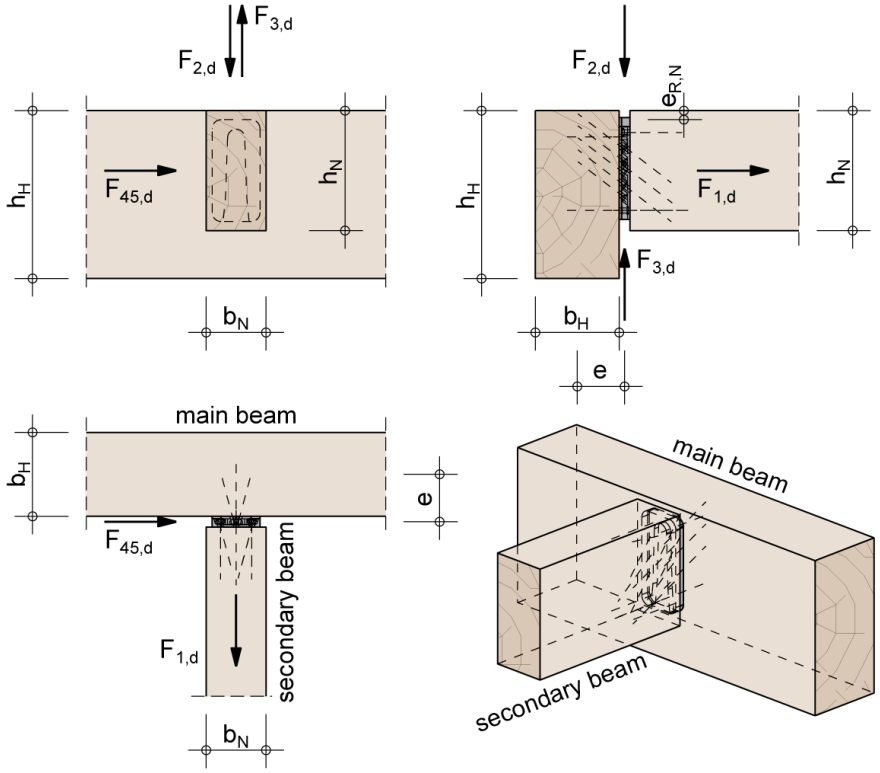
Verification Sherpa-Connector

according to ETA-12/0067 of 17 September 2019

Connection & Geometry

one-sided connection, secondary beam top edge, level



Installation situation:

The main beam is sufficiently secured against twisting.

Components:

secondary beam b_N/h_N:	140/440 mm	laminated timber, GL24c (ρ_k = 365 kg/m^3)
main beam b_H/h_H:	160/440 mm	laminated timber, GL24c (ρ_k = 365 kg/m^3)
Sherpa-Connector:	**XL 100**	dimensions: 20/120/370 mm
		edge distance $e_{R,N}$: 55.0 mm
screws:	25 pcs. 8.0 x 160 mm	
	2 pcs. 6.0 x 100 mm	(locking screws for stress $F_{3,d}$)

Loads

Service class	NKL1 - heated interiors			
$F_{1,d}$ =	10.00 kN	KLED: medium	k_{mod}:	0.80
$F_{2,d}$ =	55.00 kN	KLED: short	k_{mod}:	0.90
$F_{3,d}$ =	14.00 kN	KLED: short	k_{mod}:	0.90
$F_{45,d}$ =	1.00 kN	KLED: short	k_{mod}:	0.90

Verification:	$1.00 \leq 1.00$	**Verification fulfilled**

Annotations

This calculation provides the verification of the Sherpa-connector. The connected main and secondary beams are not included.

Calculation

Shear stress analysis of secondary beam

Capacity:

$f_{v,k} = 3.50$ N/mm^2

$f_{v,d} = k_{mod} * \frac{f_{v,k}}{\gamma_M} = 0.90 * \frac{3.50}{1.30} = 2.42$ N/mm^2

$i = 0$ mm

$\alpha = \frac{h_{ef}}{h_N} = \frac{400}{440} = 0.91$

Schraubenlänge $l = 160$ mm

$x = \frac{l}{2} = \frac{160}{2} = 80.00$ mm (ETA)

$k_n = 6.5$ (6.63)

$$k_v = min \begin{Bmatrix} 1 \\ \frac{k_n * \left(1 + \frac{1.1 * i^{1.5}}{\sqrt{h_N}}\right)}{\sqrt{h_N} * \left(\sqrt{\alpha * (1-\alpha)} + 0.8 * \frac{x}{h_N} * \sqrt{\frac{1}{\alpha} - \alpha^2}\right)} \end{Bmatrix}$$ (6.62)

$$= min \begin{Bmatrix} 1 \\ \frac{6.5 * \left(1 + \frac{1.1 * 0^{1.5}}{\sqrt{440}}\right)}{\sqrt{440} * \left(\sqrt{0.91 * (1-0.91)} + 0.8 * \frac{80.00}{440} * \sqrt{\frac{1}{0.91} - 0.91^2}\right)} = 0.86 \end{Bmatrix}$$

