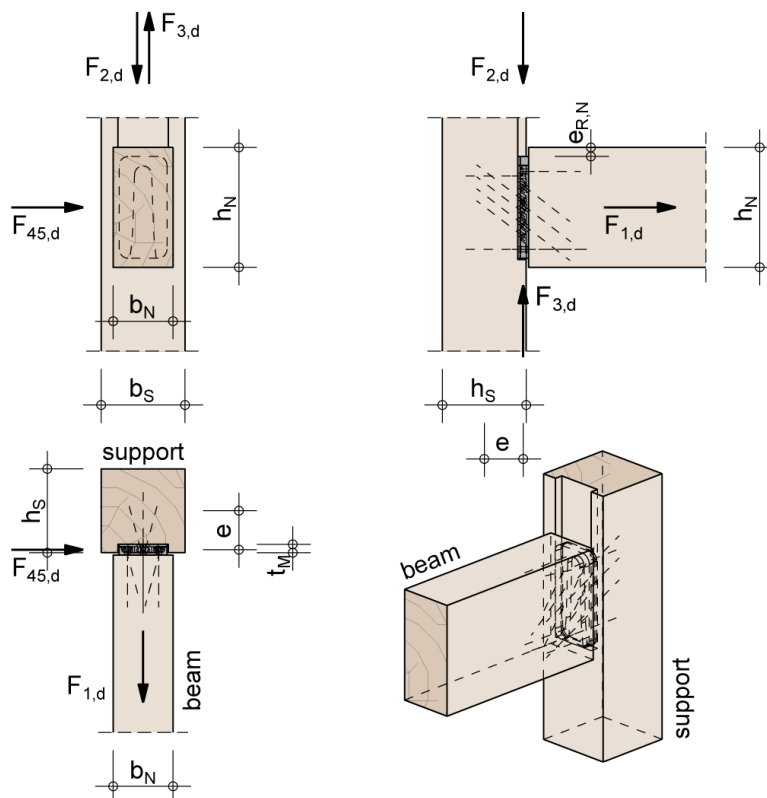


## Verification Sherpa-Connector

according to ETA-12/0067 of 17 September 2019

### Connection & Geometry

one-sided connection



#### Installation situation:

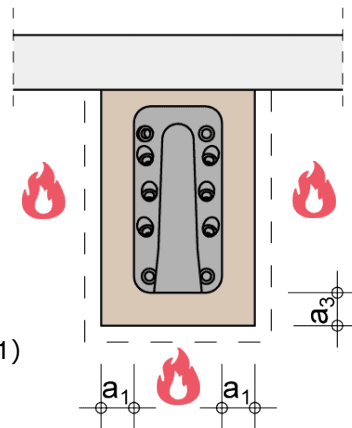
The support is sufficiently secured against twisting.

#### Components:

secondary beam $b_N/h_N$ :	160/520 mm	laminated timber, GL24c ( $\rho_k = 365 \text{ kg/m}^3$ )
support $b_S/h_S$ :	200/360 mm	laminated timber, GL24h ( $\rho_k = 385 \text{ kg/m}^3$ )
<b>Sherpa-Connector:</b>	<b>L 120</b>	dimensions: 18/80/370 mm
		edge distance $e_{R,N}$ : 75.0 mm
screws:	37 pcs. 8.0 x 120 mm	milling depth $t_M$ : 15 mm

**Fire protection:**

Classification:	R30
Erosion:	3 sided
$a_1$ :	40.0 mm
$a_3$ :	75.0 mm
$\eta$ :	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
$F_{2,d}$ =	90.00 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
$F_{2,d,t,fi}$ =	54.00 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:

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

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

Load:

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

$$A_{ef} = k_{cr} * b_N * h_N = 0.71 * 160 * 520 * 10^{-2} = 590.72 \text{ cm}^2$$

$$\tau_d = 1.5 * \frac{V_{z,d}}{A_{ef}} = 1.5 * \frac{F_{2,d}}{A_{ef}} = 1.5 * \frac{90.00 * 10^3}{590.72 * 10^2} = 2.29 \text{ N/mm}^2$$

Shear stress analysis of secondary beam:	$\frac{\tau_d}{f_{v,d}} = \frac{2.29}{2.42} =$	$0.95 \leq 1.00$
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Shear stress analysis of secondary beam in case of fire must be provided separately!

### Verification of connector in force direction 1

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

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

$$k_{sys} = 1.15$$

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

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

$$n_s = 1.25 - \text{Sherpa Schraube 8.0 x 120 mm}$$

$$R_{1,k} = k_{dens} * n_s * R_{1,Tab,k} = 1.19 * 1.25 * 63.80 = 94.90 \text{ kN}$$

$$R_{1,d} = k_{mod} * \frac{R_{1,k}}{\gamma_M} = 0.80 * \frac{94.90}{1.30} = 58.40 \text{ kN}$$

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

$$R_{1,d,t,fi} = \eta * \frac{k_{fi} * R_{1,k}}{\gamma_{M,fi}} = 0.44 * \frac{1.05 * 94.90}{1.00} = 43.84 \text{ kN}$$

Verification of connector in force direction 1:	$\frac{F_{1,d}}{R_{1,d}} = \frac{10.00}{58.40} =$	$0.17 \leq 1.00$
	$\frac{F_{1,d,t,fi}}{R_{1,d,t,fi}} = \frac{6.00}{43.84} =$	$0.14 \leq 1.00$

