Verification of HTC P2P-Connector

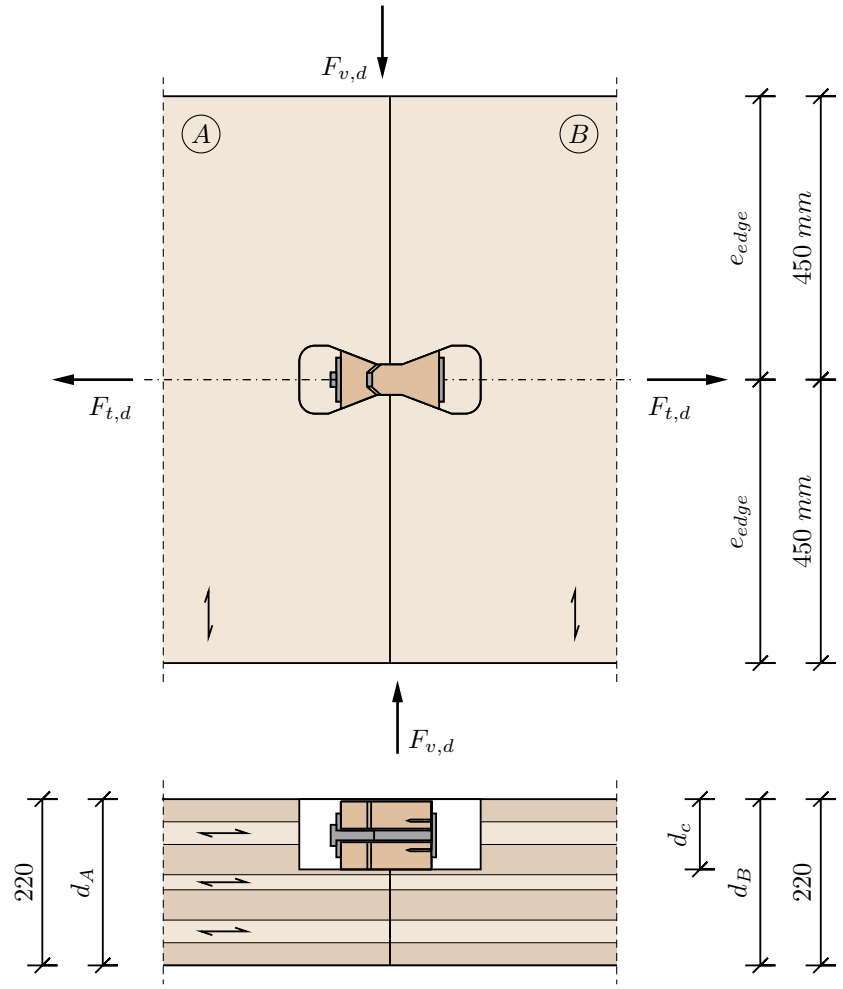
Connection & Geometry

Component A: CLT, cover layer parallel to the joint

Panel thickness d_A :	220 mm	material: C24
	7-layered	
Lamella structure:	|30| $\overline{30}$ |40| $\overline{20}$ |40| $\overline{30}$ |30|	

Component B: CLT, cover layer parallel to the joint

Panel thickness d_B :	220 mm	material: C24
	7-layered	
Lamella structure:	|30| $\overline{30}$ |40| $\overline{20}$ |40| $\overline{30}$ |30|	



Connector

Connector :	**HTC-P2P 90 M12**	No. of pieces n :	1 pcs.
Cut-out depth d_c:	93 mm	Height HTC-P2P d_e:	90 mm
e_{edge}:	450 mm		

