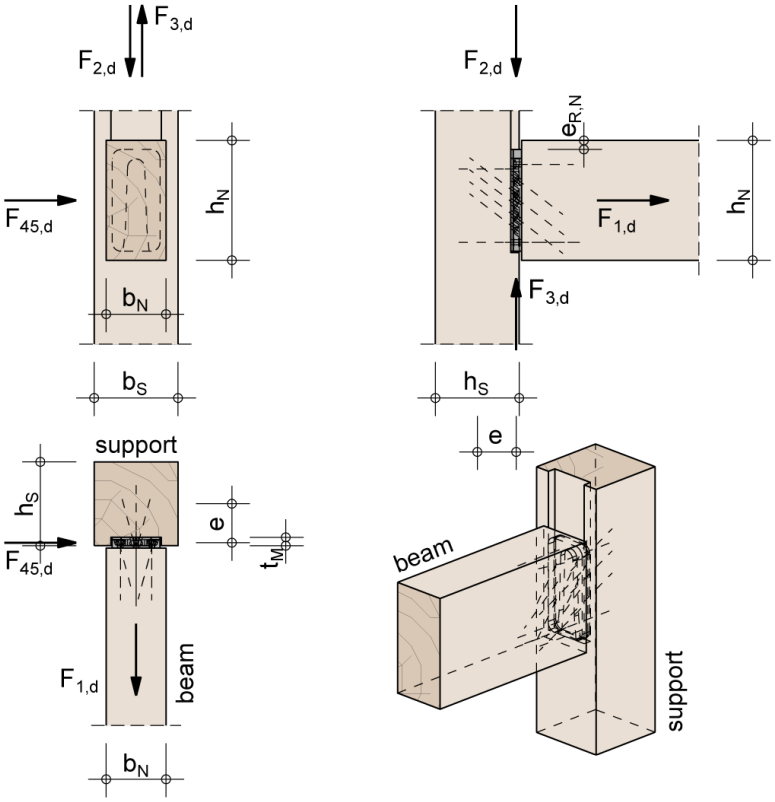
Verification Sherpa-Connector

according to ETA-12/0067 of 17 September 2019

Connection & Geometry

one-sided connection



Installation situation:

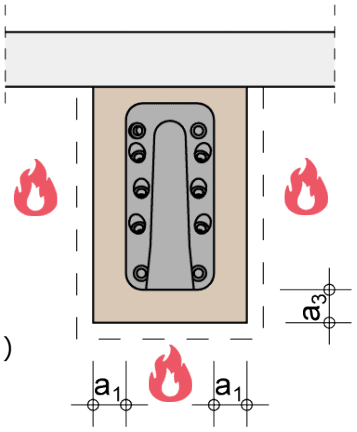
The support is sufficiently secured against twisting.

Components:

secondary beam b_N/h_N:	160/520 mm	laminated timber, GL24c (ρ_k = 365 kg/m^3)
support b_S/h_S:	200/360 mm	laminated timber, GL24h (ρ_k = 385 kg/m^3)
Sherpa-Connector:	**L 120**	dimensions: 18/80/370 mm
		edge distance $e_{R,N}$: 120.0 mm
screws:	37 pcs. 8.0 x 100 mm	milling depth t_M: 15 mm

Fire protection:

Classification:	R30
Erosion:	3 sided
a_1:	40.0 mm
a_3:	30.0 mm
η:	0.44 (ETA-12/0067)
k_{fi}:	1.05 (DIN EN 1995-1-2, Tab. 2.1)



Milling of connector in support

Loads

Service class	NKL1 - heated interiors		
$F_{1,d}$ =	10.00 kN	KLED: medium	k_{mod}: 0.80
$F_{2,d}$ =	72.00 kN	KLED: short	k_{mod}: 0.90

Loads in case of fire:

$F_{1,d,t,fi}$ =	6.00 kN	$k_{mod,fi}$: 1.00
$F_{2,d,t,fi}$ =	43.20 kN	

Verification:	$0.96 \leq 1.00$	**Verification fulfilled**

Annotations

This calculation provides the verification of the Sherpa-connector. The connected support and secondary beam 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