### 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:

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

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

$$k_{sys} = 1.15$$

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

$$n_s = 1.25 - \text{Sherpa Schraube 8.0 x 120 mm}$$

$$R_{2,k} = k_{dens} * n_S * R_{2,Tab,k} = 1.19 * 1.25 * 90.80 = 135.06 \text{ kN}$$

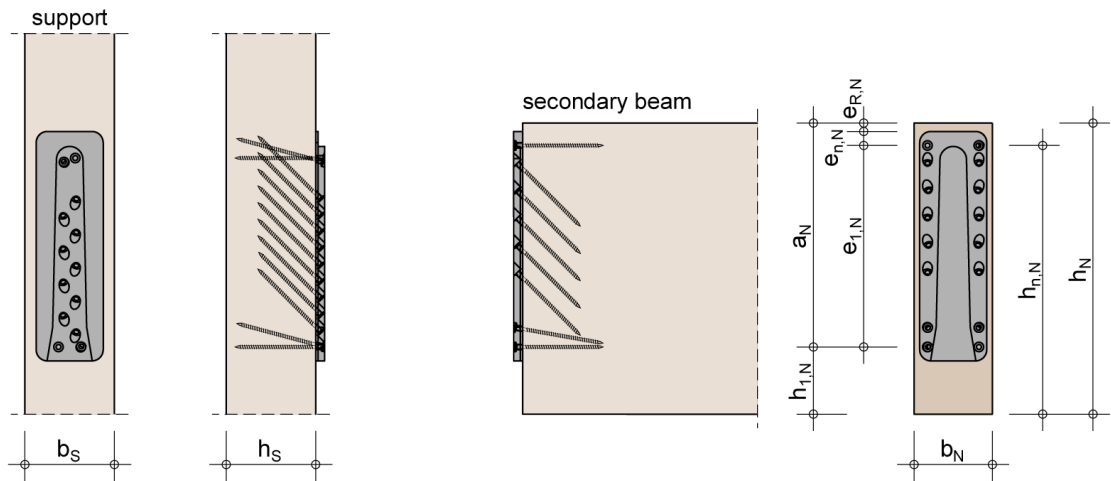
$$R_{2,d} = k_{mod} * \frac{R_{2,k}}{\gamma_M} = 0.90 * \frac{135.06}{1.30} = 93.50 \text{ kN}$$

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

$$R_{2,d,t,fi} = \eta * \frac{k_{fi} * R_{2,k}}{\gamma_{M,fi}} = 0.44 * \frac{1.05 * 135.06}{1.00} = 62.40 \text{ kN}$$

Verification of connector in force direction 2:	$\frac{F_{2,d}}{R_{2,d}} = \frac{90.00}{93.50} =$	$0.96 \leq 1.00$
	$\frac{F_{2,d,t,fi}}{R_{2,d,t,fi}} = \frac{54.00}{62.40} =$	$0.87 \leq 1.00$

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



**support:**

$b_S$ :	200 mm
$h_S$ :	360 mm

**secondary beam:**

$b_N$ :	160 mm
$h_N$ :	520 mm
$e_{R,N}$ :	75.0 mm
$e_{n,N}$ :	25.0 mm
$e_{1,N}$ :	330.0 mm
$h_{1,N}$ :	90.0 mm
$a_N$ :	430.0 mm

$$\frac{a_N}{h_N} = \frac{430.0}{520} = 0.83 > 0.70$$

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

**combined strain on the connector**

$$\left(\frac{F_{2,d}}{R_{2,d}}\right)^2 + \left(\frac{F_{45,d}}{R_{45,d}}\right)^2 + \left(\frac{F_{1,d}}{R_{1,d}}\right)^2 = \left(\frac{90.00}{93.50}\right)^2 + \left(\frac{0.00}{27.98}\right)^2 + \left(\frac{10.00}{58.40}\right)^2$$

$$= 0.92 + 0.00 + 0.03$$

$$= 0.95$$

$$\left(\frac{F_{2,d,t,fi}}{R_{2,d,t,fi}}\right)^2 + \left(\frac{F_{45,d,t,fi}}{R_{45,d,t,fi}}\right)^2 + \left(\frac{F_{1,d,t,fi}}{R_{1,d,t,fi}}\right)^2 = \left(\frac{54.00}{62.40}\right)^2 + \left(\frac{0.00}{18.67}\right)^2 + \left(\frac{6.00}{43.84}\right)^2$$

$$= 0.76 + 0.00 + 0.02$$

$$= 0.78$$

combined strain on the connector:	0.95 ≤ 1.00
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**Compilation of results**

Shear stress analysis of secondary beam:	$\frac{\tau_d}{f_{v,d}} = \frac{2.29}{2.42} =$	0.95 ≤ 1.00
Verification of connector in force direction 1:	$\frac{F_{1,d}}{R_{1,d}} = \frac{10.00}{58.40} =$	0.17 ≤ 1.00
	$\frac{F_{1,d,t,fi}}{R_{1,d,t,fi}} = \frac{6.00}{43.84} =$	0.14 ≤ 1.00
Verification of connector in force direction 2:	$\frac{F_{2,d}}{R_{2,d}} = \frac{90.00}{93.50} =$	0.96 ≤ 1.00
	$\frac{F_{2,d,t,fi}}{R_{2,d,t,fi}} = \frac{54.00}{62.40} =$	0.87 ≤ 1.00
combined strain on the connector:		0.95 ≤ 1.00

Verification:	0.96 ≤ 1.00	<b>Verification fulfilled</b>
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**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