Design module: T17 - HTC-P2P | version 1.0.0:1499 | www.ing-tools.de

Loads

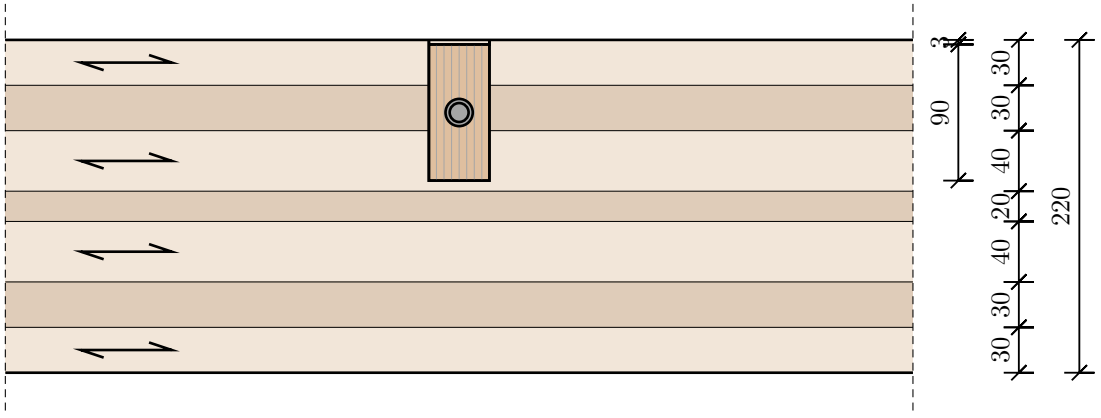
Service class	SC1 - heated interiors			
Load case: Static				
$F_{v,d}$ =	22.00 kN	LDC: short	k_{mod}:	0.90
$F_{t,d}$ =	8.00 kN	LDC: short	k_{mod}:	0.90
Load case: Fire				
$F_{v,d,fi}$ =	16.00 kN		$k_{mod,fi}$:	1.00
$F_{t,d,fi}$ =	8.00 kN		$k_{mod,fi}$:	1.00
$k_{mod,fi}$ according to FprEN 1995-1-2:2025 (E), 4.5 (4)				
Load case: Seismic				
$F_{v,Ed}$ =	30.00 kN	LDC: instantaneous	k_{mod}:	1.10
$F_{t,Ed}$ =	12.00 kN	LDC: instantaneous	k_{mod}:	1.10
k_{mod} according to EN 1995-1-1, Tab. 3.1				

Governing design verification:	$1.00 \leq 1.00$	**Verification fulfilled**

Design

Load on the connector in Component A on shear

Load case: Static and quasi-static loading



$$\beta = \frac{\sum t_p}{d_e} = \frac{27 + 33}{90} = 0.67$$ (ETA-24/1199)

$$R_{v,k} = 30.7 * \beta + 24.6 = 30.7 * 0.67 + 24.6 = 45.17 \text{ kN}$$ (ETA-24/1199)

$$k_{mod} = 0.90$$ (EN 1995-1-1, Tab. 3.1)

$$R_{v,d} = k_{mod} * \frac{R_{v,k}}{\gamma_M} = 0.90 * \frac{45.17}{1.30} = 31.27 \text{ kN}$$ (TR 085:2025-02, Eq. 4.3)

Design module: T17 - HTC-P2P | version 1.0.0:1499 | www.ing-tools.de

Verification on shear (Component A):	$\frac{F_{v,d}}{n * R_{v,d}} = \frac{22.00}{1 * 31.27}$ =	0.70 ≤ 1.00

Load case: Fire

$k_\theta = 1.0$ (TR 085:2025-02)

$k_{fi} = 1.10$ (FprEN 1995-1-2, Tab. 4.1)

$\gamma_{M,fi} = 1.0$ (FprEN 1995-1-2:2025 (E), 4.5)

$R_{v,d,fi} = k_\theta * k_{mod,fi} * \frac{k_{fi} * R_{v,k}}{\gamma_{M,fi}} = 1.0 * 1.00 * \frac{1.10 * 45.17}{1.0} = 49.69$ kN (TR 085:2025-02, Eq. 4.9)

Fire protection verifications apply if convection currents are prevented by cladding the cross laminated timber components on the unstressed side or by internal sealing measures in accordance with FprEN 1995-1-2, Section 10.4 (5).

Fire: Verification on shear (Component A):	$\frac{F_{v,d,fi}}{n * R_{v,d,fi}} = \frac{16.00}{1 * 49.69}$ =	0.32 ≤ 1.00

Load case: Seismic

HTC-P2P connector on shear (ductility class M), γ_M according to TR 085 4.4.2 and EN 1995-1-1, Tab. 2.3

$\gamma_M = 1.0$

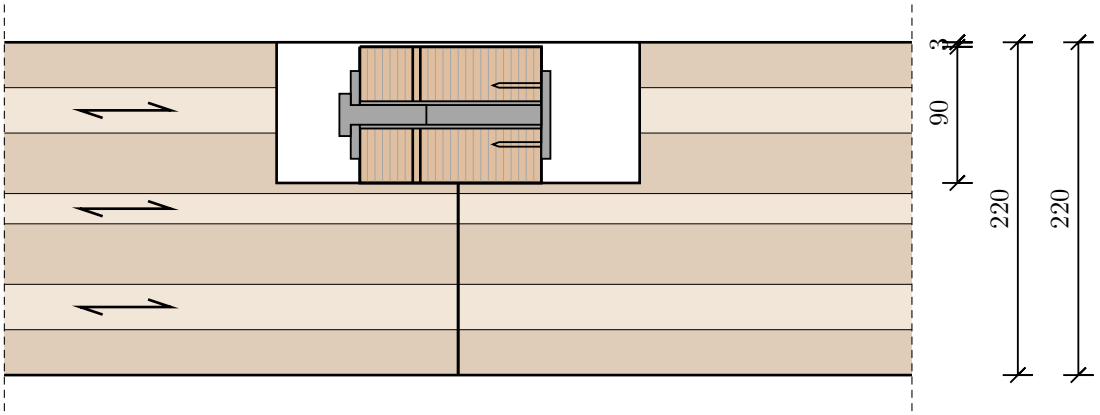
$\alpha_{v,seis} = 1.00$ (ETA-24/1199)

