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Authorised and notified according to Article 29 of the Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011

MEMBER OF EOTA

European Technical Assessment ETA-21/0336 of 2023/04/17

I General Part

Technical Assessment Body issuing the ETA and designated according to Article 29 of the Regulation (EU) No 305/2011: ETA-Danmark A/S

Trade name of the construction product:	best wood CLT BOX
Product family to which the above construction product belongs:	Prefabricated wood-based loadbearing stressed skin panels
Manufacturer:	Holzwerk Gebr. Schneider GmbH Kappel 28 DE-88436 Eberhardzell www.schneider-holz.com
Manufacturing plant:	Holzwerk Gebr. Schneider GmbH Kappel 28 DE-88436 Eberhardzell
This European Technical Assessment contains:	31 pages including 3 annexes which form an integral part of the document
This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of:	EAD 140022-00-0304 for Pre-fabricated wood-based loadbearing stressed Skin Panels
This version replaces:	The ETA with the same number issued on 2022-06-08

II SPECIFIC PART OF THE EUROPEAN TECHNICAL ASSESSMENT

1 Technical description of product

Schneider best wood CLT BOX Elements (hereinafter referred to as “CLT BOX Elements”) are glued stressed skin panels made of glulam ribs and three layer CLT panels. The adhesive is of type I polyurethane adhesive as defined in EN 15425. CLT BOX Elements may contain thermal or acoustic insulation inside the cavities, additional fire protective gypsum plasterboards and roofing. CLT BOX Elements may have cross ribs or additional parallel-to-span ribs. CLT BOX Elements may have a top or bottom CLT panel or both, a top and bottom CLT panel. The materials, dimensions and tolerances are given in Annex 1.

CLT BOX Elements are intended to be used as structural or non-structural elements in buildings and bridges. CLT BOX Elements may function as directly load bearing as well as bracing members e.g. as wall, floor and roof elements.

The products are shaped according to the customer's specification. The maximum length of the elements is 16 m and the height varies from 136 to 500 mm. Typical widths are from 900 mm to 1250 mm.

For gluing the ribs and CLT panels to form a CLT BOX element an adhesive type I according to EN 15425 is to be used. Specifications are deposited with ETA-Danmark A/S.

Chemically treated elements are not covered by this ETA.

Manufacturing
The CLT BOX Elements are manufactured in accordance with the provisions of this European technical assessment using the automated manufacturing process in accordance with the technical documentation. Gluing of ribs to CLT panels shall be performed according to the ETA holder's instructions assessed by ETA-Danmark A/S. Gluing pressure is achieved by pneumatic presses as specified in detail in the instructions of the ETA holder.

2 Specification of the intended use in accordance with the applicable European Assessment Document (hereinafter EAD)

CLT BOX Elements are intended to be used as directly load bearing parts of building constructions. They may also be used as diaphragms for bracing. CLT BOX Elements are supported below the lower CLT panel or below the ribs for elements without lower CLT panel. Reinforced notched beam supports are also permitted. The CLT BOX Elements shall be subjected to static and quasi static actions only. This includes seismic actions according to EN 1998-1.

With regard to moisture behaviour of the product, the use is limited to service classes 1 and 2 as defined in EN 1995-1-1. The product shall not be used in service class 3 / use class 3 (3.1 exterior, above ground, protected; occasionally wet). If CLT BOX Elements are intended to be a part of the external envelope of the building, they shall be protected adequately, e.g. by a roof or by cladding.

If the elements are intended to be covered by flooring, it is recommended that the moisture content of the top CLT panel is checked by a moisture meter; moisture content of the CLT panel should not exceed the value recommended by the manufacturer of the flooring material.

CLT BOX Elements with reinforced holes in ribs to provide openings for ducts, pipes etc. are covered by this ETA. CLT BOX Elements with unreinforced holes, modification or repair of the construction are not covered by this ETA.

The provisions made in this European Technical Assessment are based on an assumed intended working life of CLT BOX Elements of 50 years.

The real working life may be, in normal conditions, considerably longer without major degradation affecting the essential requirements of the works.

The indications given on the working life cannot be interpreted as a guarantee given by the producer or Assessment Body but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

3 Performance of the product and references to the methods used for its assessment

Characteristic	Assessment of characteristic
3.1 Mechanical resistance and stability (BWR1)	
Mechanical resistance and stiffness	Clause 3.1.1
Dimensional stability	Clause 3.1.2
Durability	Clause 3.1.3
3.2 Safety in case of fire (BWR2)	
Reaction to fire	Clause 3.2.1
Resistance to fire	Clause 3.2.2
External fire performance	No performance assessed
3.3 Hygiene, health and the environment (BWR 3)	
Water vapor permeability and moisture resistance	No performance assessed
Watertightness	No performance assessed
Content, emission and/or release of dangerous substances	Clause 3.3.1
3.4 Safety and accessibility in use (BWR 4)	
Impact resistance	No performance assessed
3.5 Protection against noise (BWR 5)	
Airborne sound insulation	Annex 3
Impact sound insulation	Annex 3
Sound absorption	No performance assessed
3.6 Energy economy and heat retention (BWR 6)	
Thermal resistance	Clause 3.4.1
Air permeability	Clause 3.4.2

3.1 Mechanical resistance and stability

3.1.1 Mechanical resistance and stiffness as well as serviceability

Mechanical resistance and deformations of CLT BOX Elements are determined by one of the following methods:

Method 3a: Reference to design documents of the purchaser
Method 3b: Reference to design documents produced and held by the manufacturer according to the order for the works

The structural performance of CLT BOX Elements is considered in accordance with the limit state design principles specified in Eurocodes and is described in detail in the manufacturer's instructions for design. Both ultimate limit state and serviceability limit state (comprising vibrations when relevant) are considered. Calculation methods comply with EN 1995-1-1.

CLT BOX Elements may be used in seismic areas if designed adequately. The use is limited to non-dissipative or low-dissipative structures ($q \leq 1.5$), defined according to Eurocode 8 (EN 1998-1:2004) clauses 1.5.2 and 8.1.3 b), and applicable national rules on works.

Structural design shall be documented. Strength values of glulam and CLT to be used in design together with information of the dimensions of the components are given in Annex 1.

3.1.2 Dimensional stability
In normal conditions, harmful deformations due to moisture changes of the CLT BOX Elements are not expected. When necessary, the dimensional change ΔL of a rib or CLT panel due to change of moisture content may be calculated as for the constitutive materials glulam and CLT.

3.1.3 Durability
CLT BOX Elements may only be used in service classes 1 and 2 according to EN 1995-1-1, and hazard classes 1 and 2 as specified in EN 335. The designer shall pay attention to the construction details and prevent any water accumulation by structural detailing. During the erection of the building, CLT BOX Elements have good resistance to temporary exposure to water without decay, provided that they are allowed to dry afterwards. Integrity of the bond is maintained in the assigned service classes throughout the expected life of the structure.

3.2 Safety in case of fire

3.2.1 Reaction to fire

Untreated products are classified to have reaction to fire class D-s2, d0 in accordance with EN 13501-1 and Commission Delegated Regulation 2016/364.

CLT BOX Elements treated against fire are not covered by this ETA.

3.2.2 Resistance to fire

Fire design of CLT BOX Elements shall be performed according to standards EN 1995-1- 2:2004/AC:2009 and EN 1995-1-1:2004. National determined parameters valid in the relevant Member State shall be used

CLT BOX Elements are classified according to EN 13501-2. Annex 2 provides the classification and field of application.

Charring rate for CLT shall be applied as per ETA-21/0568.

Charring rate for the glued laminated ribs shall be taken from EN1995-1-2, table 3.1.

Passage of fire to the end of the element has to be prevented. In addition, the lower CLT panel may not have such holes that can act as passages for fire to the cavity inside the CLT BOX Elements.

Note: Alternatively, fire design can also be performed in accordance with Eurocode 5. Aspects related to this are not included in this ETA

3.3 Content, emission and/or release of dangerous substances

3.3.1 Dangerous substances

Based on the assessment of the Assessment Body, the CLT BOX Elements do not contain harmful or dangerous substances > 0.1 mass %. The use of wood preservatives and flame retardants is excluded. The product does not contain pentachlorophenol, or recycled wood.

The chemical composition of the adhesives for gluing the boards and the finger joints of the individual boards has to be in compliance with the chemical composition deposited at the Technical Assessment Body.

CLT BOX Elements treated against biological attack are not covered by this ETA.