$= 0.86$

Load:

$k_{cr} = \frac{2.5}{f_{v,k}} = \frac{2.5}{3.50} = 0.71$

$h_{ef} = h_N - h_{1,N} = 440 - 40 = 400$ mm

$A_{ef} = k_{cr} * b_N * h_{ef} = 0.71 * 140 * 400 * 10^{-2} = 397.60$ cm²

$\tau_d = 1.5 * \frac{V_{z,d}}{A_{ef}} = 1.5 * \frac{F_{2,d}}{A_{ef}} = 1.5 * \frac{55.00 * 10^3}{397.60 * 10^2} = 2.07$ N/mm²

Shear stress analysis of secondary beam:	$\frac{\tau_d}{k_v * f_{v,d}} = \frac{2.07}{0.86 * 2.42} =$	$1.00 \leq 1.00$

Verification of connector in force direction 1

$R_{1,Tab,k} = 62.3 * \frac{350}{380} = 57.38$ kN - Sherpa Connector Type XL 100

Taking into account deviations of bulk density according to ETA-12/0067, Annex 5:

$k_{sys} = 1.15$

$k_{dens} = k_{sys} * \left(\frac{\rho_k}{350}\right)^{0.8} = 1.15 * \left(\frac{365}{350}\right)^{0.8} = 1.19$

$R_{1,k} = k_{dens} * R_{1,Tab,k} = 1.19 * 57.38 = 68.28$ kN

$R_{1,d} = k_{mod} * \frac{R_{1,k}}{\gamma_M} = 0.80 * \frac{68.28}{1.30} = 42.02$ kN

Verification of connector in force direction 1:	$\frac{F_{1,d}}{R_{1,d}} = \frac{10.00}{42.02} =$	$0.24 \leq 1.00$

Verification of connector in force direction 2

The main beam is sufficiently secured against twisting in and against the direction of insertion. The calculation takes this installation situation into account.
characteristic load capacity of connector according to ETA-12/0067, Annex 5:

$R_{2,Tab,k} = 88.20$ kN - Sherpa Connector Type XL 100

Taking into account deviations of bulk density according to ETA-12/0067, Annex 5:

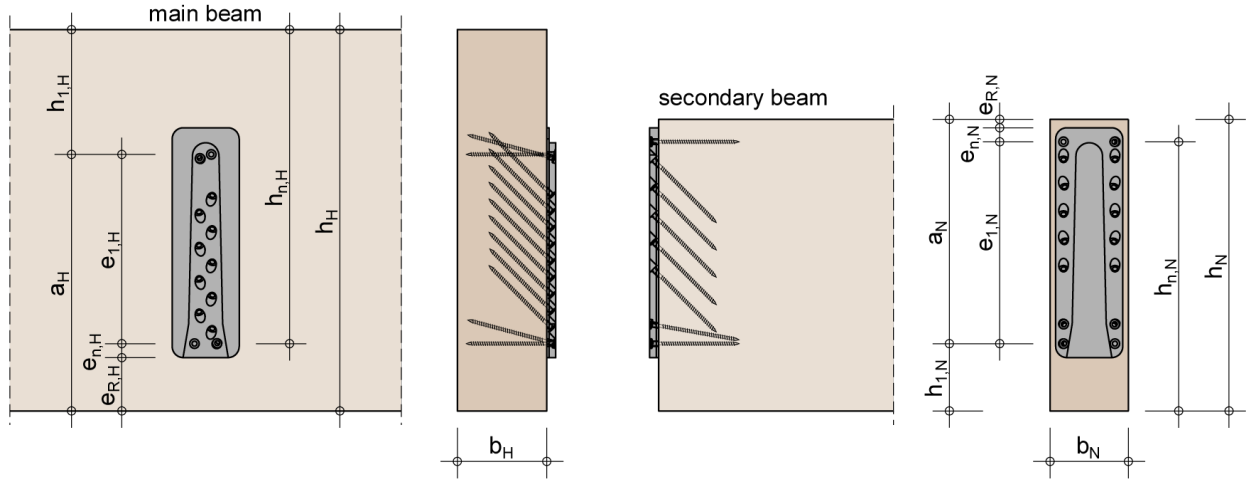
$k_{sys} = 1.15$

$k_{dens} = k_{sys} * \left(\frac{\rho_k}{350}\right)^{0.8} = 1.15 * \left(\frac{365}{350}\right)^{0.8} = 1.19$

$R_{2,k} = k_{dens} * R_{2,Tab,k} = 1.19 * 88.20 = 104.96$ kN

$R_{2,d} = k_{mod} * \frac{R_{2,k}}{\gamma_M} = 0.90 * \frac{104.96}{1.30} = 72.66$ kN

Verification of connector in force direction 2:	$\frac{F_{2,d}}{R_{2,d}} = \frac{55.00}{72.66} =$	$0.76 \leq 1.00$