$R_{v,Ed} = k_{mod} * \alpha_{v,seis} * \frac{R_{v,k}}{\gamma_M} = 1.10 * 1.00 * \frac{45.17}{1.0} = 49.69$ kN (TR 085:2025-02, Eq. 4.6)

Seismic: Verification on shear (Component A):	$\frac{F_{v,Ed}}{n * R_{v,Ed}} = \frac{30.00}{1 * 49.69}$ =	0.60 ≤ 1.00

Load on the connector in Component A in tension

Load case: Static and quasi-static loading



$$\beta = \frac{\sum t_p}{d_e} = \frac{30}{90} = 0.33$$ (ETA-24/1199)

$$R_{t,k} = 39.3 \text{ kN}$$ (ETA-24/1199)

$$R_{t,d} = k_{mod} * \frac{R_{t,k}}{\gamma_M} = 0.90 * \frac{39.30}{1.30} = 27.21 \text{ kN}$$ (TR 085:2025-02, Eq. 4.2)

Verification in tension (Component A):	$\frac{F_{t,d}}{n * R_{t,d}} = \frac{8.00}{1 * 27.21} =$	$0.29 \leq 1.00$

Load case: Fire

$$k_\theta = 1.0$$ (TR 085:2025-02)

$$k_{fi} = 1.10$$ (FprEN 1995-1-2, Tab. 4.1)

$$\gamma_{M,fi} = 1.0$$ (FprEN 1995-1-2:2025 (E), 4.5)

$$R_{t,d,fi} = k_\theta * k_{mod,fi} * \frac{k_{fi} * R_{t,k}}{\gamma_{M,fi}} = 1.0 * 1.00 * \frac{1.10 * 39.30}{1.0} = 43.23 \text{ kN}$$ (TR 085:2025-02, Eq. 4.8)

Fire protection verifications apply if convection currents are prevented by cladding the cross laminated timber components on the unstressed side or by internal sealing measures in accordance with FprEN 1995-1-2, Section 10.4 (5).

Fire: Verification in tension (Component A):	$\frac{F_{t,d,fi}}{n * R_{t,d,fi}} = \frac{8.00}{1 * 43.23} =$	$0.19 \leq 1.00$

Load case: Seismic

HTC-P2P connector in tension (ductility class L), γ_M according to TR 085 4.4.2 and EN 1995-1-1, Tab. 2.3

$$\gamma_M = 1.3$$

$$\alpha_{t,seis} = 1.00$$ (ETA-24/1199)

$$R_{t,Ed} = k_{mod} * \alpha_{t,seis} * \frac{R_{t,k}}{\gamma_M} = 1.10 * 1.00 * \frac{39.30}{1.3} = 33.25 \text{ kN}$$ (TR 085:2025-02, Eq. 4.5)

Seismic: Verification in tension (Component A):	$\frac{F_{t,Ed}}{n * R_{t,Ed}} = \frac{12.00}{1 * 33.25} =$	$0.36 \leq 1.00$

Combined stress on the fastener in the component A

Load case: Static

$$\kappa = 1.00$$ (TR 085:2025-02)

$$\left(\frac{F_{v,d}}{n * R_{v,d}}\right)^\kappa + \left(\frac{F_{t,d}}{n * R_{t,d}}\right)^\kappa = \left(\frac{22.00}{1 * 31.27}\right)^{1.00} + \left(\frac{8.00}{1 * 27.21}\right)^{1.00} = 0.70 + 0.29 = 1.00$$

Combined forces (Component A):	$\left(\frac{F_{v,d}}{n * R_{v,d}}\right)^\kappa + \left(\frac{F_{t,d}}{n * R_{t,d}}\right)^\kappa =$	$1.00 \leq 1.00$

Load case: Fire

$$\kappa = 1.00$$ (TR 085:2025-02)

$$\left(\frac{F_{v,d,fi}}{n * R_{v,d,fi}}\right)^{\kappa} + \left(\frac{F_{t,d,fi}}{n * R_{t,d,fi}}\right)^{\kappa} = \left(\frac{16.00}{1 * 49.69}\right)^{1.00} + \left(\frac{8.00}{1 * 43.23}\right)^{1.00} = 0.32 + 0.19 = 0.51$$

Fire: Combined forces (A):	$\left(\frac{F_{v,d,fi}}{n * R_{v,d,fi}}\right)^{\kappa} + \left(\frac{F_{t,d,fi}}{n * R_{t,d,fi}}\right)^{\kappa} =$	$0.51 \leq 1.00$