In addition to the specific clauses relating to dangerous substances contained in this European Technical Assessment, there may be other requirements applicable to the products falling within its scope (e.g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the EU Construction Products Directive, these requirements need to also be complied with, when and where they apply.

3.4 Energy economy and heat retention

3.4.1 Thermal resistance

The thermal conductivity λ for the rib material is 0.13 W/(m K) and 0.12 W/(m K) for the CLT panel material according to EN ISO 10456.

The natural density variation of the materials is taken into account in this value.

3.4.2 Air permeability

A construction with CLT BOX Elements, including the joints between the elements, will provide adequate airtightness in relation to the intended use, taking into account both energy economy and heat retention, risk of cold draughts and risk of condensation within the construction. The joints of the panels shall be tightened with a gasket. See Annex 3.

4 Attestation and verification of constancy of performance (AVCP)

4.1 AVCP system

According to the Decision 2000/447/EC of the European Commission, the system of assessment and verification of constancy of performance (see Annex V to the regulation (EU) No 305/2011) is System 1.

5 Technical details necessary for the implementation of the AVCP system, as foreseen in the applicable EAD

Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited at ETA-Danmark prior to CE marking

Issued in Copenhagen on 2023-04-17 by

Thomas Bruun
Managing Director, ETA-Danmark

Annex 1	General and tolerances of dimensions
	best wood CLT BOX

The different cross-section types of CLT BOX Elements and typical cross sections and symbols used are shown in Annexes 1 to 3. The products are individually designed based on the specification of the customer. The maximum length of the elements is 16 m and the height varies from 136 to 500 mm. Top and bottom CLT panels are one-piece CLT panels.

Typical dimensions of the members to be glued together are:

d = 60 to 240 mm
h1 = 100 to 400 mm
t1 = 36 to 60 mm
t2 = 36 to 100 mm

1. Tolerances of dimensions

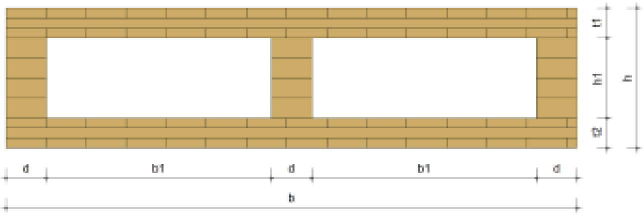
Tolerances of dimensions at the reference moisture content of 12 % are presented in Table 1- 1.

Table 1-1. Tolerances of CLT BOX Elements

Dimension	Tolerance, mm or %
Heigth of the CLT BOX Elements	± 3,0 mm or 1,5 %**
Width of the CLT BOX Elements	± 0,5 %
Length of the CLT BOX Elements	± 5,0 mm

** whichever is the smaller

Annex 1	Product description
	best wood CLT BOX - closed



Total height	h	172 – 500 mm
Rib height	h1	100 – 380 mm
Element width	b	900 – 1250 mm
Rib spacing	b1	0 – 535 mm
Rib width	d	60 – 240 mm
Upper panel thickness	t1	36 – 60 mm
Lower panel thickness	t2	36 – 100 mm
Element length	l	≤ 16 m

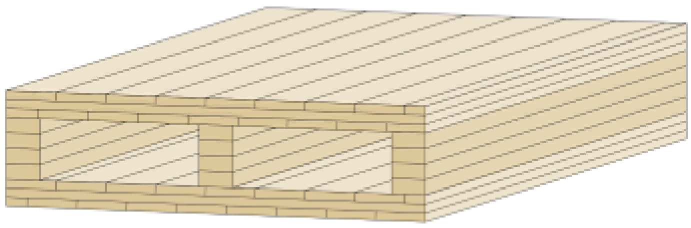
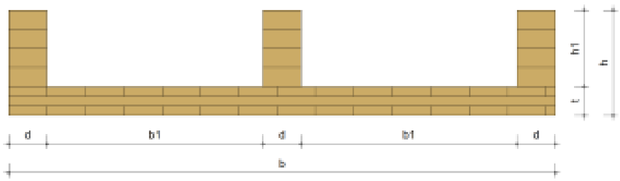


Figure 1-1: Closed type

Annex 1	Product description **best wood CLT BOX** - open



Total height	h	136 – 490 mm
Rib height	h1	100 – 400 mm
Element width	b	900 – 1250 mm
Rib spacing	b1	0 – 535 mm
Rib width	d	60 – 240 mm
Lower panel thickness	t	36 – 100 mm
Element length	l	≤ 16 m

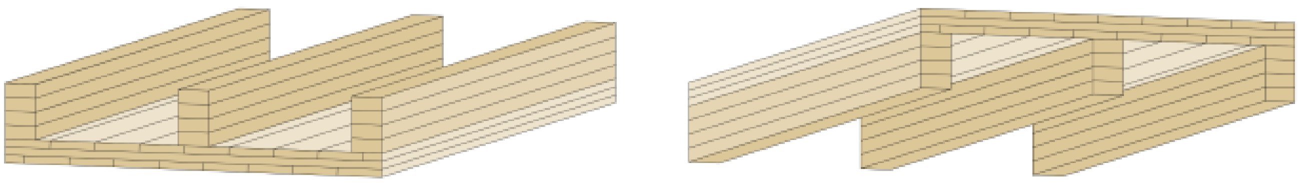
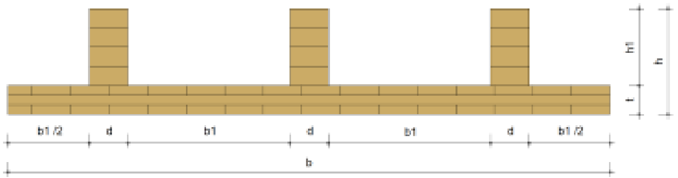


Figure 1-2: Open box with outer webs flush with flange



Total height	h	136 – 490 mm
Rib heigth	h1	100 – 400 mm
Element width	b	900 – 1250 mm
Rib spacing	b1	0 – 357 mm
Rib width	d	60 – 240 mm
Lower panel thickness	t	36 – 100 mm
Element length	l	≤ 16 m

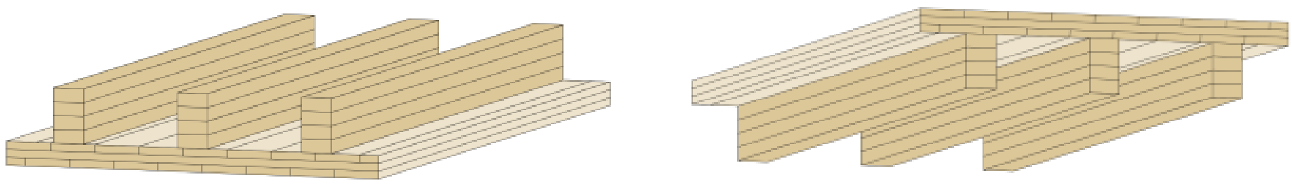
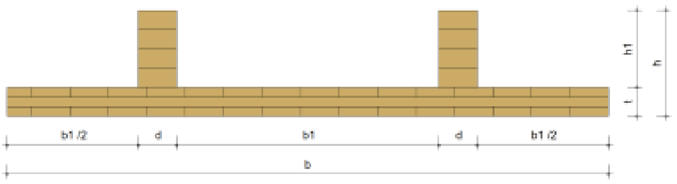


Figure 1-3: Open box with three webs and protruding flange

Annex 1	Product description
	best wood CLT BOX - open



Total height	h	136 – 490 mm
Rib height	h1	100 – 400 mm
Element width	b	900 – 1250 mm
Rib spacing	b1	0 – 535 mm
Rib width	d	60 – 240 mm
Lower panel thickness	t	36 – 100 mm
Element length	l	≤ 16 m

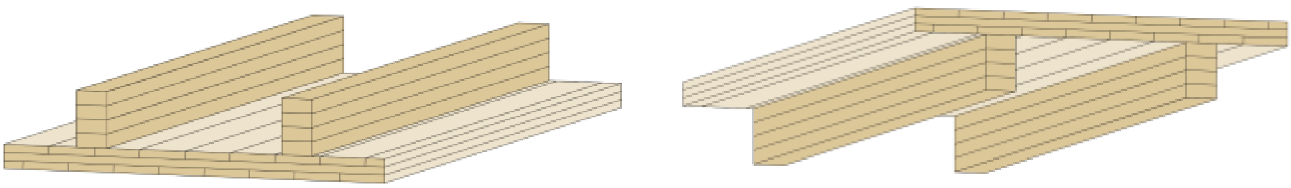
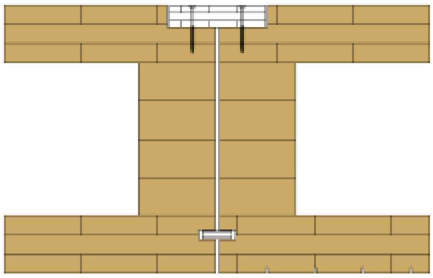


Figure 1-4: Open box with two webs and protruding flange

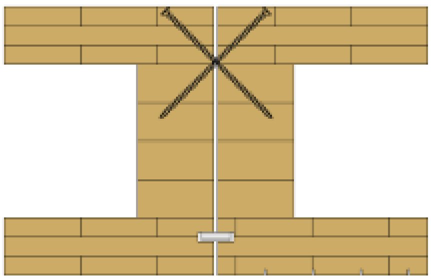
<table>
<tr><td rowspan="2">Annex 1</td><td>Exemplary butt joint</td></tr>
<tr><td>best wood CLT BOX - closed</td></tr>
</table>

The selection, number and arrangement of the mechanical fasteners as well as the thickness of the insert board must be based on static requirements.