$\alpha = \frac{h_{ef}}{h_N} = \frac{475}{520} = 0.91$

Schraubenlänge $l = 100$ mm

$$x = \frac{l}{2} = \frac{100}{2} = 50.00 \text{ mm} \quad \text{(ETA)}$$

$$k_n = 6.5 \quad \text{(6.63)}$$

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

$$= min \begin{Bmatrix} 1 \\ \dfrac{6.5 * \left(1 + \dfrac{1.1 * 0^{1.5}}{\sqrt{520}}\right)}{\sqrt{520} * \left(\sqrt{0.91 * (1-0.91)} + 0.8 * \dfrac{50.00}{520} * \sqrt{\dfrac{1}{0.91} - 0.91^2}\right)} \end{Bmatrix} = 0.87$$

$$= 0.87$$

Load:

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

$$h_{ef} = h_N - h_{1,N} = 520 - 45 = 475 \text{ mm}$$

$$A_{ef} = k_{cr} * b_N * h_{ef} = 0.71 * 160 * 475 * 10^{-2} = 539.60 \text{ cm}^2$$

$$\tau_d = 1.5 * \frac{V_{z,d}}{A_{ef}} = 1.5 * \frac{F_{2,d}}{A_{ef}} = 1.5 * \frac{72.00 * 10^3}{539.60 * 10^2} = 2.00 \text{ N/mm}^2$$

Shear stress analysis of secondary beam:	$\frac{\tau_d}{k_v * f_{v,d}} = \frac{2.00}{0.87 * 2.42} =$	$0.95 \leq 1.00$
Shear stress analysis of secondary beam in case of fire must be provided separately!		

Verification of connector in force direction 1

$R_{1,Tab,k} = 63.80 = 63.80$ kN - Sherpa Connector Type L 120

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

$k_{sys} = 1.15$

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

$$R_{1,k} = k_{dens} * R_{1,Tab,k} = 1.19 * 63.80 = 75.92 \text{ kN}$$

$$R_{1,d} = k_{mod} * \frac{R_{1,k}}{\gamma_M} = 0.80 * \frac{75.92}{1.30} = 46.72 \text{ kN}$$

Stress resistance in case of fire according to DIN EN 1995-1-2:2010-12:

$$R_{1,d,t,fi} = \eta * \frac{k_{fi} * R_{1,k}}{\gamma_{M,fi}} = 0.44 * \frac{1.05 * 75.92}{1.00} = 35.08 \text{ kN}$$

Verification of connector in force direction 1:	$\frac{F_{1,d}}{R_{1,d}} = \frac{10.00}{46.72} =$	$0.21 \leq 1.00$
	$\frac{F_{1,d,t,fi}}{R_{1,d,t,fi}} = \frac{6.00}{35.08} =$	$0.17 \leq 1.00$

Verification of connector in force direction 2

The support 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:

$R_{2,Tab,k} = 90.80$ kN - Sherpa Connector Type L 120

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

$k_{sys} = 1.15$

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

$R_{2,k} = k_{dens} * R_{2,Tab,k} = 1.19 * 90.80 = 108.05$ kN

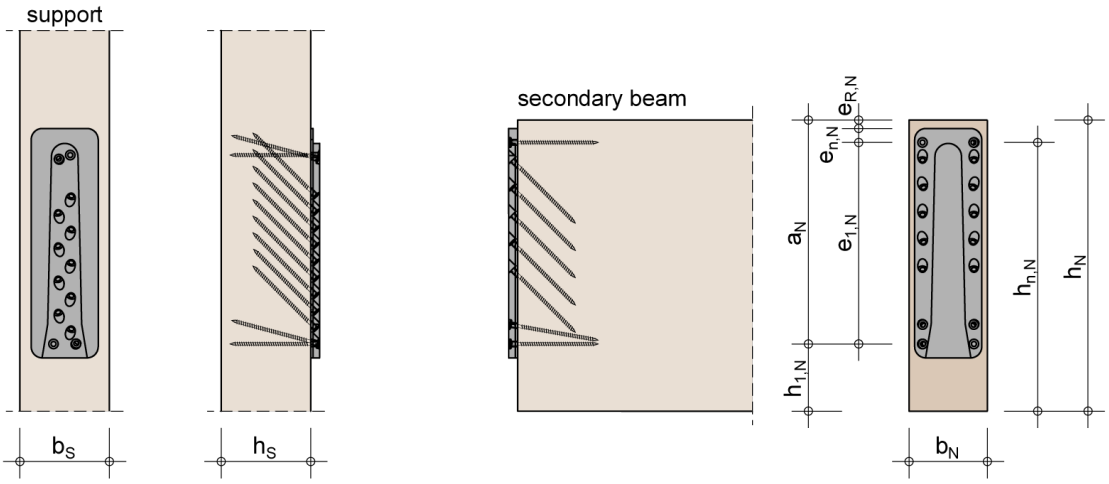
$R_{2,d} = k_{mod} * \frac{R_{2,k}}{\gamma_M} = 0.90 * \frac{108.05}{1.30} = 74.80$ kN