Load case: Seismic

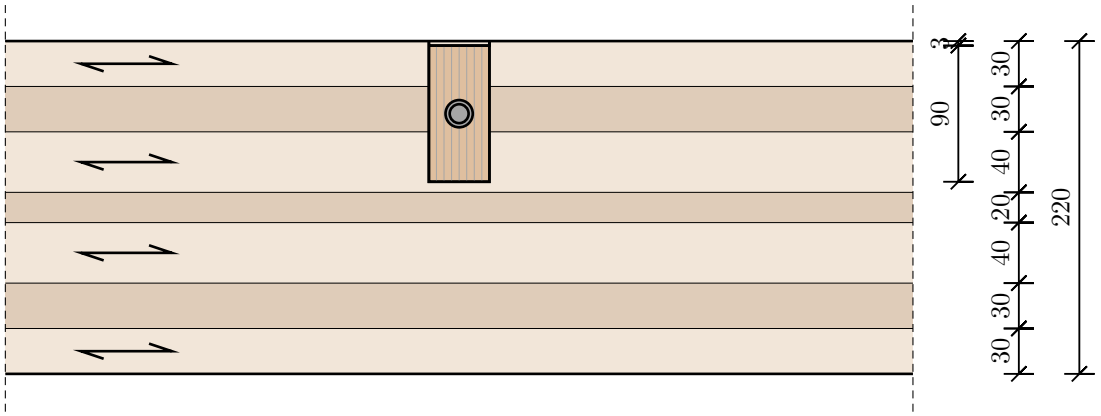
$\kappa = 1.00$ (TR 085:2025-02)

$$\left(\frac{F_{v,Ed}}{n * R_{v,Ed}}\right)^{\kappa} + \left(\frac{F_{t,Ed}}{n * R_{t,Ed}}\right)^{\kappa} = \left(\frac{30.00}{1 * 49.69}\right)^{1.00} + \left(\frac{12.00}{1 * 33.25}\right)^{1.00} = 0.60 + 0.36 = 0.96$$

Seismic: Combined forces (A):	$\left(\frac{F_{v,Ed}}{n * R_{v,Ed}}\right)^{\kappa} + \left(\frac{F_{t,Ed}}{n * R_{t,Ed}}\right)^{\kappa} =$	$0.96 \leq 1.00$

Load on the connector in Component B on shear

Load case: Static and quasi-static loading



$\beta = \frac{\sum t_p}{d_e} = \frac{27 + 33}{90} = 0.67$ (ETA-24/1199)

$R_{v,k} = 30.7 * \beta + 24.6 = 30.7 * 0.67 + 24.6 = 45.17$ kN (ETA-24/1199)

$k_{mod} = 0.90$ (EN 1995-1-1, Tab. 3.1)

$R_{v,d} = k_{mod} * \frac{R_{v,k}}{\gamma_M} = 0.90 * \frac{45.17}{1.30} = 31.27$ kN (TR 085:2025-02, Eq. 4.3)

Verification on shear (Component B):	$\frac{F_{v,d}}{n * R_{v,d}} = \frac{22.00}{1 * 31.27} =$	$0.70 \leq 1.00$

Load case: Fire

$k_\theta = 1.0$ (TR 085:2025-02)

$k_{fi} = 1.10$ (FprEN 1995-1-2, Tab. 4.1)

$\gamma_{M,fi} = 1.0$ (FprEN 1995-1-2:2025 (E), 4.5)

$R_{v,d,fi} = k_\theta * k_{mod,fi} * \frac{k_{fi} * R_{v,k}}{\gamma_{M,fi}} = 1.0 * 1.00 * \frac{1.10 * 45.17}{1.0} = 49.69$ kN (TR 085:2025-02, Eq. 4.9)

Design module: T17 - HTC-P2P | version 1.0.0:1499 | www.ing-tools.de

Fire protection verifications apply if convection currents are prevented by cladding the cross laminated timber components on the unstressed side or by internal sealing measures in accordance with FprEN 1995-1-2, Section 10.4 (5).

Fire: Verification on shear (Component B):	$\frac{F_{v,d,fi}}{n * R_{v,d,fi}} = \frac{16.00}{1 * 49.69} =$	$0.32 \leq 1.00$