<u>butt joint with insert board</u>



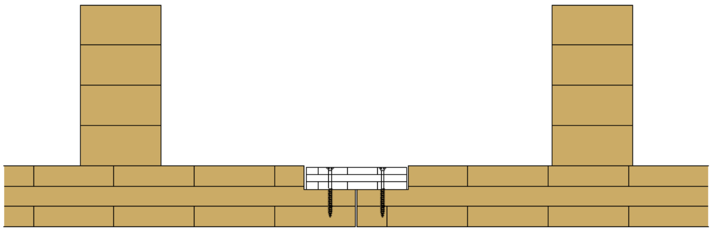
<u>butt joint with screw cross</u>



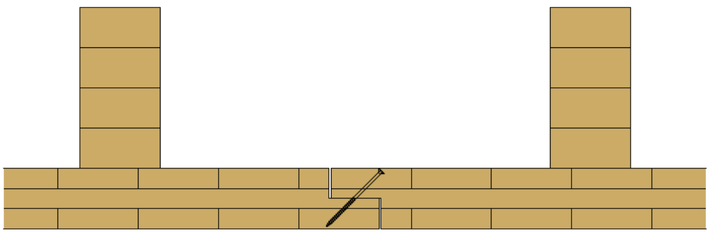
Annex 1	Exemplary butt joint
	best wood CLT BOX - open

The selection, number and arrangement of the mechanical fasteners as well as the thickness of the insert board must be based on static requirements.

butt joint with insert board



butt joint with screw cross



Annex 1	Specifications of components
	best wood CLT BOX

2. Specifications of components

The components are made of glulam according to EN 14080 and CLT according to ETA-21/0568 or EN 16351 produced by Holzwerk Gebr. SCHNEIDER GmbH. Orientation of the CLT panel material is given in Figure 1-1 to 1-4. The characteristic strength and stiffness values comply with EN 14080 and ETA-21/0568 or EN 16351, respectively.

The polyurethane adhesive used in manufacturing CLT BOX Elements is of type I as defined in EN 15425.

The modification factors k_{mod} and k_{def} for glulam and CLT, as defined in Eurocode 5, shall be used in the design of CLT BOX Elements. Partial safety factors γ_m are defined in the National annex of 1995-1-1.
The tensile stresses perpendicular to grain caused by both tensile forces and bending moments in the ribs due to the mass of the acoustic insulation material in the cavities may be taken into account as follows:

$$\frac{\tau_d}{f_{v,d}} + \frac{\sigma_{t,90,d}}{k_{dis} \cdot k_{vol} \cdot f_{t,90,d}} \leq 1$$

Where:

$$\sigma_{t,90,d} = \frac{6 \cdot M_{90,d}}{d^2} + \frac{N_{90,d}}{d}$$

$$M_{90,d} = k_1 \cdot q_d \cdot \frac{(b_1 + d)^3}{12 \cdot b_1} \cdot \left(1 - \frac{u}{2u + w} - \frac{u}{2u + 3w}\right)$$

$$q_d = g_{s,d} + g_{f,d}$$

$g_{s,d}$ permanent design gravel loadperm ^{2} floor area

$g_{f,d}$ permanent design load of the lower flange

k_1 factor taking into account unequal load distribution

$$k_1 = \begin{cases} 1{,}3 & \text{for elements with 3 ribs} \\ 1{,}5 & \text{for elements with 2 ribs} \end{cases}$$

$$u = \frac{E_0 I_f}{b_1 + d} \qquad w = \frac{E_{90} I_w}{h_1}$$

$E_0 I_f$ Bending stiffness of lower CLT panel perp. to longitudinal element axis

E_0 MOE of cross layer parallel to grain

$$I_f = \frac{t_{90}^3}{12}; \text{ where } t_{90} = \text{cross layer thickness}$$

$E_{90} I_w$ Bending stiffness of rib

E_{90} MOE of rib perp. to grain

$$I_w = \frac{d^3}{12}; \text{where } d = \text{ribs width}$$

b_1 Interspace between ribs

h_1 Rib heigth

d Rib width

$$N_{90,d} = k_2 \cdot q_d \cdot \frac{(b_1 + d)^2}{b_1}$$

$$k_2 = \begin{cases} 0{,}5 & \text{for elements without protruding flanges} \\ 1 & \text{for elements with protruding flanges} \end{cases}$$

$$k_{vol} = \left(\frac{V_0}{V}\right)^{0,2}$$

V_0 = 0,01 m³
V = $0{,}65 \cdot d \cdot h_1 \cdot \ell_{element}$
h_1 Rib heigth in m
d Rib width in m
$\ell_{element}$ maximum element span in m
k_{dis} = 2

Since the dimensions of CLT BOX Elements remain quite stable during temperature changes, it is not usually necessary to consider any effects of temperature variations on the structural design.

3. Typical connections between CLT BOX elements

CLT BOX Elements are normally connected to each other with mechanical fasteners (see Annex 1). Diagonal screwing is recommended. CLT BOX Elements shall be designed in such a way that width and thickness changes due to moisture content variation do not cause harmful stresses in the structures. Special attention shall be paid to the design of joints.

4. best wood CLT BOX elements with notched supports, holes and connections loaded perpendicular to the grain

The tensile stresses perpendicular to grain caused by connection forces acting at an angle to the grain in the ribs may be considered as follows:

To take account of the possibility of splitting caused by the tension force component, $F_{Ed} \sin \alpha$, perpendicular to the grain, the following shall be satisfied:

$$F_{90,Ed} \leq F_{90,Rd}$$

where:

$F_{90,Ed}$ is the design tension force component;

$F_{90,Rd}$ is the design splitting capacity, calculated from the characteristic splitting capacity $F_{90,Rk}$;

$$F_{90,Rk} = \frac{k_s \cdot k_{end} \cdot I}{I_1 + S \cdot z_{1s}} \cdot \left(4 + 23 \cdot \frac{a}{h} - 18 \cdot \frac{a^2}{h^2}\right)(b_w \cdot h)^{0,8} \cdot f_{t,90,k}$$

$$k_s = \max\left\{1; 0,7 + \frac{1,4 \cdot a_r}{h}\right\}$$

k_{end} Modification factor for load introduction at member ends within a length h from the member end
  k_{end} = 0,5 if $F_{90,Ed}$ is introduced at the member end of a cantilever or if the force component perpendicular to grain constitutes the member end support,
  k_{end} = 1,0 in all other cases.

a Threaded screw length within stressed skin panel, see Figure 1-5, a ≥ 0,4 h.
h Total heigth of stressed skin panel.
I_1 Effective second moment of area of the upper cross-section above the possible crack line at the screw tips.
I Effective second moment of area of the full cross-section.
S Effective first moment of area of the upper cross-section above the possible crack line at the screw tips.
z_{1s} Distance between the screw tips and the centre of gravity of the upper cross-section above the screw tips.
b_w Sum of rib widths.
a_r Distance parallel to grain between the two outermost screws in Figure 1-5.