Stress resistance in case of fire according to DIN EN 1995-1-2:2010-12:

$R_{2,d,t,fi} = \eta * \frac{k_{fi} * R_{2,k}}{\gamma_{M,fi}} = 0.44 * \frac{1.05 * 108.05}{1.00} = 49.92$ kN

Verification of connector in force direction 2:	$\frac{F_{2,d}}{R_{2,d}} = \frac{72.00}{74.80}$ =	$0.96 \leq 1.00$
	$\frac{F_{2,d,t,fi}}{R_{2,d,t,fi}} = \frac{43.20}{49.92}$ =	$0.87 \leq 1.00$

Control of a/h-values for support und secondary beam (load direction 2)



support:		**secondary beam:**	
b_S:	200 mm	b_N:	160 mm
h_S:	360 mm	h_N:	520 mm
		$e_{R,N}$:	120.0 mm
		$e_{n,N}$:	25.0 mm
		$e_{1,N}$:	330.0 mm
		$h_{1,N}$:	45.0 mm
		a_N:	475.0 mm

combined strain on the connector

$$\left(\frac{F_{2,d}}{R_{2,d}}\right)^2 + \left(\frac{F_{45,d}}{R_{45,d}}\right)^2 + \left(\frac{F_{1,d}}{R_{1,d}}\right)^2 = \left(\frac{72.00}{74.80}\right)^2 + \left(\frac{0.00}{22.38}\right)^2 + \left(\frac{10.00}{46.72}\right)^2$$
$$= 0.92 + 0.00 + 0.04$$
$$= 0.96$$

$$\left(\frac{F_{2,d,t,fi}}{R_{2,d,t,fi}}\right)^2 + \left(\frac{F_{45,d,t,fi}}{R_{45,d,t,fi}}\right)^2 + \left(\frac{F_{1,d,t,fi}}{R_{1,d,t,fi}}\right)^2 = \left(\frac{43.20}{49.92}\right)^2 + \left(\frac{0.00}{14.94}\right)^2 + \left(\frac{6.00}{35.08}\right)^2$$
$$= 0.76 + 0.00 + 0.03$$
$$= 0.79$$

combined strain on the connector:	$0.96 \leq 1.00$

Compilation of results

Shear stress analysis of secondary beam:	$\frac{\tau_d}{k_v * f_{v,d}} = \frac{2.00}{0.87 * 2.42} =$	$0.95 \leq 1.00$
Verification of connector in force direction 1:	$\frac{F_{1,d}}{R_{1,d}} = \frac{10.00}{46.72} =$	$0.21 \leq 1.00$
	$\frac{F_{1,d,t,fi}}{R_{1,d,t,fi}} = \frac{6.00}{35.08} =$	$0.17 \leq 1.00$
Verification of connector in force direction 2:	$\frac{F_{2,d}}{R_{2,d}} = \frac{72.00}{74.80} =$	$0.96 \leq 1.00$
	$\frac{F_{2,d,t,fi}}{R_{2,d,t,fi}} = \frac{43.20}{49.92} =$	$0.87 \leq 1.00$
combined strain on the connector:		$0.96 \leq 1.00$

Verification:	$0.96 \leq 1.00$	**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