Load case: Seismic

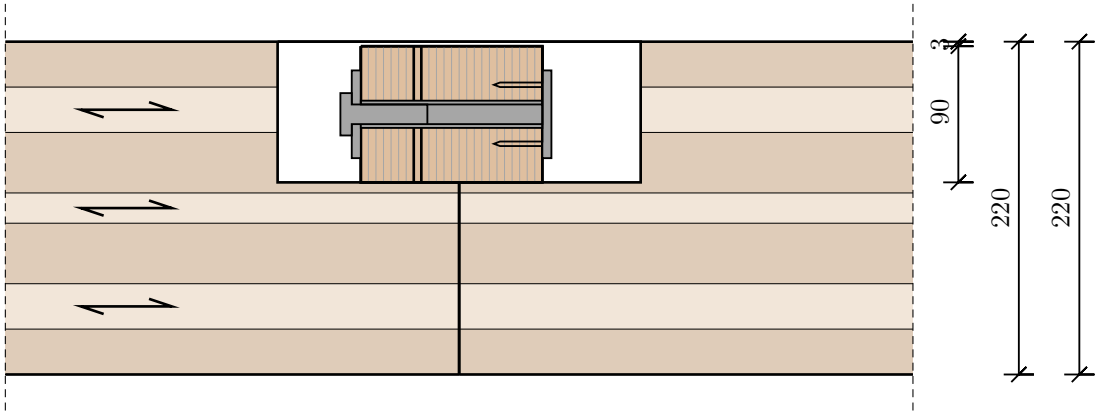
$\alpha_{v,seis} = 1.00$ (ETA-24/1199)

$R_{v,Ed} = k_{mod} * \alpha_{v,seis} * \frac{R_{v,k}}{\gamma_M} = 1.10 * 1.00 * \frac{45.17}{1.0} = 49.69$ kN (TR 085:2025-02, Eq. 4.6)

Seismic: Verification on shear (Component B):	$\frac{F_{v,Ed}}{n * R_{v,Ed}} = \frac{30.00}{1 * 49.69} =$	$0.60 \leq 1.00$

Load on the connector in Component B in tension

Load case: Static and quasi-static loading



$\beta = \frac{\sum t_p}{d_e} = \frac{30}{90} = 0.33$ (ETA-24/1199)

$R_{t,k} = 39.3$ kN (ETA-24/1199)

$R_{t,d} = k_{mod} * \frac{R_{t,k}}{\gamma_M} = 0.90 * \frac{39.30}{1.30} = 27.21$ kN (TR 085:2025-02, Eq. 4.2)

Verification in tension (Component B):	$\frac{F_{t,d}}{n * R_{t,d}} = \frac{8.00}{1 * 27.21} =$	$0.29 \leq 1.00$

Load case: Fire

$k_\theta = 1.0$ (TR 085:2025-02)

$k_{fi} = 1.10$ (FprEN 1995-1-2, Tab. 4.1)

$\gamma_{M,fi} = 1.0$ (FprEN 1995-1-2:2025 (E), 4.5)

Design module: T17 - HTC-P2P | version 1.0.0:1499 | www.ing-tools.de

$$R_{t,d,fi} = k_\theta * k_{mod,fi} * \frac{k_{fi} * R_{t,k}}{\gamma_{M,fi}} = 1.0 * 1.00 * \frac{1.10 * 39.30}{1.0} = 43.23 \text{ kN}$$ (TR 085:2025-02, Eq. 4.8)

Fire protection verifications apply if convection currents are prevented by cladding the cross laminated timber components on the unstressed side or by internal sealing measures in accordance with FprEN 1995-1-2, Section 10.4 (5).

Fire: Verification in tension (Component B):	$\frac{F_{t,d,fi}}{n * R_{t,d,fi}} = \frac{8.00}{1 * 43.23} =$	$0.19 \leq 1.00$

Load case: Seismic

$\alpha_{t,seis} = 1.00$ (ETA-24/1199)

$$R_{t,Ed} = k_{mod} * \alpha_{t,seis} * \frac{R_{t,k}}{\gamma_M} = 1.10 * 1.00 * \frac{39.30}{1.3} = 33.25 \text{ kN}$$ (TR 085:2025-02, Eq. 4.5)

Seismic: Verification in tension (Component B):	$\frac{F_{t,Ed}}{n * R_{t,Ed}} = \frac{12.00}{1 * 33.25} =$	$0.36 \leq 1.00$

Combined stress on the fastener in the component B

Load case: Static

$\kappa = 1.00$ (TR 085:2025-02)

$$\left(\frac{F_{v,d}}{n * R_{v,d}}\right)^\kappa + \left(\frac{F_{t,d}}{n * R_{t,d}}\right)^\kappa = \left(\frac{22.00}{1 * 31.27}\right)^{1.00} + \left(\frac{8.00}{1 * 27.21}\right)^{1.00} = 0.70 + 0.29 = 1.00$$

Combined forces (Component B):	$\left(\frac{F_{v,d}}{n * R_{v,d}}\right)^\kappa + \left(\frac{F_{t,d}}{n * R_{t,d}}\right)^\kappa =$	$1.00 \leq 1.00$

Load case: Fire

$\kappa = 1.00$ (TR 085:2025-02)

$$\left(\frac{F_{v,d,fi}}{n * R_{v,d,fi}}\right)^\kappa + \left(\frac{F_{t,d,fi}}{n * R_{t,d,fi}}\right)^\kappa = \left(\frac{16.00}{1 * 49.69}\right)^{1.00} + \left(\frac{8.00}{1 * 43.23}\right)^{1.00} = 0.32 + 0.19 = 0.51$$