Annex 1	Notched supports, holes and connections loaded perpendicular to the grain
	best wood CLT BOX

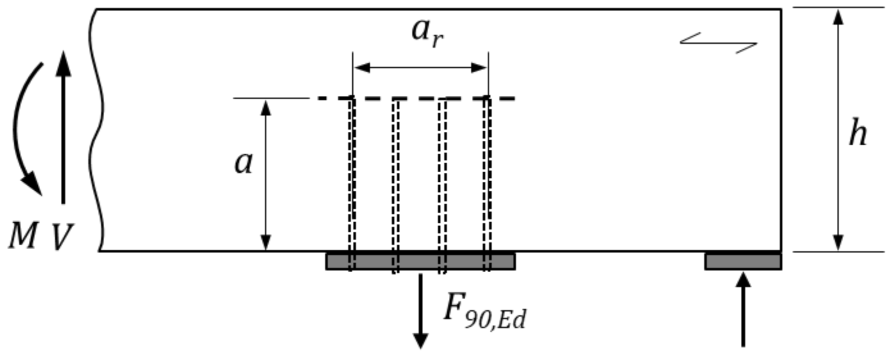


Figure 1-5: Load $F_{90,Ed}$ perpendicular to grain with possible crack line at the screw tips in the ribs of a best wood CLT BOX

For best wood CLT BOX members with a rectangular notch on the same side as the support, see Figure 1-6, the reinforcement may be designed for the design tensile force $F_{t,90,Ed}$:

$$F_{t,90,Ed} = k_\alpha \cdot k_\beta \cdot \left(1 - \frac{I_1 + S \cdot z_{1s}}{I}\right) \cdot V_d$$

Where:

$k_\alpha \quad = 0,9 + 0,5 \cdot (2\alpha - 1)^2$

$k_\beta \quad = 1 + 2\beta$

α is the ratio h_{ef}/h see Figure 1-6, $\alpha \geq 0,35$.

β is the ratio a/h see Figure 1-6.

a is the distance parallel to the grain from the line of action of the support reaction V_d to the corner of the notch.

I_1 Effective second moment of area of the upper cross-section part above the possible crack line at the notch.

I Effective second moment of area of the full cross-section.

S Effective first moment of area of the upper cross-section part above the possible crack line at the notch.

z_{1s} Distance perp. to member axis between the notch and the centre of gravity of the upper cross-section part above the notch.

V_d Support reaction.

For $\alpha \leq 0,6$ and $\beta \leq 0,2$, the product $k_\alpha \cdot k_\beta$ may be taken as $k_\alpha \cdot k_\beta = 1,3$.

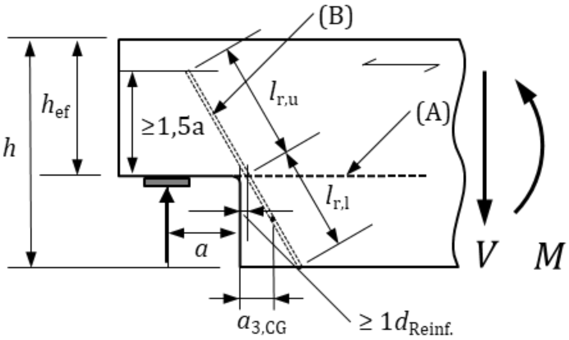


Figure 1-6: Reinforced notched beam support in the ribs of a best wood CLT BOX
(A) Possible crack line
(B) Internal reinforcement by self-tapping fully threaded screws arranged under 60° to the grain

Annex 1	Notched supports, holes and connections loaded perpendicular to the grain
	best wood CLT BOX

For best wood CLT BOX members with a reinforced individual circular or rectangular hole in areas with dominating shear stresses, see Figure 1-7 and Figure 1-8, the reinforcement may be designed for the design tensile force $F_{t,90,Ed}$:

$$F_{t,90,Ed} = F_{t,90,V,Ed} + F_{t,90,M,Ed}$$

The reinforced hole may be considered individual, if the clearance ℓ_z between adjacent holes, see Figure 1-9, fulfils the following condition:

$$\ell_z \geq \max\{1,5 \cdot h; 300\,mm\}$$

Where:

$$F_{t,90,V,Ed} = \frac{I_{1,centre} + S_{centre} \cdot z_{1s,centre} - I_{1,split} - S_{split} \cdot z_{1s,split}}{I} \cdot k_{hole} \cdot V_d \quad \text{for quadrant I}$$

$$F_{t,90,V,Ed} = \frac{I_{1,split} + S_{split} \cdot z_{1s,split} - I_{1,centre} - S_{centre} \cdot z_{1s,centre}}{I} \cdot k_{hole} \cdot V_d \quad \text{for quadrant III}$$

I	Effective second moment of area of the full cross-section.
$I_{1,split}$	Effective second moment of area of the upper cross-section part above the possible crack line at the hole.
S_{split}	Effective first moment of area of the upper cross-section part above the possible crack line at the hole.
$z_{1s,split}$	Distance perp. to member axis between the possible crack line and the centre of gravity of the upper cross-section part above the possible crack line.
$I_{1,centre}$	Effective second moment of area of the upper cross-section part above hole centre.
S_{centre}	Effective first moment of area of the upper cross-section part above the hole centre.
$z_{1s,centre}$	Distance perp. to member axis between the hole centre and the centre of gravity of the upper cross-section part above hole centre.
V_d	Shear force at hole edge.

$$k_{hole} = 1,1 + 1,3 \cdot \left[\frac{d_{hole}}{h} - \left(\frac{d_{hole}}{h} \right)^2 \right] \quad \text{for holes with the hole centre on the neutral axis.}$$

$$k_{hole} = 0,1 + \frac{d}{h} + \frac{4,5 \cdot h_r}{h} - \frac{5,0 \cdot h_r^2}{h^2} \quad \text{for holes with the hole centre not on the neutral axis.}$$

d_{hole} = hole diameter d for circular holes, $d \leq 0,3\,h$ and $d \leq 0,5\,h_w$.

$$d_{hole} = 1,25 \cdot h_d + 0,3 \cdot a \cdot \left[\frac{4 \cdot V_d \cdot h}{M_d} - \left(\frac{3 \cdot V_d \cdot h}{M_d} \right)^2 \right] \quad \text{for rectangular holes.}$$

a	Length of rectangular hole, see Figure 1-6, $a \leq 2,5\,h_d$ and $a \leq h_w$.
h_d	Heigth of rectangular hole, see Figure 1-6, $h_d \leq 0,3\,h$ and $h_d \leq 0,5\,h_w$.
h_w	Heigth of stressed skin panel rib.
M_d	Bending moment at hole edge.
h	Total heigth of best wood CLT BOX.
h_r	Distance h_{rl} respectively h_{ru} from the edge of the hole to the edge of the member, see Figure 1-9.

$$F_{t,90,M,Ed} = 0,09 \cdot \frac{M_d}{h} \cdot \left(\frac{d_{hole}}{h} \right)^2 \quad \text{for holes with the hole centre on the neutral axis}$$

$$F_{t,90,M,I,Ed} = \frac{M_d \cdot d}{h^3} \cdot \max \begin{Bmatrix} 0,62\,(0,13d - e) \\ 0,2\,(0,45d - e) \\ 0,3\,(e - 0,08d) \end{Bmatrix} \quad \text{for quadrant I}$$

Annex 1	Notched supports, holes and connections loaded perpendicular to the grain
	best wood CLT BOX

$$F_{t,90,M,III,Ed} = \frac{M_d \cdot d}{h^3} \cdot 0,22\,(e + 0,19d) \qquad \text{for quadrant III}$$

e Eccentricity of the centre of the hole to the neutral axis of the member,
e is negative in the direction of the member edge subjected to (bending) compression,
e is positive in the direction of the member edge subjected to (bending) tension

For members with holes, having their centre located eccentrically to the neutral axis of the member, the following relevant sets of forces, see Figure 1-10, should be used for quadrants I and III:

For positive bending moment: $F_{t,90,V,I} + F_{t,90,M,I}$ $F_{t,90,V,III} + F_{t,90,M,III}$

For negative bending moment: $F_{t,90,V,I} + F_{t,90,M,III}$ $F_{t,90,V,III} + F_{t,90,M,I}$