Control of a/h-values for main and secondary beam (load direction 2)

main beam:		**secondary beam:**	
b_H:	160 mm	b_N:	140 mm
h_H:	440 mm	h_N:	440 mm
$e_{R,H}$:	15 mm	$e_{R,N}$:	55.0 mm
$e_{n,H}$:	25.0 mm	$e_{n,N}$:	25.0 mm
$e_{1,H}$:	297.5 mm	$e_{1,N}$:	320.0 mm
$h_{1,H}$:	102.5 mm	$h_{1,N}$:	40.0 mm
a_H:	337.5 mm	a_N:	400.0 mm

$$\frac{a_H}{h_H} = \frac{337.5}{440} = 0.77 > 0.70$$

In main beam proof of tension perpendicular to grain for load direction 2 is not required.

Verification of connector in force direction 3

The main beam is sufficiently secured against twisting in and against the direction of insertion. The calculation takes this installation situation into account.

$R_{3,k} = 40.60$ kN - Sherpa Connector Type XL 100

$$R_{3,d} = k_{mod} * \frac{R_{3,k}}{\gamma_M} = 0.90 * \frac{40.60}{1.30} = 28.11 \text{ kN}$$

Verification of connector in force direction 3:	$\frac{F_{3,d}}{R_{3,d}} = \frac{14.00}{28.11}$ =	$0.50 \leq 1.00$

Control of a/h-values for main and secondary beam (load direction 3)

main beam:		**secondary beam:**	
$h_{n,H}$:	400.0 mm	$h_{n,N}$:	360.0 mm

$$\frac{h_{n,H}}{h_H} = \frac{400.0}{440} = 0.91 > 0.70$$

In main beam proof of tension perpendicular to grain for load direction 3 is not required.

$$\frac{h_{n,N}}{h_N} = \frac{360.0}{440} = 0.82 > 0.70$$

In secondary beam proof of tension perpendicular to grain for load direction 3 is not required.

Verification of connector in force direction 45

The main beam is sufficiently secured against twisting perpendicular to the direction of insertion. The calculation takes this installation situation into account.
characteristic load capacity of connector according to ETA-12/0067, Annex 5:

$R_{45,Tab,k} = 34.90$ kN - Sherpa Connector Type XL 100

Taking into account deviations of bulk density according to ETA-12/0067, Annex 5:

$$k_{dens} = \left(\frac{\rho_k}{350}\right)^{0.5} = \left(\frac{365}{350}\right)^{0.5} = 1.02$$

$$R_{45,k} = k_{dens} * R_{45,Tab,k} = 1.02 * 34.90 = 35.60 \text{ kN}$$

$$R_{45,d} = k_{mod} * \frac{R_{45,k}}{\gamma_M} = 0.90 * \frac{35.60}{1.30} = 24.65 \text{ kN}$$

Verification of connector in force direction 45:	$\frac{F_{45,d}}{R_{45,d}} = \frac{1.00}{24.65} =$	$0.04 \leq 1.00$

combined strain on the connector

$$\left(\frac{F_{2,d}}{R_{2,d}}\right)^2 + \left(\frac{F_{45,d}}{R_{45,d}}\right)^2 + \left(\frac{F_{1,d}}{R_{1,d}}\right)^2 = \left(\frac{55.00}{72.66}\right)^2 + \left(\frac{1.00}{24.65}\right)^2 + \left(\frac{10.00}{42.02}\right)^2$$
$$= 0.58 + 0.00 + 0.06$$
$$= 0.64$$

combined strain on the connector:	$0.64 \leq 1.00$

Compilation of results

Shear stress analysis of secondary beam:	$\frac{\tau_d}{k_v * f_{v,d}} = \frac{2.07}{0.86 * 2.42}$ =	$1.00 \leq 1.00$
Verification of connector in force direction 1:	$\frac{F_{1,d}}{R_{1,d}} = \frac{10.00}{42.02}$ =	$0.24 \leq 1.00$
Verification of connector in force direction 2:	$\frac{F_{2,d}}{R_{2,d}} = \frac{55.00}{72.66}$ =	$0.76 \leq 1.00$
Verification of connector in force direction 3:	$\frac{F_{3,d}}{R_{3,d}} = \frac{14.00}{28.11}$ =	$0.50 \leq 1.00$
Verification of connector in force direction 45:	$\frac{F_{45,d}}{R_{45,d}} = \frac{1.00}{24.65}$ =	$0.04 \leq 1.00$
combined strain on the connector:		$0.64 \leq 1.00$

Verification:	$1.00 \leq 1.00$	**Verification fulfilled**

Applied standards

DIN EN 14080:2013-09	Timber structures - Glued laminated timber
DIN EN 1995-1-1:2010-12	Eurocode 5: Design of timber structures , Part 1-1
DIN EN 1995-1-1/A2:2014-07	
DIN EN 1995-1-1/NA:2013-08	National Annex - Nationally determined parameters - EC5
ETA-12/0067 of 17 September 2019	Sherpa XS, S, M, L, XL und XXL