Fire: Combined forces (B):	$\left(\frac{F_{v,d,fi}}{n * R_{v,d,fi}}\right)^\kappa + \left(\frac{F_{t,d,fi}}{n * R_{t,d,fi}}\right)^\kappa =$	$0.51 \leq 1.00$

Load case: Seismic

$\kappa = 1.00$ (TR 085:2025-02)

$$\left(\frac{F_{v,Ed}}{n * R_{v,Ed}}\right)^\kappa + \left(\frac{F_{t,Ed}}{n * R_{t,Ed}}\right)^\kappa = \left(\frac{30.00}{1 * 49.69}\right)^{1.00} + \left(\frac{12.00}{1 * 33.25}\right)^{1.00} = 0.60 + 0.36 = 0.96$$

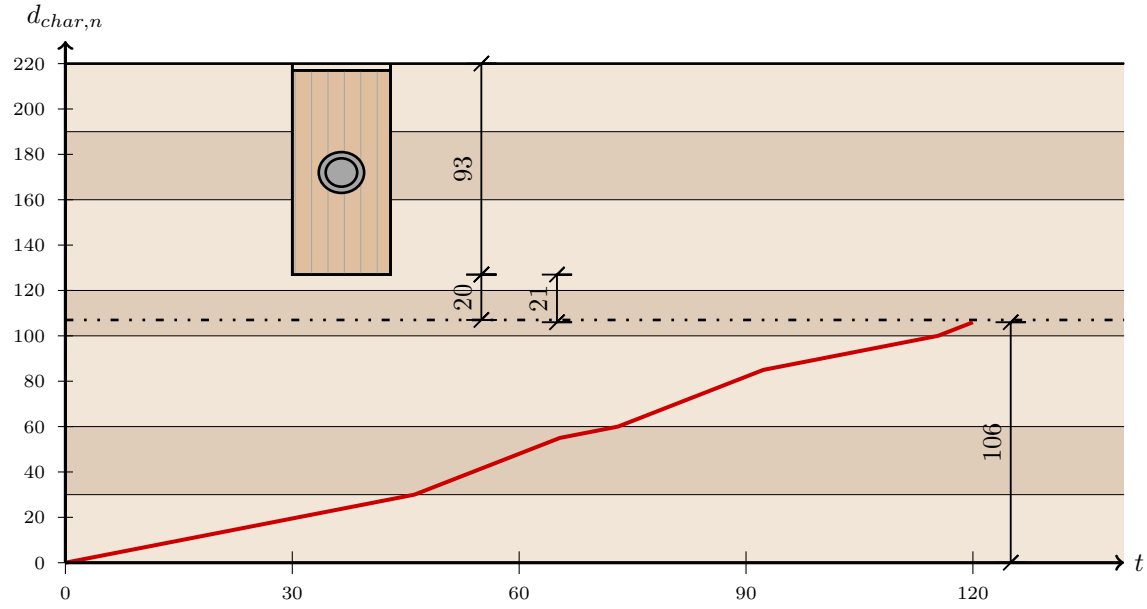
Seismic: Combined forces (B):	$\left(\frac{F_{v,Ed}}{n * R_{v,Ed}}\right)^\kappa + \left(\frac{F_{t,Ed}}{n * R_{t,Ed}}\right)^\kappa =$	$0.96 \leq 1.00$

Design module: T17 - HTC-P2P | version 1.0.0:1499 | www.ing-tools.de

Fire protection - R120

fire exposure:	R120 - burning from below		horizontal element
panelling:	unclad surface		
burn rates:	β_1 = 0.65 mm/min	β_2 = 1.30 mm/min	
	T_{start} = 0 min	d_{start} = 0 mm	