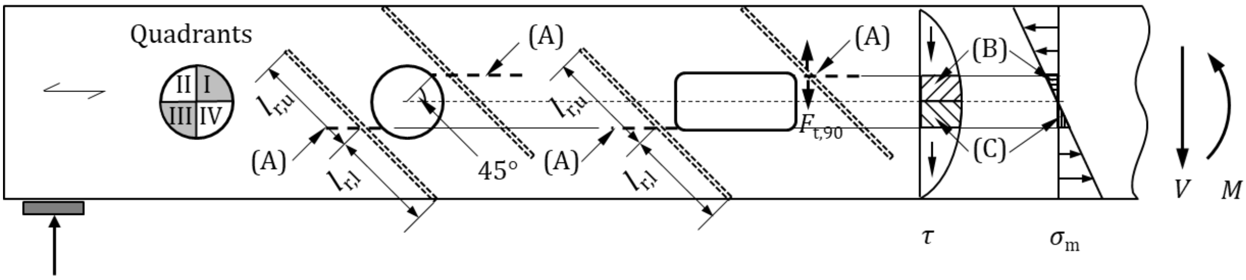


Figure 1-7: Holes in the ribs of a best wood CLT BOX
(A) Possible crack line in locations with high shear stresses ($F_{t,90,V,Ed} \geq F_{t,90,M,Ed}$)
(B) Portion of shear and bending stresses to be transferred around the upper edge of the hole
(C) Portion of shear and bending stresses to be transferred around the lower edge of the hole

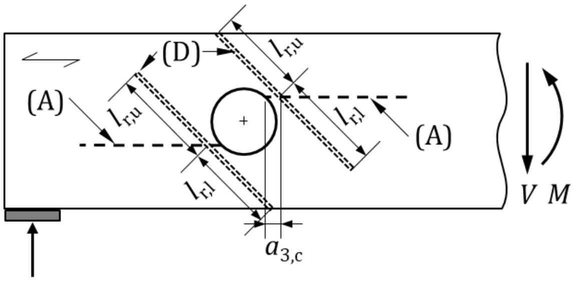


Figure 1-8: Reinforced hole in the ribs of a best wood CLT BOX
(A) Possible crack line
(D) Internal reinforcement by self-tapping fully threaded screws arranged under 45° to the grain

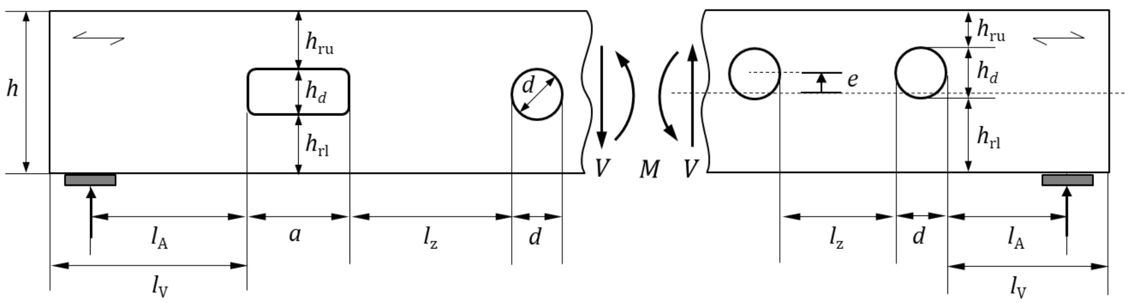


Figure 1-9: Dimensions of holes in the ribs of a best wood CLT BOX

Annex 1	Notched supports, holes and connections loaded perpendicular to the grain
	best wood CLT BOX

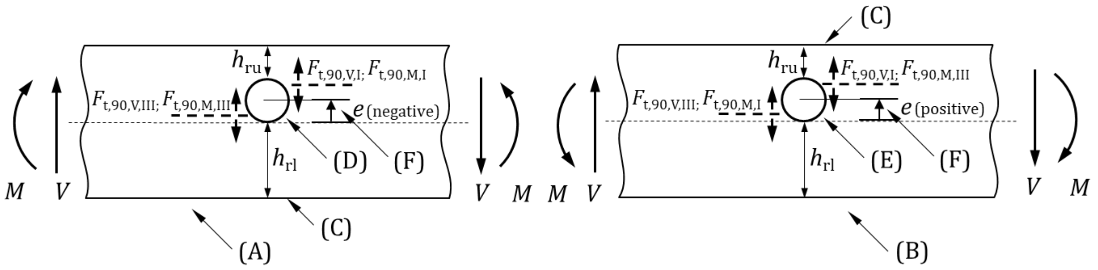
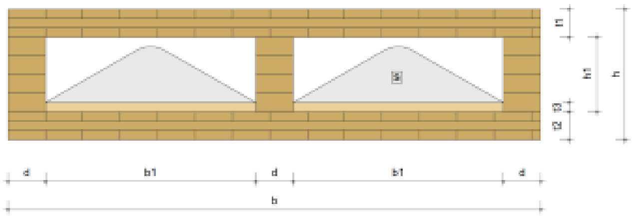


Figure 1-10: Circular hole in a member with positive (left) or negative (right) bending moment
(A) member under positive bending moment (e.g single span beam under vertical load)
(B) member under negative bending moment (e.g. cantilevered beam or continuous beam at supports)
(C) member edge subjected to (bending) tension
(D) hole with eccentricity in direction of the member edge subjected to compression (preferred)
(E) hole with eccentricity in direction of the member edge subjected to tension
(F) eccentricity of the centre of the hole to the centre line of the member,
e is negative in the direction of the member edge subjected to (bending) compression,
e is positive in the direction of the member edge subjected to (bending) tension

Annex 2	**Resistance to fire** of the best wood CLT BOX Elements
	best wood CLT BOX - closed

The structure of closed box type CLT BOX Elements and the orientation of the CLT panels are shown in Annex 1, Figure 1-1. The elements shall be glued with polyurethane adhesive of type I as defined in EN 15425. A floor or roof construction made of CLT BOX Elements with a continuous CLT panel may have resistance to fire class REI 60 if the thickness of the CLT panel is at least 60 mm and REI 90 if the thickness of the CLT panel is at least 90 mm and the following provisions are met:

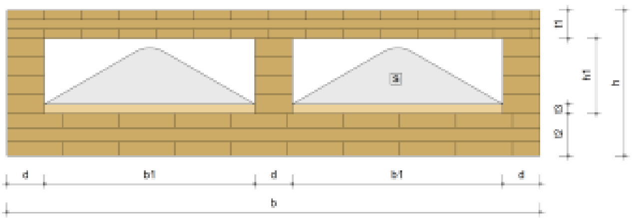
REI 60



Total height	h	≥ 260 mm
Rib height	h1	≥ 140 mm
Rib spacing	b1	≤ 585
Rib width	d	≥ 80 mm
Upper panel thickness	t1	≥ 60 mm
Lower panel thickness	t2	≥ 60 mm
woodfiber „Floor 220“	t3	≥ 22 mm
calcite balast	s	≤ 40 kg/m²

The normal and shear stresses in the glulam ribs and CLT panels must not exceed the relevant stresses in the tested element for REI 60 (width 3756 mm, span 4750 mm, thickness 260 mm) under a uniformly distributed load of 8,0 kN/m².

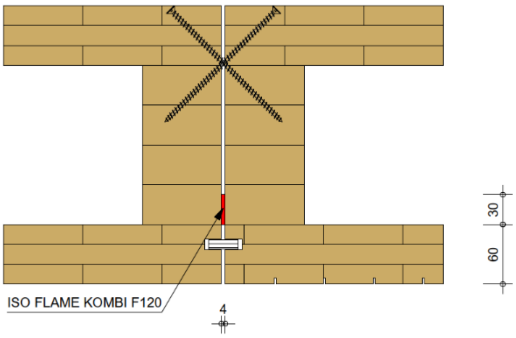
REI 90



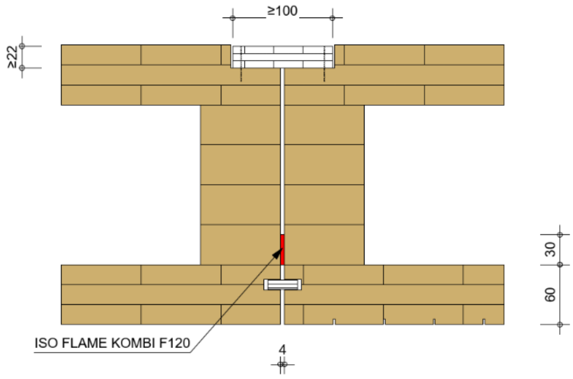
Total height	h	≥ 290 mm
Rib height	h1	≥ 140 mm
Rib spacing	b1	≤ 585
Rib width	d	≥ 80 mm
Upper panel thickness	t1	≥ 60 mm
Lower panel thickness	t2	≥ 90 mm
woodfiber „Multitherm 140“	t3	≥ 20 mm
calcite balast	s	≤ 80 kg/m²

The normal and shear stresses in the glulam ribs and CLT panels must not exceed the relevant stresses in the tested element for REI 90 (width 3756 mm, span 4750 mm, thickness 290 mm) under a uniformly distributed load of 5,5 kN/m².

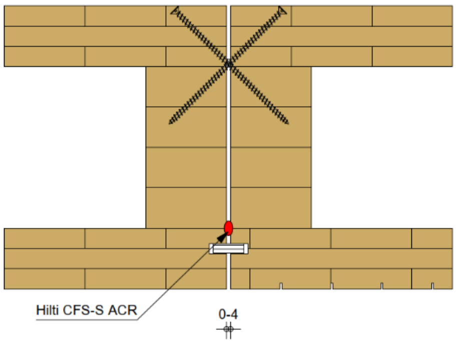
Annex 2	**Butt joints** with requirements on resistance to fire
	REI 60



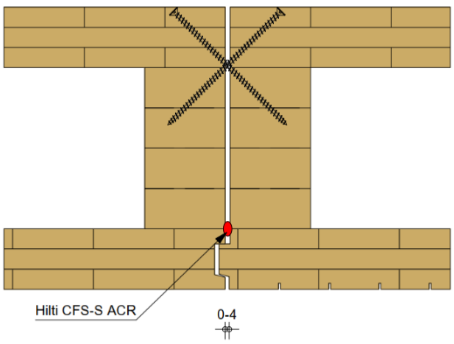
Element height	≥	220 mm
ISO FLAME KOMBI F120	Typ	30/4-6
screw cross with	≥	ø 6 mm x 120 mm
HECO UNIX-top	a	≤ 1000 mm



Element height	≥	220 mm
ISO FLAME KOMBI F120	Typ	30/4-6
Insert board	≥	100 x 22 mm
stapled with	≥	10,55 x 50
Würth type WN	a	≤ 400 mm

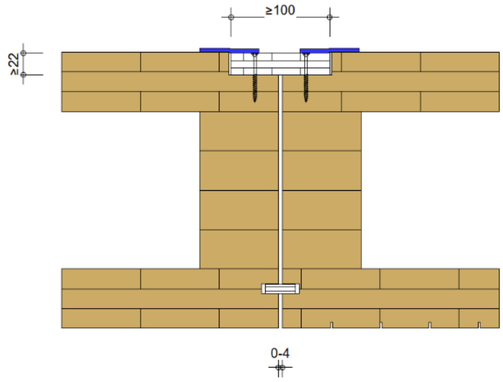


Element height	≥	220 mm
Hilti fire protection acrylic	Typ	CFS-S ACR
screw cross with	≥	ø 6 mm x 160 mm
HECO TOPIX plus	a	≤ 1000 mm

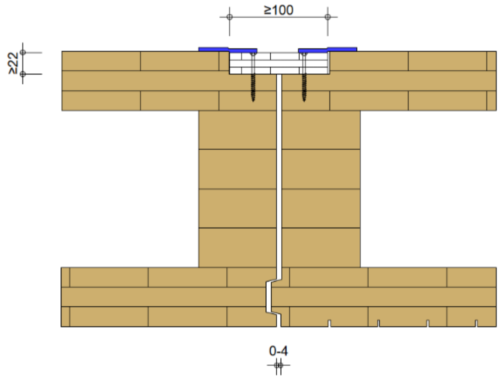


Element height	≥	220 mm
Hilti fire protection acrylic	Typ	CFS-S ACR
screw cross with	≥	ø 6 mm x 160 mm
HECO TOPIX plus	a	≤ 1000 mm

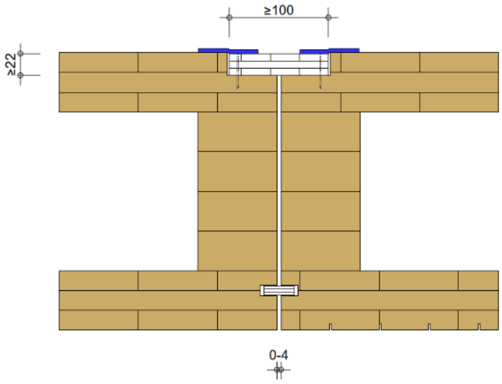
Annex 2	**Butt joints** with requirements on resistance to fire
	REI 60



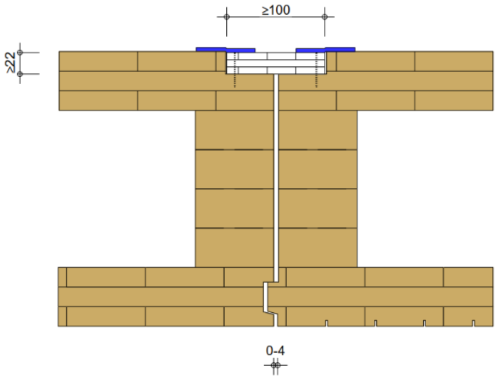
Element height	≥	220 mm
Insert board	≥	100 x 22 mm
screwed with	≥	ø 5 mm x 50 mm
Würth Assy 3.0	a	≤ 350 mm
Sealing top with TESCON VANA	b	≥ 60 mm



Element height	≥	220 mm
Insert board	≥	100 x 22 mm
screwed with	≥	ø 5 mm x 50 mm
Würth Assy 3.0	a	≤ 350 mm
Sealing top with TESCON VANA	b	≥ 60 mm

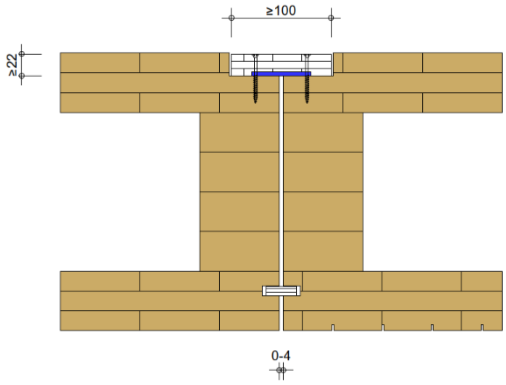


Element height	≥	220 mm
Insert board	≥	100 x 22 mm
stapled with	≥	10,55 x 50 mm
Würth type WN	a	≤ 200 mm
Sealing top with TESCON VANA	b	≥ 60 mm

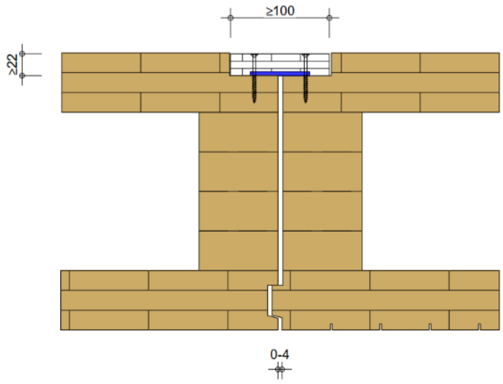


Element height	≥	220 mm
Insert board	≥	100 x 22 mm
stapled with	≥	10,55 x 50 mm
Würth type WN	a	≤ 200 mm
Sealing top with TESCON VANA	b	≥ 60 mm

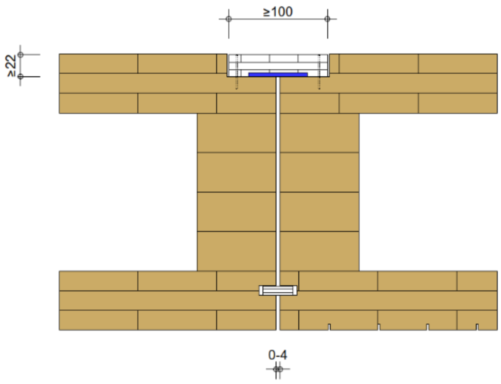
Annex 2	**Butt joints** with requirements on resistance to fire **REI 60**



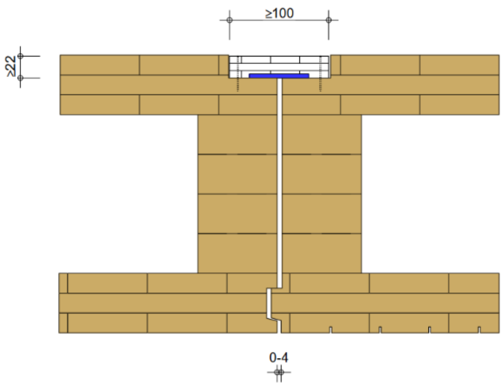
Element height	≥	220 mm
Insert board	≥	100 x 22 mm
screwed with	≥	ø 5 mm x 50 mm
Würth Assy 3.0	a	≤ 350 mm
Sealing bottom with TESCON VANA	b	≥ 60 mm