Verification fire exposure R120 Component A



$$t_{fi,1} = \frac{30.0}{0.65} = 46.15 \text{ min}$$

$$t_{fi,2} = \frac{25.0}{1.30} = 19.23 \text{ min}$$

$$t_{fi,3} = \frac{5.0}{0.65} = 7.69 \text{ min}$$

$$t_{fi,4} = \frac{25.0}{1.30} = 19.23 \text{ min}$$

$$t_{fi,5} = \frac{15.0}{0.65} = 23.08 \text{ min}$$

$$t_{fi,6} = \frac{6.0}{1.30} = 4.62 \text{ min}$$

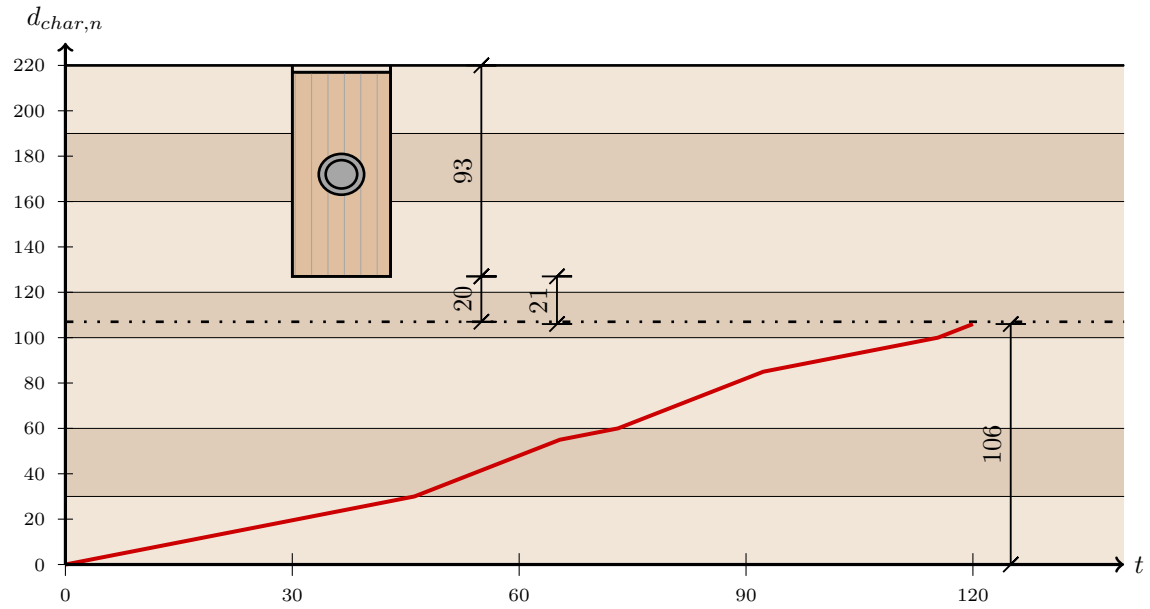
$$t_{fi} = \sum t_{fi,i} = 46.15 + 19.23 + 7.69 + 19.23 + 23.08 + 4.62 = 120 \text{ min}$$

$$d_{char,n} = 30.0 + 25.0 + 5.0 + 25.0 + 15.0 + 6.0 = 106 \text{ mm}$$

Verification fire exposure R120 (Component A):	21 mm $>$ 20 mm	Verification fulfilled

Design module: T17 - HTC-P2P | version 1.0.0:1499 | www.ing-tools.de

Verification fire exposure R120 Component B



$$t_{fi,1} = \frac{30.0}{0.65} = 46.15 \text{ min}$$

$$t_{fi,2} = \frac{25.0}{1.30} = 19.23 \text{ min}$$

$$t_{fi,3} = \frac{5.0}{0.65} = 7.69 \text{ min}$$

$$t_{fi,4} = \frac{25.0}{1.30} = 19.23 \text{ min}$$

$$t_{fi,5} = \frac{15.0}{0.65} = 23.08 \text{ min}$$

$$t_{fi,6} = \frac{6.0}{1.30} = 4.62 \text{ min}$$

$$t_{fi} = \sum t_{fi,i} = 46.15 + 19.23 + 7.69 + 19.23 + 23.08 + 4.62 = 120 \text{ min}$$

$$d_{char,n} = 30.0 + 25.0 + 5.0 + 25.0 + 15.0 + 6.0 = 106 \text{ mm}$$

Verification fire exposure R120 (Component B):	21 mm $>$ 20 mm	Verification fulfilled

Design module: T17 - HTC-P2P | version 1.0.0:1499 | www.ing-tools.de

Compilation of results

Verifications of the connector in the component A

Static: Verification on shear:	$\frac{F_{v,d}}{n * R_{v,d}} = \frac{22.00}{1 * 31.27} =$	$0.70 \leq 1.00$
Fire: Verification on shear:	$\frac{F_{v,d,fi}}{n * R_{v,d,fi}} = \frac{16.00}{1 * 49.69} =$	$0.32 \leq 1.00$
Seismic: Verification on shear:	$\frac{F_{v,Ed}}{n * R_{v,Ed}} = \frac{30.00}{1 * 49.69} =$	$0.60 \leq 1.00$
Static: Verification in tension:	$\frac{F_{t,d}}{n * R_{t,d}} = \frac{8.00}{1 * 27.21} =$	$0.29 \leq 1.00$
Fire: Verification in tension:	$\frac{F_{t,d,fi}}{n * R_{t,d,fi}} = \frac{8.00}{1 * 43.23} =$	$0.19 \leq 1.00$
Seismic: Verification in tension:	$\frac{F_{t,Ed}}{n * R_{t,Ed}} = \frac{12.00}{1 * 33.25} =$	$0.36 \leq 1.00$
Static: Combined forces:	$\left(\frac{F_{v,d}}{n * R_{v,d}}\right)^{\kappa} + \left(\frac{F_{t,d}}{n * R_{t,d}}\right)^{\kappa} =$	$1.00 \leq 1.00$
Fire: Combined forces:	$\left(\frac{F_{v,d,fi}}{n * R_{v,d,fi}}\right)^{\kappa} + \left(\frac{F_{t,d,fi}}{n * R_{t,d,fi}}\right)^{\kappa} =$	$0.51 \leq 1.00$
Seismic: Combined forces:	$\left(\frac{F_{v,Ed}}{n * R_{v,Ed}}\right)^{\kappa} + \left(\frac{F_{t,Ed}}{n * R_{t,Ed}}\right)^{\kappa} =$	$0.96 \leq 1.00$
Verification fire exposure R120:	21 mm $>$ 20 mm	Verification fulfilled