Element height	≥	220 mm
Insert board	≥	100 x 22 mm
screwed with	≥	ø 5 mm x 50 mm
Würth Assy 3.0	a	≤ 350 mm
Sealing bottom with TESCON VANA	b	≥ 60 mm

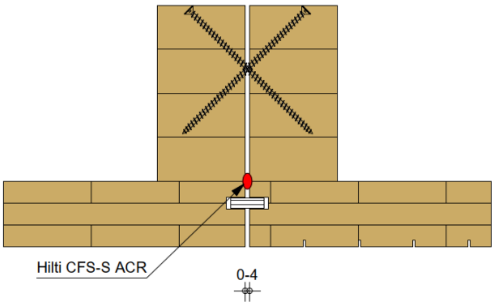


Element height	≥	220 mm
Insert board	≥	100 x 22 mm
stapled with	≥	10,55 x 50 mm
Würth type WN	a	≤ 200 mm
Sealing bottom with TESCON VANA	b	≥ 60 mm

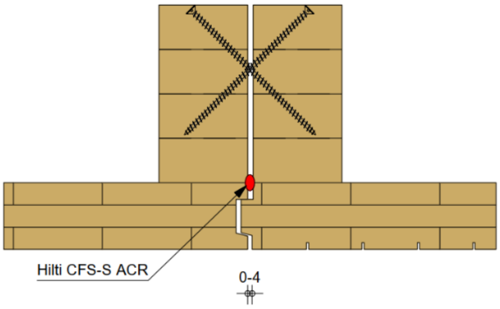


Element height	≥	220 mm
Insert board	≥	100 x 22 mm
stapled with	≥	10,55 x 50 mm
Würth type WN	a	≤ 200 mm
Sealing bottom with TESCON VANA	b	≥ 60 mm

Annex 2	**Butt joints** with requirements on resistance to fire
	REI 60

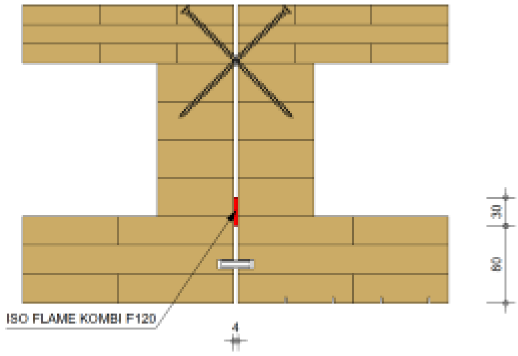


Element height	≥	160 mm
Hilti fire protection acrylic	Typ	CFS-S ACR
screw cross with	≥	ø 6 mm x 160 mm
HECO TOPIX plus	a	≤ 1000 mm

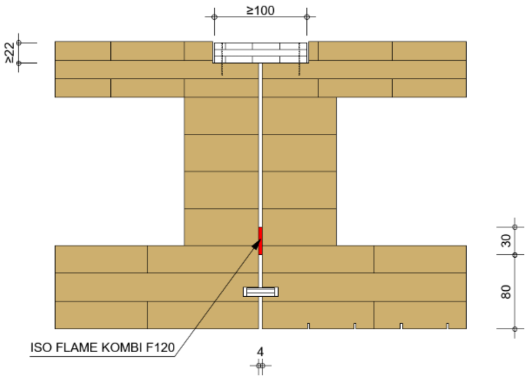


Element height	≥	160 mm
Hilti fire protection acrylic	Typ	CFS-S ACR
screw cross with	≥	ø 6 mm x 160 mm
HECO TOPIX plus	a	≤ 1000 mm

Annex 2	**Butt joints** with requirements on resistance to fire **REI 90**

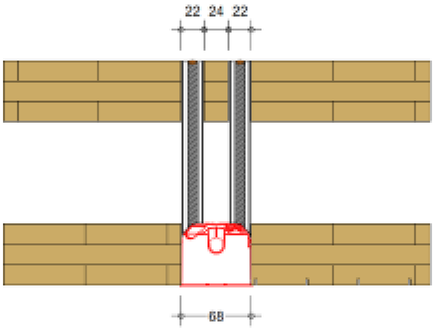


Element height	≥	220 mm
ISO FLAME KOMBI F120	Typ	30/4-6
screw cross with	≥	ø 6 mm x 120 mm
HECO UNIX-top	a	≤ 1000 mm



Element height	≥	220 mm
ISO FLAME KOMBI F120	Typ	30/4-6
Insert board	≥	100 x 22 mm
stapled with	≥	10,55 x 50
Würth type WN	a	≤ 400 mm

Annex 2	**Openings** and **installations** with requirements on resistance to fire
	EI 30



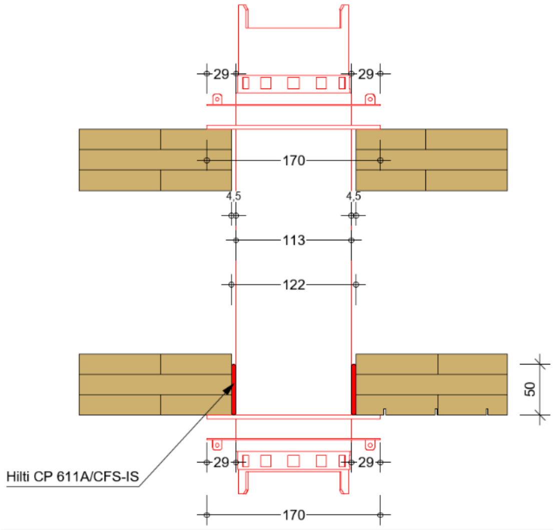
Element height	≥	220 mm
f-tronic fire protection socket	Typ	BS3700TC/BS3500TC
cable or empty pipe*	≤	ø 22 mm

*possible variants

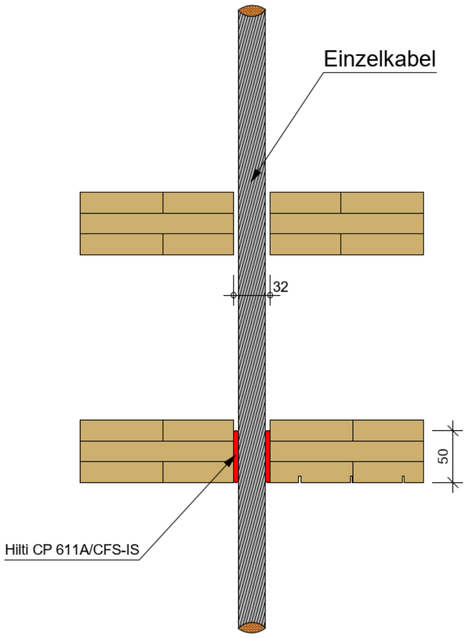
cable: max. 2 with each 5x2,5mm²

empty pipe: max. 2 with each ø ≤ 20 mm

<table>
<tr><td rowspan="2">Annex 2</td><td>Openings and installations with requirements on resistance to fire</td></tr>
<tr><td>EI 60</td></tr>
</table>

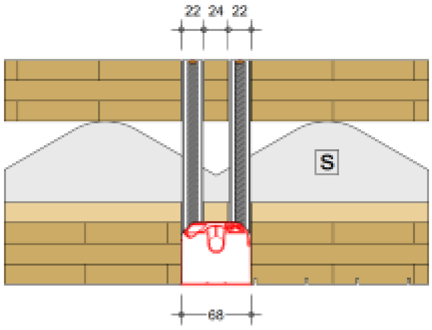


Element height	≥	220 mm
Hilti fire protection sleeve	Typ	CFS-SL GA
Hilti fire protection sealant	Typ	CP 611A/CFS-IS



Element height	≥	220 mm
cable*	≤	ø 32 mm
Hilti fire protection sealant	Typ	CP 611A/CFS-IS
*possible variants		
cable:	1x	A1
	1x	A3
	1x	A1 + A3

Annex 2	**Openings** and **installations** with requirements on resistance to fire
	EI 60



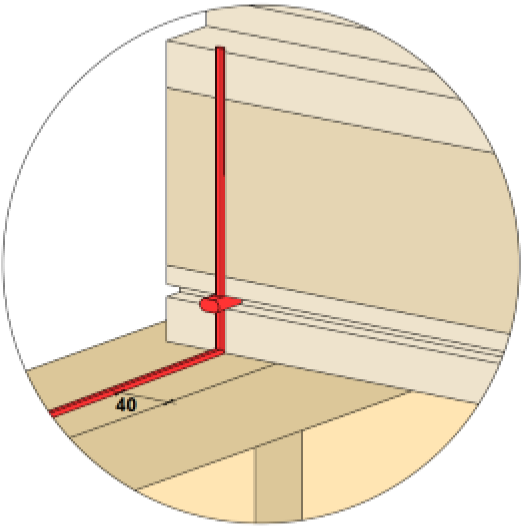
Element height	≥	220 mm
f-tronic fire protection socket	Typ	BS3700TC/BS3500TC
cable or empty pipe*	≤	ø 22 mm
woodfiber „Floor 220“	≥	22 mm
calcite balast „S“	≤	40 kg/m²

*possible variants

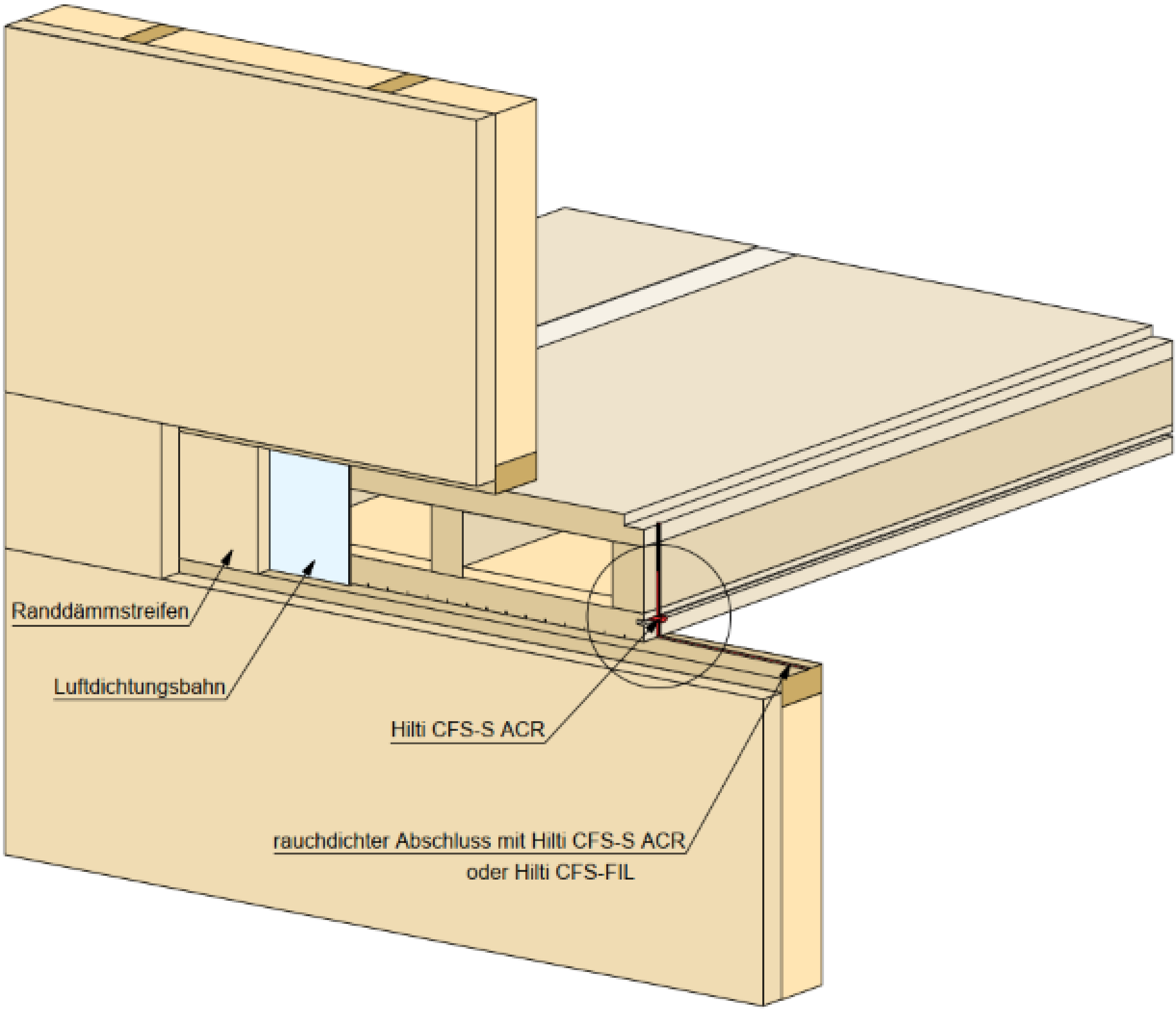
cable: max. 2 with each 5x2,5mm²

empty pipe: max. 2 with each ø ≤ 20 mm

Annex 2	**Bearing** with requirements on resistance to fire
	EI 60

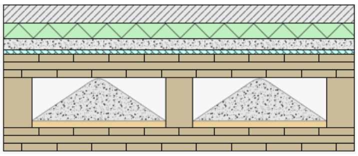
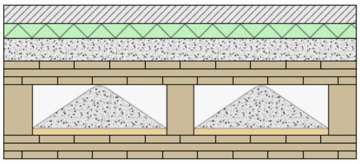
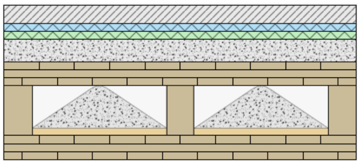
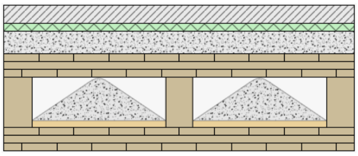
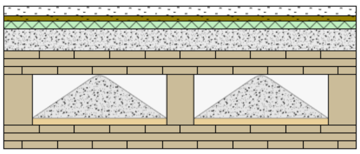
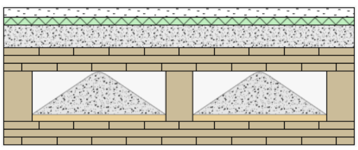


Hilti fire protection acrylic /	Typ	CFS-S ACR
fire protection filler	Typ	CFS-FIL
Distance to the inner egde of the wall	≥	40 mm



Annex 3	Protection against noise of CLT BOX Elements **best wood CLT BOX** - closed

Laboratory measurement of Airborne sound insulation and impact sound insulation according to EN ISO 10140-2 and EN ISO 10140-3.

Sectional drawing	Components	Airborne sound insulation R_w $(C ; C_{tr})$ in dB	Impact sound insulation $L_{n,w}$ $(C_I ; C_{I,50-2500})$ in dB
	50 mm screed 40 mm ISOVER Akustic EP1 30 mm calcite ballast 10 mm Silent Floor Evo 260 mm CLT BOX - CEILING FS	70 (-1 ; -5)	43 (0 ; +2)
	50 mm screed 40 mm ISOVER Akustic EP1 60 mm calcite ballast 260 mm CLT BOX - CEILING FS	72 (-1 ; -5)	43 (-2 ; +1)
	50 mm screed 20 mm Tackerplatte 20-2 20 mm ISOVER Akustic EP1 60 mm calcite ballast 260 mm CLT BOX - CEILING FS	73 (-2 ; -6)	42 (-1 ; +2)
	50 mm screed 20 mm ISOVER Akustic EP1 60 mm calcite ballast 260 mm CLT BOX - CEILING FS	72 (-1 ; -5)	43 (-1 ; +3)
	25 mm Fermacell dry screed 12,5 mm PhoneStar TRI 20 mm ISOVER Akustic EP3 60 mm calcite ballast 260 mm CLT BOX - CEILING FS	66 (-3 ; -10)	47 (0 ; +5)
	25 mm Fermacell dry screed 20 mm ISOVER Akustic EP3 60 mm calcite ballast 260 mm CLT BOX - CEILING FS	65 (-4 ; -11)	51 (0 ; +4)

Annex 3	Protection against air permeability of CLT BOX Elements **best wood CLT BOX**

Air permeability CLT Flange

The best wood CLT flanges with 60 mm minimum thickness tested according to EN 1026 and EN 12114 fulfil air permeability class 4 according to EN 12207.