Verifications of the connector in the component B

Static: Verification on shear:	$\frac{F_{v,d}}{n * R_{v,d}} = \frac{22.00}{1 * 31.27} =$	$0.70 \leq 1.00$
Fire: Verification on shear:	$\frac{F_{v,d,fi}}{n * R_{v,d,fi}} = \frac{16.00}{1 * 49.69} =$	$0.32 \leq 1.00$
Seismic: Verification on shear:	$\frac{F_{v,Ed}}{n * R_{v,Ed}} = \frac{30.00}{1 * 49.69} =$	$0.60 \leq 1.00$
Static: Verification in tension:	$\frac{F_{t,d}}{n * R_{t,d}} = \frac{8.00}{1 * 27.21} =$	$0.29 \leq 1.00$
Fire: Verification in tension:	$\frac{F_{t,d,fi}}{n * R_{t,d,fi}} = \frac{8.00}{1 * 43.23} =$	$0.19 \leq 1.00$
Seismic: Verification in tension:	$\frac{F_{t,Ed}}{n * R_{t,Ed}} = \frac{12.00}{1 * 33.25} =$	$0.36 \leq 1.00$
Static: Combined forces:	$\left(\frac{F_{v,d}}{n * R_{v,d}}\right)^{\kappa} + \left(\frac{F_{t,d}}{n * R_{t,d}}\right)^{\kappa} =$	$1.00 \leq 1.00$
Fire: Combined forces:	$\left(\frac{F_{v,d,fi}}{n * R_{v,d,fi}}\right)^{\kappa} + \left(\frac{F_{t,d,fi}}{n * R_{t,d,fi}}\right)^{\kappa} =$	$0.51 \leq 1.00$
Seismic: Combined forces:	$\left(\frac{F_{v,Ed}}{n * R_{v,Ed}}\right)^{\kappa} + \left(\frac{F_{t,Ed}}{n * R_{t,Ed}}\right)^{\kappa} =$	$0.96 \leq 1.00$
Verification fire exposure R120:	21 mm $>$ 20 mm	Verification fulfilled

Governing design verification:	$1.00 \leq 1.00$	**Verification fulfilled**

norms and literature used

EN 1995-1-1:2004 + AC:2006 + A1:2008	Eurocode 5: Design of timber components, part 1-1
FprEN 1995-1-2:2025 (E)	Eurocode 5: Design of timber structures, Part 1-2 Final Draft V0 FV 2025-06-04
EN 1998-1:2014 + AC:2009 + A1:2013	Eurocode 8: Design of buildings against earthquakes, Part 1
ETA-24/1199 dated 18.12.2025	Timber Connector HTC-P2P Hilti Aktiengesellschaft, 9494 Schaan, Liechtenstein
TR085 - February 2025	EOTA - Technical Report Design of Point Connectors - Dovetails made of plywood for cross laminated timber

Installation tools



Torque impact wrench - SIW 6AT-A22



Adapter M12 SW19 offset

Remarks and your Cooperation Duties

- Any and all information and data contained in the Software concern solely the use of Hilti products and are based on the principles, formulas and security regulations in accordance with Hilti's technical directions and operating, mounting and assembly instructions, etc., that must be strictly complied with by the user. All figures contained therein are average figures, and therefore use-specific tests are to be conducted prior to using the relevant Hilti product. The results of the calculations carried out by means of the Software are based essentially on the data you put in. Therefore, you bear the sole responsibility for the absence of errors, the completeness and the relevance of the data to be put in by you. Moreover, you bear sole responsibility for having the results of the calculation checked and cleared by an expert, particularly with regard to compliance with applicable norms and permits, prior to using them for your specific facility. The Software serves only as an aid to interpret norms and permits without any guarantee as to the absence of errors, the correctness and the relevance of the results or suitability for a specific application.
- You must take all necessary and reasonable steps to prevent or limit damage caused by the software. In particular, you must ensure that data is backed up regularly. If you culpably breach this obligation, NR Ingenieurgesellschaft holztragwerke mbH shall not be liable for any resulting consequences, in particular not for the recovery of lost or damaged data.